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STATE OF THE ART ANALYSIS OF STEAM EDUCATION PRACTICES IN SLOVENIA

WP 2: State of the art analyze and joint strategy development
about Green STEM education practices

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TABLE OF CONTENTS

| | | |
|-------|--|----|
| 1 | EXECUTIVE SUMMARY | 3 |
| 2 | INTRODUCTION | 3 |
| 3 | SLOVENIAN EDUCATION SYSTEM..... | 4 |
| 4 | STATE-OF-THE-ART – (GREEN) STEAM EDUCATION IN SLOVENIA..... | 5 |
| 4.1 | PRE-SCHOOL EDUCATION (Primary) (age 1 to 6)..... | 6 |
| 4.2 | BASIC EDUCATION (Primary& Lower secondary) (age 6 – 15) | 6 |
| 4.2.1 | First educational cycle (age 6 – 9) | 7 |
| 4.2.2 | Second educational cycle (age 9 – 12) | 8 |
| 4.2.3 | Third educational cycle (age 12 – 15)..... | 9 |
| 4.3 | UPPER SECONDARY EDUCATION (Secondary) (age 15 – 19)..... | 10 |
| 4.3.1 | General Education (Matura)..... | 11 |
| 4.3.2 | Technical and Vocational Education..... | 12 |
| 4.4 | HIGHER AND SHORT-CYCLE HIGHER VOCATIONAL EDUCATION (Tertiary)..... | 13 |
| 4.4.1 | Green Education and Research at University of Ljubljana | 15 |
| 4.5 | Adult education and life-long learning | 23 |
| 5 | EDUCATION AND TRAINING MONITOR IN STEAM..... | 24 |
| 6 | CONCLUSIONS | 27 |
| 7 | REFERENCES | 28 |
| 8 | APPENDIX | 29 |



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1 EXECUTIVE SUMMARY

Report WP2 is a comprehensive study that explores STEAM (Science, Technology, Engineering, Arts, and Mathematics) education in Slovenia, with a particular focus on incorporating sustainable practices and the green transition. The introduction highlights Green STEAM, which seamlessly integrates environmental awareness throughout all levels of learning.

The subsequent section delves into the Slovenian education system, outlining its unique characteristics. This system encompasses primary, secondary, and tertiary education, along with adult education opportunities.

The heart of the report is in the chapter, where a detailed examination of green STEAM education's current state in Slovenia takes place. While green transition and sustainability are partially present in various educational stages, their strongest integration is found in tertiary education and research institutions. Despite this, there's a noticeable lack of systematic inclusion of green technologies and sustainability across educational frameworks. Encouragingly, multiple initiatives are underway at different education levels to address this gap on a national scale.

The final chapter presents a blueprint for a STEAM education and training monitoring framework. This framework enables a comparison between Slovenian students and global educational approaches. An important finding emerges from this assessment: Slovenian educational methods and test results surpass the average.

Crucially, a significant conclusion arises from this analysis. Educational approaches and test outcomes go beyond the norm, indicating the system's adeptness in assimilating novel skills relevant to contemporary environmental issues. This readiness spans the entire spectrum of education, from early years to adulthood, demonstrating the education system's responsiveness to urgent ecological concerns.

2 INTRODUCTION

Green STEAM, which stands for Science, Technology, Engineering, Arts, and Mathematics with a focus on environmental consciousness, eco-friendly technologies, and sustainable practices, holds immense importance for the future society. It plays a crucial role in promoting sustainability, preserving the environment, and mitigating climate change. The integration of



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environmental awareness into STEAM education fosters Sustainable Innovation, Climate Change Mitigation, Environmental Awareness, Cross-disciplinary Collaboration, Green Career Opportunities, Resilient Communities, and Global Impact.

Through green STEAM education, individuals should be equipped with the knowledge, skills, and mindset necessary to tackle environmental challenges and create a sustainable and resilient world. By encouraging the application of arts, technology, and scientific principles in an environmentally conscious manner, we inspire the next generation to become environmentally responsible innovators. This, in turn, leads to a brighter future for everyone, with a focus on harmonious coexistence with nature and a commitment to global sustainability.

