Baseline report

Building an Ecosystem for 21CS Education in STEM

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Project: Building an Ecosystem for 21st Century Skills Education in STEM (BE-21-SKILLED)

Consortium Partners

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University of Belgrade (Serbia)
Momentum marketing services, Ltd (Ireland)
Accreditation Council for Entrepreneurial and Engaged Universities (ACEEU) (Germany)
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INTRODUCTION

The rapid change of technology, growing globalisation and internationalisation, in addition to the shift from industrial to knowledge-based economies, has accelerated the need for 21st century skills (21CS). Well-rounded 21CS are vital in battling an uncertain future and aiding Europe in being more resilient and responding better to looming threats. STEM graduates are often reported to lack 21st century skills by employers, which in turn prevents them from innovating, developing, and adapting in uncertain, volatile times.

The **Be21Skilled project** argues that the introduction of 21CS and their integration into existing curricula has the potential impacts of firstly, creating more competent, job-ready STEM graduates, and secondly, fostering a support system and by extension increasing retention rates of at-risk female STEM students. Therefore, there is a clear need in fostering 21CS by upskilling both STEM HEI teachers and students.

The objectives of the project are to:

1) Facilitate the understanding and identification of 21CS in region-specific and labour-market relevant contexts through multi-stakeholder collaborative efforts (via PR1- Regional Skill Councils Blueprint and Skill Panorama).
2) Foster the HEI teachers' abilities to instil 21CS in their students via training and feedback loops (via PR3: BE-21- SKILLED Teacher Empowerment Program).
3) Enhance the skills among students to increase their employability and capitalise on their innovative potential (via PR5: BE-21-SKILLED Student Pilot and Playbook).
4) Improve the understanding of non-female STEM actors (students, teachers, employers, etc.) on the need to support female STEM students and instil 21CS in them.
5) Innovate the curricula by embedding tools targeted at developing particular skills in students (via PR2: BE-21-SKILLED Toolkit) 6)
6) Actively participate in the dissemination of results and good practices (via PR4: BE-21-SKILLED eCompass).

This report sets the baseline for the first activities of the BE-21-SKILLED project and captures the consultations with external partners involved in the Regional Skill Councils:

- Chapter 1 summarizes the desk research results about status quo on the 21CS.
- Chapter 2 describes the meta-analysis results of the 21CS frameworks.
- Chapter 3 provides the basis for project results approbation at the national level. Firstly, the national context in the two national partner countries in which the project results will be approbated – Latvia and Serbia – is described (chapters 3.1 and 3.2). And secondly, a proposal for a consultation mechanism with the national stakeholders is proposed in the chapter 3.2.

The project team

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1| THE EXISTING 21ST CENTURY SKILLS FRAMEWORKS

Within our desk research, ten 21st century skills (hereinafter – 21CS) frameworks were selected as relevant for the project, based on the following criteria:

- Relevance for the current and future labour market demands and social challenges.
- Based on solid research methodology.
- Internationally developed and recognised.
- Not published earlier than in 2018, considering the impact of rapid transition to digital and green economies on skills demand.

The list of the recent reports describing 21CS frameworks is provided in the Table 1.1.

Table 1.1. Recent reports on the 21st century skills frameworks

Year	Title	Authors	
2018	The Future of Education and Skills. Education 2030	OECD	Link
2018	Skills forecast: trends and challenges to 2030	Cedefop, Eurofound (EK aģentūras)	Link
2018	EntreComp into Action - Get inspired, make it happen: A user guide to the European Entrepreneurship Competence Framework	McCallumn E., Weicht, R., McMullan, L., Price, A.	Link
2020	The Future of Jobs report 2020	World Economic Forum	Link
2020	LifeComp: The European Framework for Personal, Social and Learning to Learn Key Competence	Sala, A., Punie, Y., Garkov, V., Cabrera, M.	Link
2021	The Unbounded University: Unlocking Opportunities Through Online Learning	Coursera	Link
2021	McKinsey Global Surveys, 2021: A year in review	McKinsey & Company	Link
2021	Defining the skills citizens will need in the future world of work.	McKinsey & Company (Dondi, M., Klier, J., Panier, F. & Schubert, J.)	Link
2022	GreenComp The European sustainability competence framework	Bianchi, G., Pisiotis, U., Cabrera Giraldez, M.	Link
2022	DigComp 2.2: The Digital Competence Framework for Citizens - With new examples of knowledge, skills and attitudes	Vuorikari, R., Kluzer, S., Punie, Y.	Link

We now summarise their key findings as relevant to our research:

- **The OECD Learning Framework 2030** (Taguma & Rychen, 2016; OECD, 2018) has been co-created for the OECD Education 2030 project by government representatives and a growing community of partners, including thought leaders, experts, school networks, school leaders, teachers, students and youth groups, parents, universities, local organisations and social partners. It considers environmental, economic and societal challenges. To cope with volatility, uncertainty and ambiguity, the framework promotes resilience (thriving in a structurally imbalanced world), innovation (creating new value to the world) and stainability (keeping the world in balance) (Taguma et.al, 2016).

The **three cross-cutting transformative competencies for 2030** that address the growing need for young people to be innovative, responsible and aware (Taguma et.al, 2016, p.10-13; OECD, 2018, p.5-7):

1. **Creating new value** – innovating to shape better lives, such as creating new jobs, businesses and services, as well as developing new knowledge, insights, ideas, techniques, strategies and solutions and applying them to problems both old and new. Questioning the status quo, collaborating with others and trying to think "outside the box".
2. **Reconciling tensions and dilemmas** – taking into account the many interconnections and inter-relations between seemingly contradictory or incompatible ideas, logics and positions, as well as considering the results of actions from both short- and long-term perspectives. Acquiring a deeper understanding of opposing positions, developing arguments to support own position and finding practical solutions to dilemmas and conflicts.
3. **Taking responsibility** – the ability to reflect upon and evaluate one's own actions in light of one's experience and education, and by considering personal, ethical and societal goals.

- The **OECD Education 2030 Framework** translates these transformative competencies and other key concepts into 36 specific 21CS skills (OECD, 2018, p.18) so that teachers and school leaders can better incorporate them into curricula.

- The **Joint Cedefop-Eurofound Publication on Skills Forecast to 2030** (2018) presents the results of the Cedefop's skill supply and demand projections, based on the current structure of Europe's labour market and potential future trends, along with Eurofound's analysis on the task content of employment, using the jobs monitor approach. The research analyses the trends in occupational demand. The projections imply a fall in physical tasks and an increase in intellectual and social tasks, particularly business literacy, selling/persuading and serving/attending. They also project a large increase in the use of ICT skills with some increase in autonomy and a reduction in routine work (Cedefop, Eurofound, 2018, p.76). In terms of the tasks performed, these three tasks stand out in terms of their projected increase: business literacy, selling/persuading and serving/attending. The biggest overall change in any of the indices was the use of basic ICT skills (one of the means of performing tasks). There was also a projected increase in autonomy and a decline in routine (Cedefop, Eurofound, 2018, p.92-94).