3 SLOVENIAN EDUCATION SYSTEM

The education system in Slovenia comprises three main sections: primary, secondary, and tertiary education, with additional provisions for adult and special needs education.¹ For detailed schematics see the APPENDIX – *Education system in Slovenia*

1. Primary education encompasses a variety of institutions such as public and private kindergartens, basic schools, those with adapted education programs, music schools, and educational institutions catering to children with special educational needs. This stage covers early childhood education and care, basic education, and music education.
2. Secondary education is delivered through upper secondary schools and secondary schools, each offering distinct pathways. Students can choose between general or vocational technical education and secondary professional or technical education.
3. Tertiary education is available through both public and private institutions and includes higher post-secondary vocational education and higher education. Higher vocational colleges offer short-cycle higher vocational education, while faculties, academies, and independent higher education institutions provide higher education options.



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Additionally, Slovenia also emphasizes adult education and Special needs education, which are organized by private entities or non-profit organizations, providing opportunities for individuals seeking further development or requiring specialized support. By structuring the education system in this manner, Slovenia aims to provide a comprehensive and diverse learning experience for its citizens, catering to various interests, abilities, and needs. The focus on both general and specialized education paths equips students with the necessary skills and knowledge for future success, while adult education and special needs education initiatives contribute to a more inclusive and accessible learning environment for all members of society.

4 STATE-OF-THE-ART – (GREEN) STEAM EDUCATION IN SLOVENIA

STEAM education in Slovenia has been gaining significant attention and recognition in recent years and it represents an interdisciplinary approach to learning that encourages creativity, critical thinking, problem-solving, and collaboration among students. In Slovenia, the implementation of STEAM education has been driven by the recognition of the importance of equipping students with skills that are essential in the 21st century workforce. The government, educational institutions, and various non-governmental organizations have been actively promoting STEAM initiatives to foster innovation and prepare the next generation for a technology-driven and rapidly changing world.

One of the primary goals of STEAM education in Slovenia is to bridge the gap between traditional academic subjects and real-world applications. By integrating science, technology, engineering, arts, and mathematics, students are encouraged to approach problems in a holistic manner, allowing them to better understand complex issues and develop comprehensive solutions.

Slovenia has been investing in the professional development of teachers to ensure they have the necessary skills and knowledge to effectively implement STEAM methodologies in their classrooms. Workshops, training programs, and networking opportunities have been organized to support educators in incorporating STEAM principles into their teaching practices. Moreover, the Slovenian government has collaborated with private sector companies and research institutions to provide students with access to cutting-edge technology and real-world experiences. These partnerships have resulted in various



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mentorship programs, internships, and school-industry collaborations, giving students the chance to work on actual projects and learn from professionals in different fields. Furthermore, initiatives promoting diversity and inclusion in STEAM education have also gained traction in Slovenia. Efforts are being made to encourage more girls and underrepresented groups to pursue STEAM-related fields and careers, aiming to create a more diverse and inclusive workforce in the future.

STEAM education in Slovenia is on a positive trajectory, as it continues to empower students with the skills, knowledge, and mindset needed to thrive in a technology-driven society. With a focus on hands-on learning, interdisciplinary approaches, and industry partnerships, Slovenia is positioning itself to foster a new generation of innovative thinkers and problem solvers, making significant contributions to both local and global challenges.

4.1 PRE-SCHOOL EDUCATION (Primary) (age 1 to 6)

The curriculum for kindergartens has remained relatively unchanged since its establishment in 1999.² Primarily focused on the fundamentals of art and mathematics, it employs a playful approach to early learning. However, a transformative shift is evident in 2022, marked by the release of revised guidelines for kindergarten curriculum renewal.³ Notably, these revisions place a significant emphasis on sustainability as a cornerstone. This update underscores the critical role of instilling sustainable development values, particularly fostering a sense of responsibility towards oneself, fellow human beings, other living entities, and the surrounding environment within the realm of childhood education. As part of a larger initiative funded by the Mechanisms for Recovery and Resilience (NOO - Mehanizma za okrevanje in odpornost),⁴ the rejuvenation of educational programs coincides with the revitalization of key foundational documents, encompassing the curriculum for kindergartens, lesson plans, and knowledge catalogs. This comprehensive endeavor operates under the imperative of accomplishing its goals by the deadline of December 31, 2025.