- **The EU EntreComp** is a common reference framework that identifies 15 competences in three key areas that describe what it means to be entrepreneurial. EntreComp offers a comprehensive description of the knowledge, skills and attitudes that people need to be entrepreneurial and create financial, cultural or social value for others. The entrepreneurship competence is increasingly recognised as a competence for life, relevant to personal development and fulfilment, finding and progressing in employment, as well as initiating new ventures ranging from community campaigns, social enterprises to new start-up businesses. In the report by McCallum et al. (2018), entrepreneurship as a competence is defined as 'the capacity to act upon opportunities and ideas to create value for others. The value created can be social, cultural, or financial. EntreComp recognises the opportunity to be entrepreneurial in any situation: from school curriculum to innovating in the workplace, from community initiatives to applied learning at university (McCallum et al., 2018, p.13).

- **Report "The Future of Jobs 2020"** by the World Economic Forum (2020) sheds light on the expected outlook for technology adoption jobs and skills in the next five years, providing provides in-depth information for 15 industry sectors and 26 advanced and emerging countries. It aggregates the views of business leaders—chief executives, chief strategy officers and chief human resources officers–on the frontlines of decision-making regarding human capital with the latest data from public and private sources.

- **The European Union (EU) LifeComp** conceptual framework (Sala et al., 2020) aims at establishing a shared understanding and a common language on the "Personal, Social and Learning to Learn" competences which are key competences according to the EU Recommendation on Key Competences for Lifelong Learning. LifeComp is made up of three intertwined competence areas: 'Personal', 'Social', and 'Learning to Learn'. The report by Sala et al. (2020) stresses the importance of citizens being able to reflect on and develop their personal, social, and learning to learn competences in order to unleash their dynamic potential, self-regulate their emotions, thoughts and behaviours, build a meaningful life, as well as to cope with complexity as thriving individuals, responsible social agents and reflective lifelong learners.

- **The Coursera "Unbounded University" report** (2021) is the only report among the selected that was STEM-specific and offered skillset for each STEM field. The report leverages data from millions of learners on Coursera to identify skills proficiency gaps between students and working professionals that may contribute to the employability gap. The Be21Skilled project team selected TOP 6 skills of working professionals relevant across several STEM fields (see Table 1.2).

Table 1.2. TOP six skills of working professionals across STEM fields

Skills for STEM professionals	Biological Sciences	Computer Science	Enginee-ring	Health Sciences	Mathema-tics and Statistics	Physical Sciences	Score
Statistical programming	X	X	X	X	X	X	**6**
Leadership & management	X	X	X	X	X	X	**6**
Sales	X	X	X	X	X	X	**6**
Communication	X	X	X		X	X	**5**
Computer programming	X	X				X	**3**
Computer graphics			X				1
Design & product				X			1
Probability & statistics				X			1
Finance					X		1
Data analysis	X			X		X	**3**
Data management		X			X		2
Human computer interaction			X				1

Source: Coursera (2021), The Unbounded University.

- **A business survey by McKinsey (2021)** (n=700) show that most of the skills that companies are increasingly focused on developing in their employees are social, emotional, and advanced cognitive. However, research by McKinsey Global Institute (Dondi et al., 2021) identified a set of 56 foundational 21CS skills that will benefit all citizens, based on the survey of 18,000 people in 15 countries. These fall into four main groups: cognitive, interpersonal, self-leadership and digital skills, They are associated with a higher likelihood of employment, higher incomes, and job satisfaction.

- **The EU GreenComp** (Bianchi et al., 2022) identifies a set of sustainability competences to feed into education programmes to help learners develop knowledge, skills and attitudes that promote ways to think, plan and act with empathy, responsibility and care for our planet and for public health. The development of a European sustainability competence framework is one of the policy actions set out in the European Green Deal as a catalyst to promote learning on environmental sustainability in the European Union. Bianchi et al. (2022) defines sustainability competence as "empowering learners to embody sustainability values, and embrace complex systems, in order to take or request action that restores and maintains ecosystem health and enhances justice, generating visions for sustainable futures" (p. 15).

- **The EU DigComp** or the Digital Competence Framework for Citizens, provides a common language to identify and describe the key areas of digital competence. It is an EU-wide tool to improve citizens' digital competence, help policymakers formulate policies that support digital competence building and plan education and training initiatives to improve the digital competence of specific target groups. The aim of the DigComp framework is to create an agreed vision of what is needed in terms of competences to overcome the challenges that arise from digitisation in almost all aspects of modern lives.

All skill frameworks described are current, research-based, internationally recognized. A meta-analysis of the skill frameworks was performed to create a single list of skills that would combine all the skill frameworks mentioned.

2| ELABORATING A 21ST CENTURY SKILLS META FRAMEWORK

In order to conduct a meta-analysis of 21CS frameworks and elaborate one comprehensive set of 21CS skills, the following steps have been made:

1. Sorting of all possible skill names was done into 21 skill groups; each skill group was coded with a number and was given one overall name describing the whole concept of the skill group (see Annex 1).
2. For each skills framework, each skill was assigned a score calculated according to the following formula: year/10-199. Thus, the range of scores for each skill varied between 2.8 (for publications from 2018) and 3.1 (for publications from 2021).
3. The score for each skill was multiplied by the number of mentions across all skills frameworks included in the analysis.
4. As a result, each skill group was assigned a relevance score, which took into account both the publishing year of the source and popularity in various skill frameworks (number of mentions).

Figure 2.1. The list of 21 CS and their relevance score, developed by conducting a meta-analysis of 21CS frameworks published in 2018 – 2022

Source: author's calculations

Thus, a meta 21CS framework was generated ranging skills by their relevance score. The list of 21CS with their relevance scores can be seen in Figure 2.1.

It should be noted that this list of 21 CS has been developed to include general competencies and competencies that apply equally to all areas of STEM education. It does not cover professional skills or skills that are specific only to certain fields or occupations.

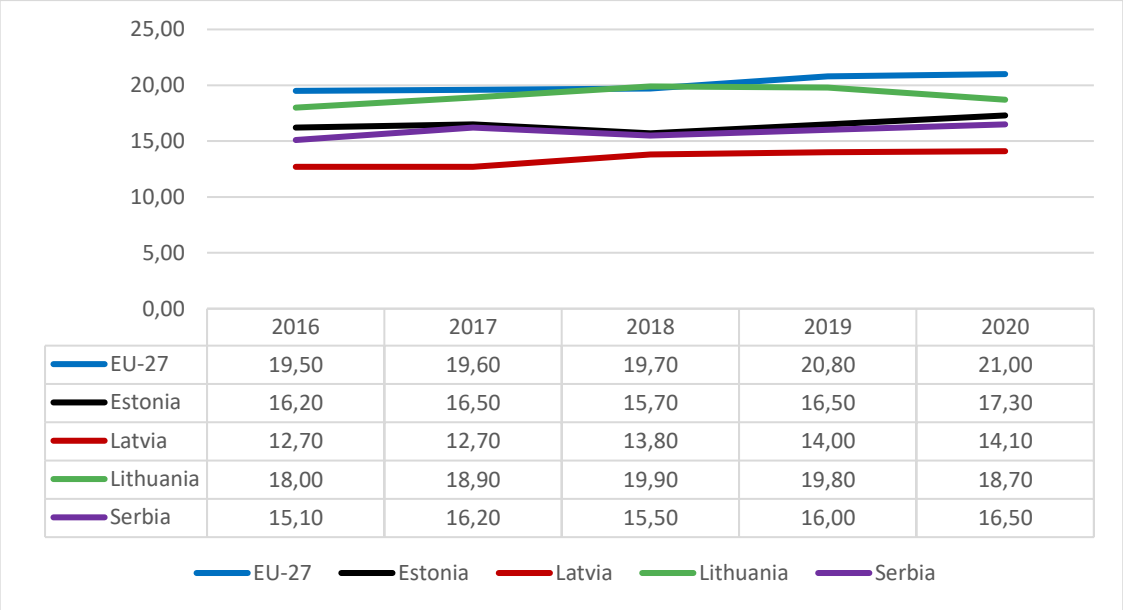
This list of 21CS obtained through meta-analysis of 21CS frameworks served as a basis for developing the Be21Skilled European Employer Survey, aimed at bringing the perspective of employers in determining the most in-demand 21st century skills in the labor market and priority action at the level of universities.

3| APPROBATION AT THE BASELINE LEVEL

To ensure the relevance of the project results to the grassroots level, under the auspices of our ERASMUS+ funded Be21Skilled project**,** the Regional Skills Councils will be created, and the project results will be approbated in two countries: Latvia and Serbia. Considering the national context in terms of STEM fields development and existing consultative mechanisms is important in elaborating the model for sustainable stakeholder consultations and engagement.

3.1. Key data about STEM studies in Latvia and Serbia

The number of graduates in tertiary education in science, maths, computing, engineering, manufacturing and construction (STEM fields) per 1000 of population aged 20-29 in Serbia, Estonia, Lithuania and Latvia are below the EU average (see Figure 3.1).



	2016	2017	2018	2019	2020
EU-27	19,50	19,60	19,70	20,80	21,00
Estonia	16,20	16,50	15,70	16,50	17,30
Latvia	12,70	12,70	13,80	14,00	14,10
Lithuania	18,00	18,90	19,90	19,80	18,70
Serbia	15,10	16,20	15,50	16,00	16,50

Figure 3.1. **Graduates in tertiary education, in science, math., computing, engineering, manufacturing, construction, by sex - per 1000 of population aged 20-29**
Source: "Graduates in tertiary education, in science, math., computing, engineering, manufacturing, construction, by sex - per 1000 of population aged 20-29" by Eurostat, 2022

In Latvia, only 25 % of students at the higher education level study in STEM fields, which is below Lithuania's 28 % and Estonia's 30 % (Kanaviņa, 2022, p.15). At the same time, the proportion of STEM students in the total number of students is gradually increasing, indicating to a positive trend. The Ministry of Education and Science (MoES) and the Ministry of Economics explains this by the availability of budget places for STEM studies, which means that students do not have to pay tuition fees. While the total number of students in Latvia has significantly decreased in the period from 2013-2019, the proportion of STEM students has increased by 3 percentage points (the 4th largest increase within the EU) (Kanaviņa, 2022, p.16; Ministry of Economics, 2022, p.42).

In Serbia, around 39 % of the total student population study in the STEM fields[1], including the fields of agriculture, forestry, fishery and veterinary which belong to the engineering study field in the Serbian higher education classification system (calculations, based on the data of Statistical Office of the Republic of Serbia, 2022b).

High labor market demand for qualified STEM specialists

In the labour market, a significant disproportion between the availability of STEM graduates and labour market demand is predicted in both Latvia and Serbia. The Ministry of Economics of Latvia (2022, p. 106) predicts that by 2030, the shortage of highly qualified specialists in STEM fields may increase to 9.1 thousand.

At the level of higher education, ICT specialists are most in demand on the labour market in Latvia, followed by the science and engineering specialists. Qualified specialists with vocational secondary education in various fields are also in demand in the labor market (see Figure 3.2).

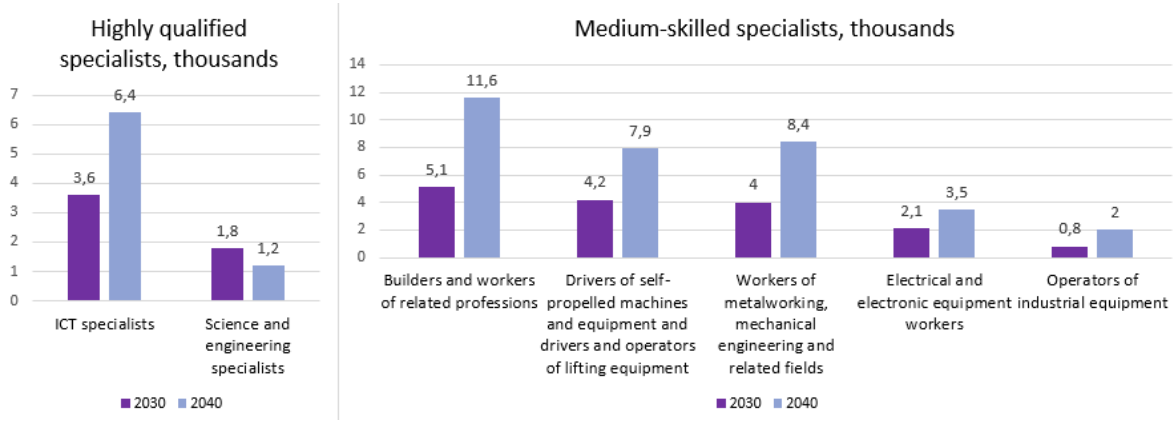


Figure 3.2. **Shortage of qualified workers in Latvia (in thousands, difference between labour market demand and availability of workers)**
Source: "Informative report on mid- and long-term labour market forecasts" by Ministry of Economics, 2022

Similar trends in the labour demands can be also observed in Serbia. Here, the most sought-after profiles with higher education are mechanical, electrical, civil and ICT-computer engineers, according to the interviews with experts from the National Employment Service.

Both countries experience particularly significant qualified labour shortages in the ICT sector explained by the rapid sector's growth. In Latvia, the ICT sector's share in GDP has increased from 3.51 % in 2010 to 5.41 in 2019 (Eurostat, 2022a), and, consequently, the share of the ICT personnel in total employment has increased from 2.05 % in 2010 to 4.13 % in 2019 (Eurostat, 2022b),

[1] Study fields included: Natural Sciences, Mathematics and Statistics; Information and Communications Technology; Engineering, Manufacturing and Construction; Agriculture, Forestry, Fishery and Veterinary

exceeding EU average. A very similar trend can be observed in Serbia. According to Kutlaca et al. (2018), employment in the ICT sector in Serbia increased by 57 % in a 5-year period.

In Serbia, the share of the ICT students is 10 % of the total number of students, which is insufficient number to satisfy the industry's demand. Serbia experiences significant lack of qualified ICT specialists, in particular developers and designers. According to Kleibrink et al. (2018), the Serbian ICT industry also experiences capability issues with respect to non-technical competences such as management and marketing.