4.2 BASIC EDUCATION (Primary& Lower secondary) (age 6 – 15)

Primary and lower secondary education in Slovenia follows a unified nine-year structure within a single basic school system, catering to students aged 6 to 15 years. This educational framework is offered by both public and private schools, with private basic schools accounting



Basic school programme

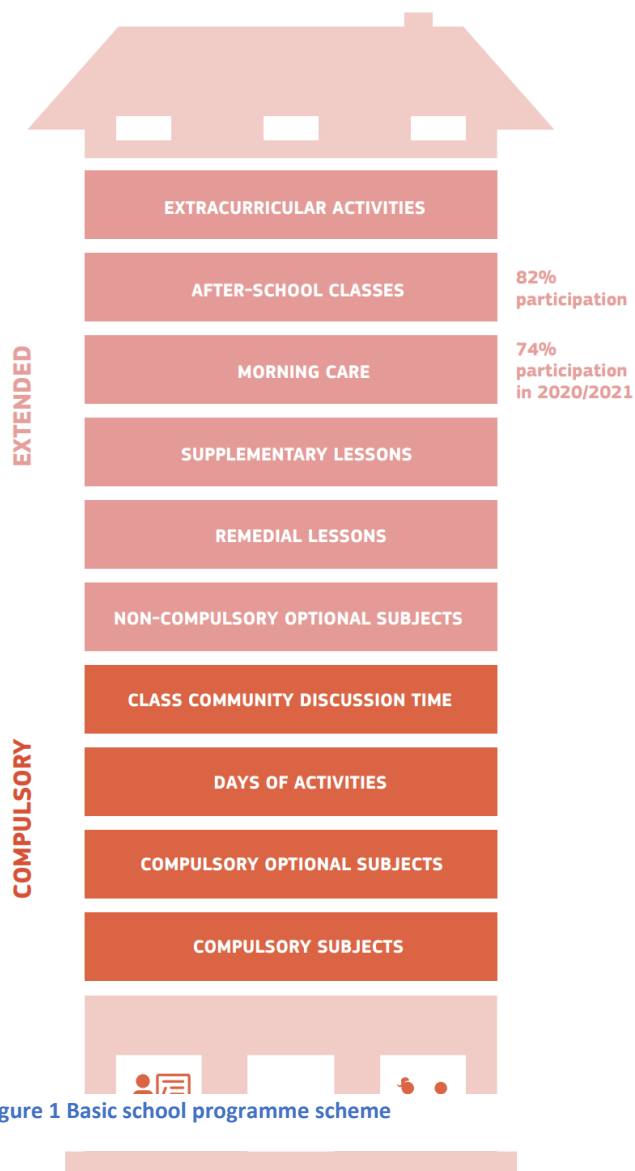


Figure 1 Basic school programme scheme

for a minority share of students (less than 1%). Additionally, educational institutions catering to students with special educational needs and adult education organizations are also part of the educational landscape. Basic school programme is composed of Compulsory and Extended programs (Figure 1)⁵. For detailed program see APPENDIX for *Basic Education school program*.

Aligned with the stipulations of the Constitution of the Republic of Slovenia, basic school education is not only mandatory but also financially supported by the state.

4.2.1 First educational cycle (age 6 – 9)

Within the First Educational Cycle, a quartet of compulsory courses emerges, aptly classified as STEAM subjects, encapsulating Mathematics, Fine Art, Music, and the Fundamentals of the Environment (*slo.* "Spoznavanje okolja"). Notably, the curriculum of the Fundamentals of the Environment course extends its purview to

encompass green technologies as well. The course of environmental topics serves as a catalyst for fostering education and training aimed at sustainable development. This course comprehensively embraces interconnected facets of the environment, economy, and society. The curriculum of this course is rooted in foundational concepts that not only enhance understanding within disciplines such as natural sciences and technology, but also extend into



the realms of society. This integration takes place within the second educational cycle. Furthermore, it spans across subjects involving natural sciences, technology, and social sciences in the subsequent educational phase, solidifying its multi-dimensional impact.

4.2.2 Second educational cycle (age 9 – 12)

The spectrum of subjects constituting the realm of STEAM education undergoes expansion within the second cycle, now encompassing an array of disciplines: Mathematics, Fine Art, Music, Natural Science (*slo.* "Naravoslovje"), Natural Science and Technology (*slo.* "Naravoslovje in Tehnika"), and Engineering and Technology (*slo.* "Tehnika in Tehnologija"). Notably, all subjects pertaining to the domain of natural sciences, engineering, and technology incorporate references to green technologies within their curricula. This integration creates a vertical interconnectedness between them and Fundamentals of the Environment (*slo.* "Spoznavanje okolja") from First educational cycle. In the realm of technical courses, students delve into the fundamental framework of technology, which is delineated by four interconnected domains:

- **Technical Resources:** This domain encapsulates an array of vital components including processing tools, machinery, energy converters, transmission systems, movements, and mechanisms for handling information.
- **Technological Processes:** Within this realm, students explore the various facets of technological manipulation such as shaping, transformation, cutting, joining, surface treatment, and related operations.
- **Organizational Dynamics:** This domain encompasses the dynamic interplay of problem analysis and product development, serving as the driving force behind efficient work methodologies.
- **Economic Considerations:** Here, the evaluation of products and work takes center stage, shedding light on the economic dimension of technological endeavors.

Together, these domains collectively enrich the learning journey and create a holistic educational experience. Notably, within this landscape, energy converters assume a pivotal role. They delve into Energy and Storage technologies, offering a doorway to the realm of alternative green technologies. This comprehensive approach equips students not only with



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knowledge but also the awareness of the transformative potential of sustainable energy solutions.

On the other hand, within the realm of natural sciences, students embark on a journey of learning and cultivating a profound comprehension of fundamental natural science concepts and principles. These foundational elements serve as the bedrock for comprehending the intricate tapestry of phenomena in the natural world. Moreover, students delve into the intricate interplay between living and non-living aspects of nature, unraveling the complex relationships that exist between the structure, properties, and functions of these dynamic systems. Throughout their exploration of science, students gain insights into the profound significance that natural sciences hold for the advancement of humanity. This process not only cultivates knowledge but also nurtures attitudes and perspectives toward themselves, their environment, and the broader natural world. It instills an acute awareness of the imperative of responsible behavior, underpinning the care of personal safety and the well-being of others. Through this holistic approach, students are empowered to forge a symbiotic relationship with nature, fostering a sense of stewardship and underscoring the vitality of conscientious actions for the collective welfare. All of this knowledge serves as a crucial foundation for the development of modern green technologies.

Concluding the second educational cycle, students' proficiency in core subjects—Slovene language, Mathematics, and English—is assessed through the National Knowledge Test (NPZ). This assessment is obligatory for all students.

4.2.3 Third educational cycle (age 12 – 15)

The distinctive feature of the third educational cycle is that only subject-specialist teachers (*slo.* Predmetni pouk) are responsible for instruction. This unique arrangement fosters more comprehensive and in-depth exploration across all fields, including the STEAM courses. Additionally, students are mandated to opt for a minimum of two hours' worth of elective courses annually.

In this advanced phase, the canvas of subjects aligned with the STEAM framework widens further, encompassing Physics, Chemistry, and Biology. Alongside these, students enjoy the freedom to select two elective courses from an extensive assortment of options. Essentially, these electives are divided into two sets: one covering Social Sciences and Humanities, and



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the other focusing on Natural Science and Technical domains. Among these courses are Mathematical Workshops, Nutritional Practices, Material Processing, Chemistry and Physics Experiments, Engineering and Computational Principles, as well as Geometry and Technical Drawing (involving 3D printing and modeling). Notably, several of these offerings establish either direct or indirect ties to green technologies.

An additional significant aspect of basic education comprises mandatory activity days (Figure 1), encompassing excursions, nature outings, and technical sessions. During these periods, students are provided with chances to explore research laboratories, institutions, museums, and more. Much like the second educational cycle, students in the third cycle undergo assessment via the National knowledge test (NPZ). This evaluation covers proficiency in Slovene language, Mathematics, and a third subject determined by the Government. This mandatory assessment applies to all students.

4.3 UPPER SECONDARY EDUCATION (Secondary) (age 15 – 19)

After completing their mandatory primary education, students, typically at around the age of 15, can opt to continue their academic path at the upper secondary level, selecting a school and program that aligns with their preferences. This phase typically spans from two to five years for completion.



Moreover, attaining an upper secondary education qualification remains attainable during adulthood through regular programs that incorporate specialized organizational adjustments tailored for adult learners. However, the enrollment of candidates may be constrained if the number surpasses the school's capacity.

The framework of upper secondary education operates within a centralized structure. Consequently, determinations concerning school establishment, funding, and educational programs are formulated at the national level. While schools and educators uphold autonomy in executing mandated programs, they also wield independence in matters pertaining to human resource selection and management.

Upper secondary education is organized

into two streams: general education and technical and vocational education. Among the students, approximately one-third opt for general education, while the remaining two-thirds opt for technical and vocational education (as shown in Figure 2).⁶ The duration of general programs spans four years, while technical and vocational education can vary in length, spanning 2, 3, or 4 years. The latter is further categorized into different tracks, including Technical Programs (4 years), Short Vocational Programs (2 years), Vocational Programs (3 years), and Vocational Technical Programs (2 years).