High drop-out rate

The insufficient number of graduates in the STEM fields is also significantly affected by the large number of students who drop out during their studies. There is a **high dropout rate** of STEM students in both Latvia and Serbia.

A proportion between number of graduates and the number of enrolled students in STEM fields varies between 0,38 and 0,40 during the period of time between 2016/17 and 2020/21 academic years (Kanaviņa, 2022, p.17). Approximately 28% of students in STEM studies programs drop out each year (Ministry of Economics, 2022, p.71). MoES (Kanaviņa, 2022, p.17) explains it by low competition to enroll in studies, availability of budget places and social benefits that encourage students to enroll but not graduate from study programmes.

In Serbia, there are no national or university-level data on the drop-out rate of STEM students, but this level is unofficially estimated in the range of 40-50 % by collecting separate data from different faculties. Generally, the main reasons for so high level of dropout rate at the largest university in Serbia – the University of Belgrade – is the inadequate prior-knowledge gained at the secondary level of education and high level of poverty. Insufficient number of places in students' dormitories and high prices in Belgrade for renting flats) impose the necessity to many students to find additional full-time jobs which has a very negative impact on students' ability to devote time to studies.

3.1. Gender aspects in STEM education in Latvia and Serbia

Gender aspects in STEM education in Latvia

Although both women and men have the same opportunities to choose education in Latvia, there are significant differences between the sexes in the educational achievements and in the choice of education area. According to the official statistics of Latvia (Central Statistical Bureau, 2022), Education programmes in the STEM fields are more often chosen by men in Latvia at both secondary and higher education level.

Gender differences in higher education:

- On average, more women than men have obtained higher education degree in Latvia: in 2021, 40 % of women in Latvia (by 10.3 percentage points higher than the EU average) and 25 % of men had higher education (by 1.1 percentage points lower than the EU average).
- Study programs in the field of engineering and natural sciences are **more often chosen by men** in Latvia. Although 65 % of total higher education graduates (14.707 persons) in 2021 were women, only almost a third (30 %) of graduates in the STEM fields (natural sciences, mathematics, IT, engineering, production and construction) were female graduates (see Figure 3.3).

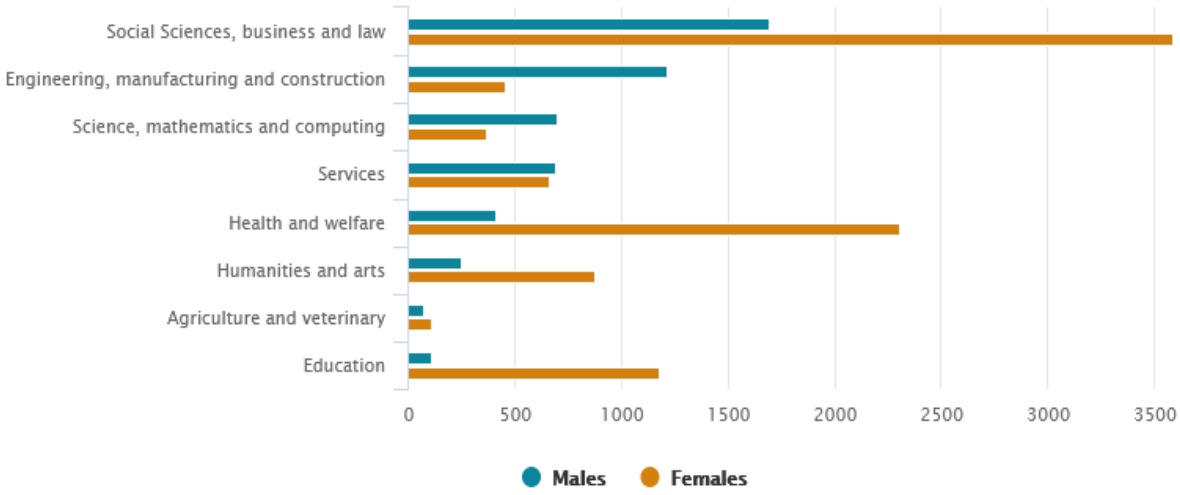


Figure 3.3. **Graduates from higher education institutions and colleges with a degree or qualification by sex and field of education, 2021**
Source: "Gender equality: Education and Science" by Central Statistical Bureau, 2022

Gender differences in doctoral level education and science:

- Number of graduates from doctoral level programmes were similar for females (3.960 female PhD holders) and males (3,755 male PhD holders). Likewise, half (50 %) of scientific personnel in Latvia were women (2020). At the same time the proportion of men in the fields of engineering and technology was 65 % and in natural sciences 54 % – the highest among all fields.

Gender differences in academic achievement and choice of study areas are manifested already in the earlier stages of education. Gender differences in the choice of type and level of education:

- Men predominate in the number of those who have obtained a vocational qualification (secondary or primary level) – 34 % of men and 28 % of women.
- Men are more likely than women not to continue their education after primary education: 9 % of men and 6 % of women aged 18-24 with primary or lower education did not continue their education in 2021.
- Proportion of girls involved in non-mandatory non-formal education programmes (interest education programmes) in STEM fields (e.g., environment, computing and construction and

technical modelling education programmes) in general secondary education schools varies between 24 % and 39 % in 2019/2020 (depending on the type of school) (SIA "Dynamic University" et al., 2021, p.118). These programmes are important in facilitating the interest and advancing the knowledge of young people in STEM subjects.

Gender differences in the choice of educational fields in secondary vocational education (see Figure 3.4):

- VET qualifications in STEM fields are significantly more often obtained by men in Latvia: in natural sciences, mathematics and information technology - 95 % of graduates were men in 2021, in engineering, production and construction - 86 %.
- Women, however, dominate in health care and social welfare programs (93 % of graduates were women) and social sciences, commercial sciences and law programs (76 % were women).
- After graduating from VET, men aged 18-24 most often work in manufacturing and trade (20 % and 18 %, respectively). The most common field of work for women after graduation is trade, as well as accommodation and catering (respectively 29 % and 15 %). The most common occupation for men who graduated from VET institutions is skilled workers and craftsmen (26 % of men graduated from this sector), and for women - service and sales workers (45 %).

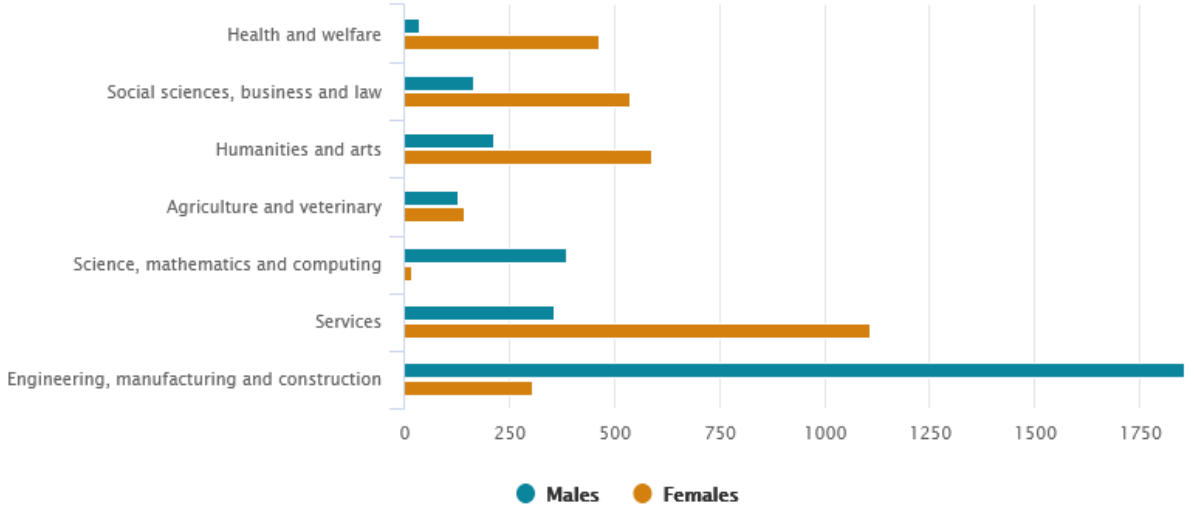
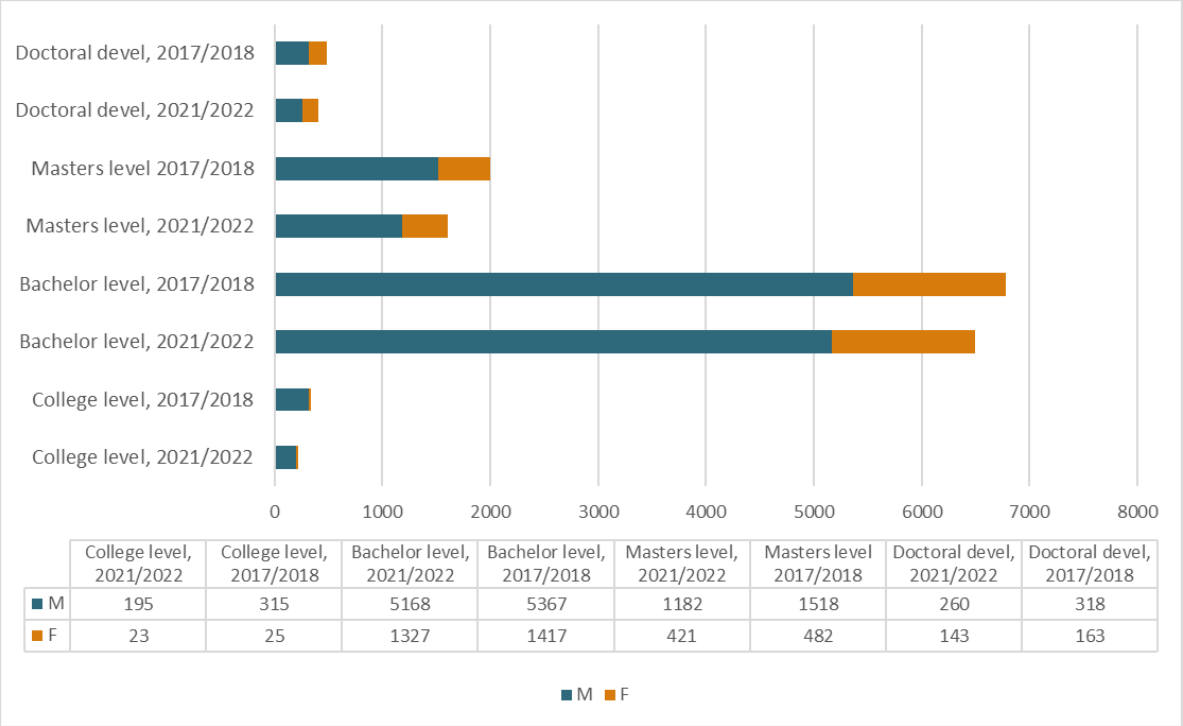


Figure 3.4. **Secondary VET school graduates by sex and field of education, 2021**
Source: "Gender equality: Education and Science" by Central Statistical Bureau, 2022

The number of students at Riga Technical University, which is the largest university in Latvia in terms of the number of STEM students, shows similar trends in the choice of studies by student gender: STEM studies are significantly less popular among women (see Figure 3.5).



	College level, 2021/2022	College level, 2017/2018	Bachelor level, 2021/2022	Bachelor level, 2017/2018	Masters level, 2021/2022	Masters level 2017/2018	Doctoral devel, 2021/2022	Doctoral devel, 2017/2018
M	195	315	5168	5367	1182	1518	260	318
F	23	25	1327	1417	421	482	143	163

Figure 3.5. **Student number in STEM fields at the Riga Technical University, by gender, by level of study, 2017/2018 and 2021/2022 study year**
Source: Riga Technical University, 2022

Regarding gender differences in employment, females more commonly are employed in lower salaried economic activities as well as sectors of national economy having lower average wages and salaries. Industry, transportation, storage, information and communication sectors are economic activities more popular among males, whereas trade as well as education sectors are the most popular among females. The largest share of females may be observed in human health and social care activities (84.7 %), while the largest share of males in construction (90.3 %) (Central Statistical Bureau, 2022a).

In 2021, the average gross hourly earnings of Latvian women were by 14,6 % lower than those of men (Central Statistical Bureau, 2022a).

Research by Stafecka and Tarasova (2020) showed that low participation of females in ICT industry is closely linked to the deeply rooted stereotypes in Latvian society about the technology sector as a field of activity for men. Although the technology industry is generally perceived as a very attractive for employment, girls are significantly less encouraged to pursue ICT careers. Women need to be much more self-motivated to choose this field for studies, as they are more likely to face headwinds based on stereotypes both during the process of obtaining education and later when starting to work in the profession.

Gender aspects in STEM education in Serbia

Similar trends in the choice of STEM fields between both sexes can be observed in Serbia: although overall more women obtain higher education, a smaller proportion of women choose STEM studies.

According to the data of the Statistical office of the Republic of Serbia (2022), in the 2021/22 school year, 243 730 students enrolled at all levels of studies and at all higher education institutions. Among the total number of enrolled students, 102 527 (only 42.1 %) were men and 141 203 (57.9 %) were women. In the 2021 calendar year, 39.956 students graduated at all levels of studies and at all higher education institutions. Of the total number of graduated students, 15 508 (38.8 %) were men and 24 448, (61.2 %) were women.

Despite the predominance of women in higher education in general, females are underrepresented in the STEM fields in Serbia. According to the World Bank, the share of female graduates by field in 2018 was the following:

- In Science, Technology, Engineering and Mathematics (STEM) – 43 %,
- In Engineering, manufacturing and construction – 39 %,
- In Natural Sciences, Mathematics and Statistics – 71 %,
- In Agriculture, Forestry, Fisheries and Veterinary – 49 %.

The Statistical Office of the Republic of Serbia (2022a) provides the following data regarding employed in research and development, by sectors, fields of science and by sex, in 2021:

- In Engineering and technology: females make up 43% of those employed, 42 % of researchers are female and 30 % of researcher assistants are female.
- In Natural sciences: females make up 59 % of those employed, 56 % of researchers are female and 71 % of researcher assistants are female.