Enrolment by type of upper secondary education programme, 2015

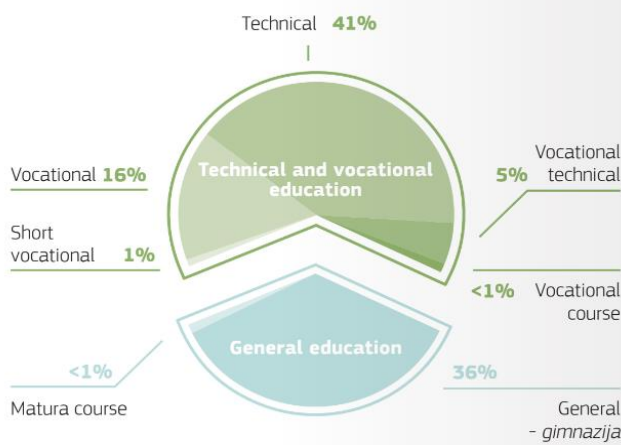


Figure 2 Enrolment by type of upper secondary education programme, 2015

4.3.1 General Education (Matura)

The primary benefit of General high school education (*slo.* "Gimnazija") lies in its comprehensive knowledge spectrum. This knowledge equips students with the prerequisites for pursuing further education at universities, both in Slovenia and across the globe. Completion of a gymnasium program, along with achieving a general Matura, is a prerequisite for those aspiring to pursue higher education at universities and certain colleges.



The curriculum for general education comprises a blend of compulsory and elective courses. Within the realm of STEAM, pivotal subjects are incorporated as compulsory components, including Fine Art, Biology, Physics, Geography, Informatics, Chemistry, and Mathematics. Similarly, an array of elective courses is available, presenting students with more advanced or in-depth iterations of Biology, Physics, Geography, Informatics, Chemistry, and Mathematics. The current study program briefly touches upon green technologies in different sections, lacking in-depth exploration. Addressing this, a specialist working group has drafted foundational principles for revamping curricula in elementary and high schools.⁷ Their key observation is that the 21st century demands education to reflect significant societal changes that influence society's essence. This era emphasizes resolving environmental and societal issues such as digitization's impact, resource implications of consumer choices, and environmental preservation. Thus, fostering sustainable development awareness and digital competence in the youth becomes pivotal.

Moreover, a transformative shift is underway wherein machines transcend their traditional confines of physical labor and increasingly contribute to human cognitive capacities. This reevaluation of their function necessitates a comprehensive comprehension of machine dynamics, akin to the established scientific disciplines. As a result, the curriculum's evolution endeavors to foster environmental consciousness, digital adeptness, and a nuanced comprehension of machine intricacies, aligning seamlessly with the transformative landscape of the 21st century. These insights underscore the imperative of incorporating Green STEAM into the education system.

4.3.2 Technical and Vocational Education

Technical and vocational education presents a specialized array of STEAM courses that delve deeply into distinct technical and natural fields. This facet of education provides a concentrated focus on diverse areas, offering students a comprehensive understanding of various technical and scientific disciplines. In addition to the conventional subjects like Mathematics, Music, Fine Art, Biology, Chemistry, Physics, and Informatics, this avenue introduces a range of specialized courses closely aligned with the realms of Green STEAM.



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These specialized courses encompass a multitude of disciplines that are intrinsically connected to the domains of sustainability and environmental consciousness. Notable examples include Biotechnology, Electrical Engineering, Materials Science, Mechanics, Computer Science, Electronic Systems, Construction, Agriculture, Woodworking, Microbiology, Spatial Modeling, Computer Systems and Networks, Mechanical Engineering, Laboratory Exercises, Astronomy, Selected Chapters in Biotechnology, Creative Entrepreneurship, Research Papers and Other Products, Project Work Incorporating Research Methodologies, Environmental Studies, and Education for Solidarity. The list, though extensive, merely scratches the surface of the comprehensive offerings.

Despite this expansive selection, the core challenge remains that the current curricula lack a holistic perspective when it comes to comprehending green technologies. The intricate interplay between various STEAM components and their application to sustainability-focused fields such as renewable energy, resource management, and ecological preservation often gets fragmented. This deficiency underscores the need for a unified approach that bridges the gaps, providing students with a profound grasp of green technologies within a broader educational context.

4.4 HIGHER AND SHORT-CYCLE HIGHER VOCATIONAL EDUCATION (Tertiary)

Following the Bologna reform, Slovenia's tertiary education structure comprises three cycles: the 1st cycle - Bachelor's (3 years), the 2nd cycle - Master's (2 years), and the 3rd cycle - Doctoral. The country is home to four distinguished universities: the University of Ljubljana, the University of Maribor, the University of Primorska, and the University of Nova Gorica.