Additionally, the study by the Regional Cooperation Council (Risteska et al., 2020), under the chapter “Effective participation and equal opportunities for women in STEM in Serbia”, reports that the total female share of graduates in STEM fields in Serbia is 43 %. In 2016, women accounted for more than a half of all graduates in a large number of fields of education, while men were dominant in the fields of Informatics and Communication Technologies (74 %) and Engineering, manufacturing and civil engineering (63 %). According to the data presented in the paper by Grljević et al. (2019), for the school year 2017/2018, we can observe that the **ICT field is the least attractive field for female students** and that women currently represent only 27 % of Serbia’s ICT students, while the British Council (n.d.) reports that about 20 % of employees in the IT sector in Serbia are women.

According to the available data for the University of Belgrade (UB), gathered within the research in Horizon 2020 project TARGET – 741672 “Taking a Reflexive approach to Gender Equality for Institutional Transformation’’ (https://www.gendertarget.eu/), the Gender Composition of UB

Student Population (Bachelor, All Faculties) in 2017/2018 and 2020/2021 is presented in the Figure 3.6.

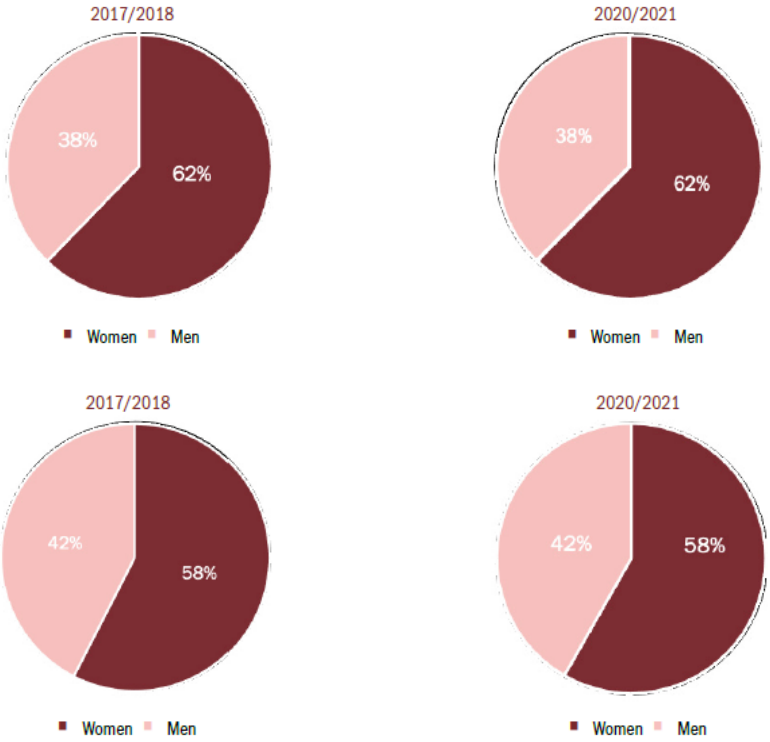


Figure 3.6. **The Gender Composition of student population, University of Belgrade**
Source: Horizon 2020 project TARGET – 741672 "Taking a Reflexive approach to Gender Equality for Institutional Transformation'', https://www.gendertarget.eu/

Once the data is narrowed down to the faculty level, it shows that the gender segregation tendency established previously still exists when it comes to scientific fields traditionally attributed to one gender or the other (technology and engineering as 'male dominated' disciplines vs. e.g. philology as a 'female' discipline). One such extreme example from the academic year 2017/2018 that pertains also to 2020/2021 is found at the Faculty of Mechanical Engineering, where men still make up for the majority of students at all levels (Figure 3.6).

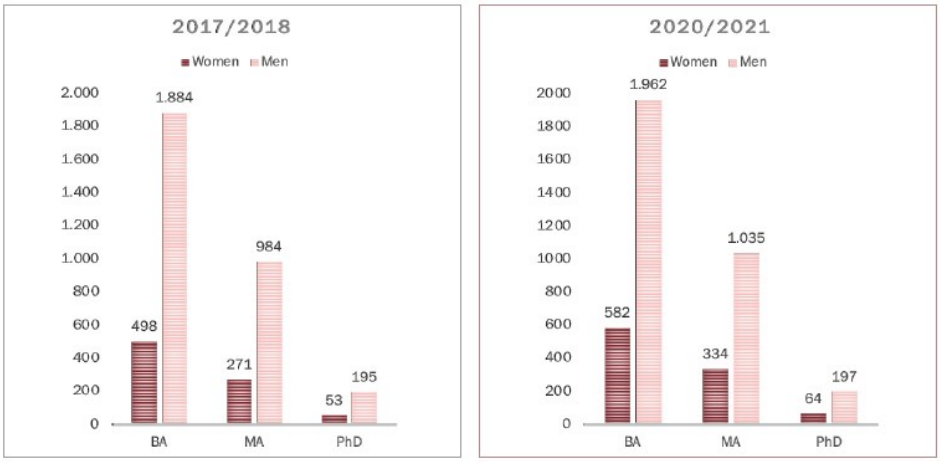


Figure 3.6. **The Gender Composition of student population, University of Belgrade, Faculty of Mechanical Engineering**

Source: Horizon 2020 project TARGET – 741672 "Taking a Reflexive approach to Gender Equality for Institutional Transformation'', https://www.gendertarget.eu/

Thus, the gender distribution of students at the University of Belgrade reflects national trends: despite a higher proportion of female students, STEM fields are significantly less attractive to women.

Although the data shows that a majority of employees in research sector are also women, we must note that over 39 % of these jobs are of support staff and not really researchers. Human resources in science and technology comprise persons aged 15-74 who have completed tertiary education or are employed in the fields of science and technology as professionals, engineers, associate professionals, or technicians. The results of the Labour Force Survey (LFS) in 2019 indicate that there were 991 118 such persons in Serbia, of which 53 % were women. In 2019, the core of human resources in science and technology was formed by persons who met both conditions (completed tertiary education and work in the fields of science and technology in the mentioned occupations), totalling 497 089, of which 58 % were women.

The labour market in Serbia does not seem so discriminatory and the women graduating from STEM fields can also find jobs in STEM fields. Namely, the ILO reports that the female share of STEM occupations (which are 319 in total according to ILO) is 48 % which suggests parity of women and men in STEM jobs. STEM jobs account for around 11 % of the total jobs in the Serbian labour market.

Taking into account the abovementioned challenges such as insufficient number of graduates, high drop-out rates and historic gender bias linked to STEM fields, the Be21Skilled project will have to look for solutions, how the integration of 21st century skills in the higher education curriculum can promote the involvement of women and reduce student dropout rate.

3.3. Consultation mechanisms with the stakeholders

The Be21Skilled project will set up the Regional Skills Councils tasked with identifying and discussing the relevant but underestimated/neglected 21 CS skills and their relevance to the given region's needs and demands, to support the retention and success of female STEM students, as well as to identify success stories and good practices will be identified by each Council.

The Regional Skill Councils will be forged in the city of Riga (Latvia) and in the Belgrade region (Serbia).

The main task of the Councils will be to analyse the status quo with respect to:

- current STEM graduate skill mismatches
- graduate skills required for the region-specific labour market in STEM
- challenges experienced by female STEM students and ways they can be supported to promote their retention
- HEI teacher skills deficiencies and challenges in delivering 21CS
- challenges faced by students in acquiring 21CS
- the link between fostering 21CS and female STEM students' retention

Consultations mechanism with the stakeholders in Latvia

The National Tripartite Council is the main tripartite consultation mechanism between the government and the social partners. It has one sub-council that is devoted to the VET and employment issues: The Vocational Education and Employment Sub-Council (in Latvian – *Profesionālās izglītības un nodarbinātības trīspusējā sadarbības apakšpadome*, hereinafter – PINTSA). The PINTSA has been established to promote the cooperation of the government, employers and trade unions in the field of development and implementation of national policy and strategic human resources development, education and employment.

PINTSA is responsible for establishment and monitoring the operation of the Sectorial Expert Councils (SECs) which are the tripartite consultative boards dealing with human resource development in particular sectors. PINTSA is also responsible for adopting sectoral qualification frameworks, occupational standards; it decides on the number of learners to be financed by the state budget in vocational education. In these decisions, PINTSA relies on the recommendations of SECs.

In 2022 there were 13 SECs established in Latvia. According to Professional Education Law, the aim of SECs is to promote the compliance of sectoral VET with the requirements of the labour market, increase its efficiency and quality and to promote the cooperation among all stakeholders. The main responsibilities of SECs as defined by the Professional Education Law as:

- development of the sectoral qualification frameworks
- considering the occupational standards and professional qualification requirements
- participating in the planning of the network of VET institutions and VET programme offer
- making proposals for the admission plans of VET institutions

- delegating experts for licensing and accreditation procedures and for qualification exams
- facilitating cooperation between employers and VET institutions in organising work-based learning and traineeships
- addressing any issues related to employment, demand and supply in the labour market of the relevant sector

Thus, the SECs in Latvia have the legitimate basis to define the labour market demands for education.

The SECs representing STEM fields are the following:

1. Chemical and Environmental SEC
2. Construction SEC
3. Timber industry SEC
4. Energy SEC
5. Metalworking, machine building, mechanical engineering SEC
6. Manufacturing of electronic and optical equipment, ICT SEC
7. Transport and Logistics SEC

SECs involve all of the main organisations that have both expertise on the industry situation and motivation to deal with education development issues. Organizations participating in SECs represent wide wider group of companies or professionals, not just few individuals. Thus, SECs legitimately speak on behalf of the sectors. Experts involved in SECs are in the best position in Latvia to formulate the needs for qualified workforce, considering their expertise of the industries and labour, while simultaneously understanding the education system.

Therefore, it is recommended that the Regional Skills Councils established within the Be21Skilled project involve experts from STEM-relevant SECs to ensure the sustainability of the project results.

Consultation mechanisms with the stakeholders in Serbia

After the adoption of the Law on National Qualifications Framework of the Republic of Serbia (NQFS) in 2018, a legal basis was created for the formation of organizations and bodies responsible for its implementation and in 2018 members of the NQFS Council were appointed, a Qualifications Agency was established, as well as 12 Sector Skills Councils (SSC). The NQFS Law creates the legal basis for the Ministry of Education, Science and Technological Development of the Republic of Serbia (MoESTD) to set standards for the recognition of qualifications in the informal system, through the introduction of more flexible pathways to qualifications. The main goals of the NQFS are:

- development of qualification standards based on the needs of the labour market and society as a whole
- ensuring learning outcomes-based approach in the education system and alignment of qualifications to the competencies defined by the qualification standards
- enhancing cooperation between relevant stakeholders and social partners
- affirmation of the importance of key, general and cross-curricular competencies for lifelong learning

The implementation of the NQFS significantly contributes to the promotion of social partnership, setting up the system with standardized procedures, methodologies and decision making in the process of qualifications standards development on the national level. This is a basis for curricula quality improvement in all parts of education system (primary, secondary, higher and adult education). The key instruments and mechanisms are:

- labour market analysis on the sectoral level (methodology of sector profiles which introduce the analysis of administrative data within education and employment information systems)
- the establishment of National classifications in line with international classifications of education and occupations (ISCED and ISCO)
- enabling the active role of employers in proposing and developing new qualifications within the newly established databased policy format for new qualification proposals (Initiative and Elaboration for development of qualification)

There are 12 Sectoral Skills Councils (SSC) in Serbia covering the sectors of education and economy. The members of the councils have delegates from the Chamber of Commerce and Industry and representative associations of employers (representatives of entrepreneurs), Council for Vocational Education and Adult Education, National Employment Service, Conference of Universities of Serbia and Conference of Academies of Applied Studies, associations of vocational schools, the MoESTD (the ministry responsible for the area of work covered by the SSC), trade unions and professional associations e.g. the Serbian Chamber of Engineers.

The SSC is an expert and advisory body established on the principle of social partnership. Its main role is to carry out activities on analysis and decision-making regarding relevancy of the qualifications within a certain sector, on all levels of NQFS including higher education (1-8 level). The SSCs report annually to the Qualifications Agency, the Ministry of Education, Science and Technological Development and the Government of the Republic of Serbia. Creating and maintaining an organised and relevant system of qualifications, as well as raising the quality of the education and training system in the Republic of Serbia, are the primary goals of the SSCs.

It is recommended that the Be21Skilled project involves Sectoral Skills Councils (SSC) and the Serbian Regional Skills Council for the following reasons:

- Considering the role of Sectoral Skills Councils in the Serbian education system, their involvement would ensure sustainability of project results.
- Members involved in Sectoral Skills Councils combine unique expertise of both education system and labour market.

The following Sectoral Skills Councils are relevant to the STEM field and the Be21Skilled project:

1. Sectoral Skill Council for Natural Sciences, Mathematics and Statistics
2. Sectoral Skills Council for the Industrial Development Sector.

KEY MESSAGES

Based on the meta-analysis of ten recent, research-based and internationally recognised 21st century skills frameworks, the ten **most relevant 21st century skills that STEM graduates need for successful and sustainable careers in the 21st century**, are the following:

1. Self-management, purposefulness
2. Interpersonal skills, effective teamwork
3. Critical thinking and problem-solving
4. Emotional intelligence and empathy
5. Positive attitudes, motivation, and mindfulness
6. Advanced technical skills
7. Adaptability, resilience, and stress resistance
8. Leadership and managing, persuading others
9. Creativity, curiosity, and open mindset
10. Growth mindset and learning

A European Employer Survey will be conducted to assess the full list of 21st century skills, with the aim to bring the perspective of employers in determining the most in-demand 21st century skills in the labour market and priority action at the level of universities.

To ensure the relevance of the Be21Skilled project results to the grassroots level, under the auspices of our ERASMUS+ funded Be21Skilled project, the Regional Skills Councils will be created, and the project results will be approbated in two countries: Latvia and Serbia.