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These universities are united by a shared mission centered around fostering interdisciplinary exploration, innovation, and creativity.

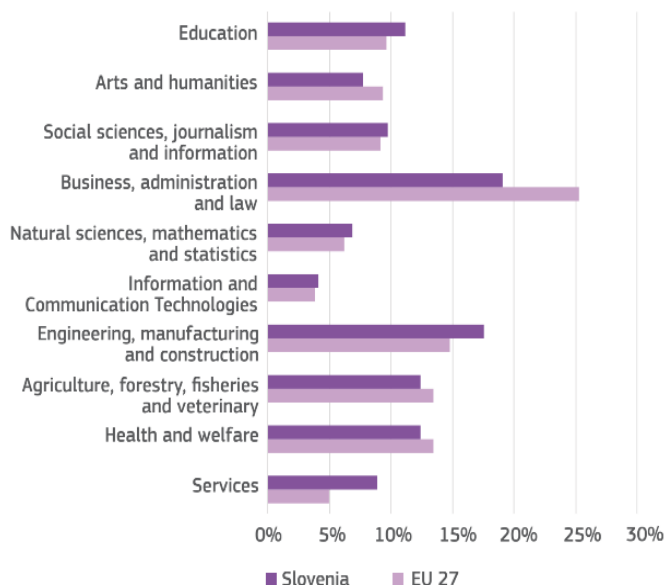


Figure 3 Distribution of tertiary education graduates by broad field of education, 2020

They are dedicated to empowering students as critical thinkers and active contributors to society, emphasizing the essential connection between science, art, and societal progress. Through adaptable and dynamic educational methodologies, these institutions strive to equip graduates with the capabilities necessary to confront the intricate challenges of the contemporary world, including the realm of green technologies (Figure 3)⁸.

Green technologies are well represented within various study programs as well as within the research groups at the universities.

All four universities establish robust connections with public research institutes (Jozef Stefan Institute, National Institute of Chemistry, National Institute of Biology, The Geological Survey of Slovenia, Slovenian Forestry Institute, Institute for Hydraulic Research, The Institute of Metals and Technology, Agricultural Institute of Slovenia, Educational Research Institute, Urban Planning Institute of the Republic of Slovenia, Slovenian National Building and Civil Engineering Institute, etc.) and select private entities, as well as house formidable research and development units within the corporate realm. The synergy between a rich scientific heritage and a contemporary research and development structure drives substantial engagement in the fields of green technologies and sustainability. Despite Slovenia's relatively modest population of around 2 million, the nation's scientific community comprises over 11,000 dedicated researchers who contribute significantly, resulting in 1.346 international scientific co-publications per 100,000 individuals.



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Slovenia's deep appreciation for science and education is evident in the remarkable count of new doctoral graduates per 100,000 residents, an impressive figure of 355. This unwavering commitment to scholarly pursuits is deeply ingrained in the country's culture, underscoring the pivotal role that science and research play in shaping Slovenia's society. This shared dedication signifies that the critical mass needed to embrace and implement innovative green technologies is substantial enough to drive transformative changes across various sectors as well as down the education vertical.

4.4.1 Green Education and Research at University of Ljubljana

Slovenia, notably the University of Ljubljana, proudly stands as a distinguished member of the EU STEM Coalition. This coalition functions as a pan-European network devoted to advancing STEM (Science, Technology, Engineering, Mathematics) education across the continent. Its overarching mission is to craft and implement STEM education policies and strategies that not only drive economic growth but also create widespread opportunities and enhance overall well-being. Collaborating closely with policymakers, educational institutions, and industry stakeholders, the coalition is committed to championing innovative approaches to educational delivery. Furthermore, it actively seeks out and disseminates evidence-based solutions to address the pressing issue of skill mismatches within the STEM fields. By tackling challenges ranging from the shortage of skilled STEM professionals to fostering robust partnerships between educational bodies, corporations, and governments, the coalition offers an unparalleled platform. At the core of its activities lies the provision of a unique forum and knowledge hub, serving as a repository for data-driven analyses, sharing of best practices, and direct support. Through this multifaceted approach, the coalition not only envisions a future with an abundance of STEM talent but also catalyzes collaboration that extends beyond traditional boundaries, ensuring the continued advancement of STEM education and its myriad benefits.⁹

The University of Ljubljana is the oldest and largest higher education and scientific research institution in Slovenia. The university was founded in 1919. It has approximately 38,000 undergraduate and postgraduate students and employs approximately 6,000 higher