Challenges in STEM fields in both Latvia and Serbia are similar. **STEM graduates are in high demand on the labour market**, most notably ICT professionals. Universities prepare an **insufficient number of graduates**. In addition, colleges face a **high dropout rate** in STEM studies. Likewise, STEM fields in both countries face a **historic gender bias**, as despite the higher proportion of women in higher education overall, significantly fewer women choose to study in STEM fields. Taking into account these challenges, the Be21Skilled project will have to look for solutions, how the integration of 21st century skills in the higher education curriculum can promote the involvement of women and reduce student dropout rate.

To ensure sustainability of project results, the **Regional Skills Councils will be created based on the existing Sectoral Expert Councils** (SECs). The representatives from six STEM-relevant SECs will be invited to join the Latvia's Regional Skills Council, however the Serbia's Regional Skills Council will involve experts from the Sectoral Skill Council for Natural Sciences, Mathematics and Statistics and from the Sectoral Skills Council for the Industrial Development Sector. Thus, the project will employ a consultative mechanism that is interlinked with the existing national educational consultative mechanisms in both countries, providing an opportunity for the project to both, gain unique expertise and offer project results for the improvement of national systems.

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ANNEX 1

Classification of 21CS framework skills into groups

(1) Basic, scientific, economic, and technological literacies	(2) Critical thinking, problem-solving and systems thinking	(3) Communication, collaboration, teamwork
▪ **Core disciplines** ▪ **Scientific, economic, and technological literacies** ▪ **Core knowledge, Education, Disciplinary Knowledge and Skills** ▪ **Quantitative literacy, Numeracy/accounting** ▪ **ICT literacy/ Basic digital skills** ▪ **Basic skills & Knowledge** ▪ **ICT (basic, performing tasks)** ▪ **Scientific literacy** ▪ **Financial & economic literacy**	▪ Critical thinking and decision making ▪ Problem solving, complex problem solving ▪ Problem framing ▪ System skills, ▪ Systems analysis and evaluation ▪ Analytical thinking ▪ Cognitive processes and strategies ▪ Reasoning, problem-solving and Ideation	▪ Collaboration ▪ Communication ▪ Teamwork, Working with others ▪ Teamwork effectiveness ▪ Social skills ▪ Selling/ persuading, sales ▪ Interpersonal skills ▪ Developing relationships ▪ Serving/attending, including caring ▪ Generic Skills/Competencies ▪ Engagement/ Communication skills/ Collaboration skills
(4) Creativity, curiosity, open mindset, spotting opportunities	**(5) Responsibility and fairness**	**(6) Vision, leadership, mobilizing and managing others**
▪ **Creative thinking, Creativity** ▪ **Innovation** ▪ **Curiosity** ▪ **Open Mindset, Intellectual openness** ▪ **Originality and Initiative** ▪ **Inventive thinking** ▪ **Exploratory thinking** ▪ **Spotting opportunities** ▪ **Valuing ideas**	▪ Responsibility ▪ Productivity/ accountability ▪ Work ethic/ conscientiousness ▪ Integrity ▪ Justice ▪ Supporting fairness	▪ Leadership/ responsibility ▪ Productivity/ accountability ▪ Leadership and Social influence ▪ Persistence/ grit ▪ Persuasion and negotiation ▪ Leadership and management ▪ Mobilizing others ▪ Pro-activeness ▪ Vision
(7) Advanced technical skills	**(8) Wellbeing, positive attitudes, mindfulness**	**(9) Self-management, purposefulness, perseverance**
▪ **Technical skills** ▪ **Technology use, monitoring and control** ▪ **Technology design and programming** ▪ **Statistical programming** ▪ **Computer programming** ▪ **Advanced IT skills and programming** ▪ **Software use and development**	▪ Positive core self-evaluation ▪ Self-competencies ▪ Efficacy and Beliefs ▪ Metacognition ▪ Reflection ▪ Attitude Motivation & Willingness ▪ Aspiration ▪ Gratitude & Hope ▪ Identity/Spiritual identity ▪ Mindfulness ▪ Reflective thinking/ Evaluating/ Monitoring	▪ Autonomy ▪ Self-efficacy ▪ Self-awareness and self-management ▪ Self-control, Self-regulation, Self-direction ▪ Goals achievement ▪ Goal orientation and completion (e.g., grit, persistence) ▪ Decision Making ▪ Motivation & perseverance ▪ Planning & management

▪ **Understanding digital systems**	▪ Self-efficacy/Positive self-orientation ▪ Trust (in self, others, institutions) ▪ Taking the initiative ▪ Wellbeing	▪ Project management ▪ Risk management ▪ Resource management skills ▪ Purposefulness
(10) Growth mindset and learning	**(11) Emotional intelligence and empathy**	**(12) Adaptability, resilience and stress resistance**
▪ **Learning to learn** ▪ **Lifelong learning** ▪ **Active learning and learning strategies** ▪ **Growth mindset** ▪ **Continuous learning** ▪ **Manual skills for information and communication technology (related to learning strategies)** ▪ **Meta-learning skills (including learning to learn skills)** ▪ **Managing learning** ▪ **Learning through experience**	▪ Empathy ▪ Emotional Intelligence ▪ Service orientation ▪ Personal Traits ▪ Emotional Intelligence ▪ Compassion ▪ Conflict resolution ▪ Equality/ Equity ▪ Human dignity	▪ Adaptability ▪ Flexibility/adaptability ▪ Adaptability/flexibility ▪ Resilience, stress tolerance and flexibility ▪ Mental flexibility ▪ Adaptability/ Flexibility/ Adjustment/ Agility ▪ Perspective-taking and cognitive flexibility ▪ Resilience/Stress resistance ▪ Flexibility ▪ Coping with uncertainty, ambiguity & risk
(13) Information and data literacy, information interpretation	**(14) Global mind-set, social and cultural awareness**	**(15) Business literacy**
▪ **Media literacy** ▪ **Information literacy** ▪ **Complex information processing and interpretation** ▪ **Information and data literacy**	▪ Social/cross-cultural skills ▪ Cultural and civic literacy ▪ Social and cultural awareness ▪ Digital fluency and citizenship ▪ Global mind-set ▪ Respect (for self, others, including cultural diversity)	▪ Business literacy
(16) User experience	**(17) Advanced data analysis and mathematical skills**	**(18) Entrepreneurship**
▪ **Troubleshooting and user experience**	▪ Data analysis ▪ Advanced data analysis and mathematical skills ▪ Quantitative and statistical skills	▪ Entrepreneurship
(19) Display of skills, presentation	**(20) Career management skills**	**(21) Social and human capital**
▪ **Work and/ or Life Experience, Use of Skills**	▪ Career Development Learning ▪ Career Management skills ▪ Career Identity	▪ Social and Human Capital

▪ **Presentation, Display of Skills**		
(22) Sustainability competence	**(23) Safety**	**(24) Digital content creation**
▪ **Valuing sustainability** ▪ **Promoting nature** ▪ **Futures literacy** ▪ **Political agency** ▪ **Collective action** ▪ **Individual initiative** ▪ **Ethical & sustainable thinking**	▪ Safety	▪ Digital content creation