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education teachers, researchers, assistants and administrative staff in 23 faculties and three arts academies.¹⁰ The University of Ljubljana stands out for its exceptional programs in both social and natural sciences, as well as technical studies. These programs are meticulously designed in accordance with the principles set forth in the Bologna Declaration. The institution remains at the forefront of advancements in arts, sciences, and technology, both within the country and on the global stage. Recognizing the pressing need for STEM expertise in Slovenia, the University of Ljubljana is actively engaged in a diverse array of outreach initiatives, aimed at fostering a robust pipeline of STEM talent. These initiatives encompass:

- Collaborative efforts through Quadhelix partnerships, bringing together educational institutions, industries, non-profit organizations, and government bodies.
- Engaging STEM activities within MakerLabs and FabLabs, empowering hands-on exploration and creativity.
- Orchestrating summer and winter schools, along with CAMPs, tailored for students in elementary and secondary education.
- Playing a key role in formulating a comprehensive national STEM strategy in conjunction with other stakeholders.
- Offering specialized training sessions for students, parents, and educators alike.
- Promoting awareness about promising STEM careers and showcasing inspirational role models.
- Undertaking research ventures focused on pressing issues such as Sustainable Innovation, Climate Change Mitigation, Environmental Awareness, Cross-disciplinary Collaboration, Green Career Opportunities, Resilient Communities, and Global Impact.

While these efforts hold immense significance, it's crucial to recognize that they currently don't fully come together as a well-integrated and organized approach to effectively address the complex challenges of Green STEAM. Nevertheless, a shining model of commitment to green challenges is evident at the University of Ljubljana. Here, a comprehensive approach to tackling a range of green challenges is built upon three main pillars:

- a) Enriched or dedicated Study Programs:
- b) Cutting-edge Research Endeavors:



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c) Impactful Project Ventures:

Study Programs

The University of Ljubljana is forging ahead by infusing sustainability-oriented content and principles across its diverse array of study programs. Students are being equipped not only with foundational knowledge but also with a profound understanding of the interconnectedness between their chosen fields and the pressing environmental concerns. Through thoughtfully curated coursework, students are empowered to become proactive agents of change, steering industries towards greener horizons.

University of Ljubljana and its Faculties are fostering several study programs that are devoted to Delivering the European Green Deal with the aim to transform the economy and societies.¹¹ This comprehensive initiative aims to drive transformative changes in both economies and societies. Across all three academic cycles, a majority of the existing study programs now offer a selection of courses that center around the principles of the green transition. Refer to Table 1 for an overview of these efforts.

Table 1 University of Ljubljana member Faculties that offer courses related to Sustainability.

| Faculty: | Study program: | Study cycle | Courses: |
|--|------------------------|-------------|---|
| Faculty of Chemistry and Chemical Technology | Chemical sciences | 3. | <ul style="list-style-type: none"> Selected topics in environmental engineering Selected topics in materials for new energy sources |
| | Chemistry | 2. | 6 different courses related to Materials for Energy Storage and Conversion. Detailed curriculum ¹² |
| Faculty of Mechanical Engineering | Mechanical Engineering | 3. | 3 different fields related to Green Transition: <ul style="list-style-type: none"> Machine Design and Mechanics Engineering Science, |



| | | | |
|---|--|----|--|
| | | | <ul style="list-style-type: none"> • Energetical, Process and Environmental Engineering Sciences, • Production Engineering Sciences, Cybernetics and Mechatronic |
| | | | |
| Faculty of Electrical Engineering | Electrical Engineering | 3. | <ul style="list-style-type: none"> • Photovoltaics • Energy Conversions and Environment • Intelligent buildings • Intelligent mobile transport systems |
| | Advanced Power Systems | 2. | Several courses see reference ¹³ |
| Biotechnical Faculty, Faculty of Arts, Faculty of Chemistry and Chemical Technology, Faculty of Civil and Geodetic Engineering, Faculty of Law, Faculty of Maritime Studies and Transport, Faculty of Mathematics and Physics, Faculty of Mechanical Engineering, Faculty of Medicine, Faculty of Natural Sciences and Engineering, | Interdisciplinary doctoral programme in Environmental protection | 3. | Several courses see reference ¹⁴ |



| | | | |
|---|---|----|--|
| Faculty of Social Sciences, School of Economics and Business, Veterinary Faculty | | | |
| Faculty of Education | Teacher Education and Educational Sciences | 3. | <ul style="list-style-type: none"> Semantic Technology and the Virtual Learning Environment |
| Biotechnical Faculty | Forestry and Renewable Forest Resources | 1. | <ul style="list-style-type: none"> Forest Entrepreneurship Landscape ecology Forest harvesting Forest Ecology and Tending Introduction to Ecology Production of Forest Reproductive Material |
| | <ul style="list-style-type: none"> Economics of Natural Resources Ecology and Biodiversity Forestry and Forest Ecosystem Management Biotechnology | 2. | Several courses see reference ¹⁵ |
| Biotechnical Faculty, Faculty of Computer and Information Science, Faculty of Electrical Engineering, Faculty | Biosciences | 3. | Several courses see reference ¹⁶ |



| | | | |
|--|-------------------------------------|----|---|
| of Health Sciences, Faculty of Mechanical Engineering | | | |
| Faculty of Computer and Information Science | Computer and Information Science | 3. | <ul style="list-style-type: none"> Selected Topics in Artificial Intelligence 1 Selected Topics in Artificial Intelligence 1 |
| Faculty of Natural Sciences and Engineering | Getechnology | 2. | <ul style="list-style-type: none"> Geothermal energy Waste treatment Energy politics Clean technologies Geothermal research and underground fluid modelling |
| | Matrials and Metallurgy | 2. | <ul style="list-style-type: none"> Industrial ecology and energetics |
| | Geology | 2. | <ul style="list-style-type: none"> Environmental mineralogy Protection and managenemt og groundwater resources |
| Faculty of Civil and Geodetic Engineering, Faculty of Natural Sciences and Engineering | Built Environment | 3. | <ul style="list-style-type: none"> Applied Environmental Geochemistry Assessment of Water Management Impact on River Basin Protection of Water Environment Climate adapted buildings |

Research Endeavors

UL boasts a formidable team of over 3,500 researchers whose collective efforts have garnered remarkable recognition. According to data gleaned from the Thomson-Reuters Web of Knowledge database, faculty members and researchers at the University of Ljubljana



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consistently contribute to nearly half of all globally renowned scientific publications emerging from the Republic of Slovenia.

In recent years, UL has ascended to exceptional heights. It proudly resides within the top 3% of the world's most accomplished universities according to The Times Higher Education ranking. Additionally, in the esteemed Shanghai Ranking, UL secures a place among the top 500 research universities worldwide. Its influence extends beyond rankings, evidenced by its strong presence in terms of international resonance, as reflected by citations of its scientific publications. A remarkable showcase of its pinnacle research accomplishments is presented annually during the University Week.

This institution provides a thriving research milieu alongside modern cutting-edge equipment,¹⁷ both to its resident researchers and those visiting. Such an environment is conducive to the pursuit of groundbreaking research breakthroughs and fostering innovation. The University's commitment to pioneering research is manifesting prominently in its initiatives focused on green initiatives too. By fostering an environment conducive to innovative exploration, researchers are delving into the depths of complex challenges, unraveling intricate relationships between the environment and technology. These investigations are yielding insights that have the potential to catalyze transformative breakthroughs, reshaping industries and practices for a more sustainable future.

Project Ventures

Recognizing that practical implementation is an indispensable component of sustainable progress, the University of Ljubljana is not merely confining itself to theoretical pursuits. Instead, it's engaging in hands-on project endeavors that bridge the gap between conceptualization and real-world application. Collaborative projects, spanning disciplines, are channeling the collective wisdom of academia towards tangible solutions. These projects don't just remain confined to campus but have the potential to radiate positive change throughout local and global communities. Report on EU tenders and applications for EU projects in 2021 and the current status of EU projects at University of Ljubljana is very telling of many ongoing research activities related to sustainability.¹⁸



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Probably the biggest project and the most relevant at University of Ljubljana is project ULTRA – reform of the university curriculum for a sustainable society (duration of the project: from 01.07.2022 until 31.12.2025, project value: 25.620.588,00 EUR). The investment is strategically designed to propel forward the implementation of pivotal pilot projects that focus on revamping the curricula across 29 Faculties and their professional study programs. This comprehensive endeavor by University of Ljubljana spans a dynamic landscape, establishing inter- and multidisciplinary pilot projects that synergistically bring together multiple stakeholders in each initiative. This collaborative approach empowers University of Ljubljana to holistically confront the intricate challenges posed by the green and digital transition across a diverse spectrum of academic domains. Moreover, it positions University of Ljubljana to effectively address the societal and economic intricacies connected to the pervasive green and digital transformation reshaping our world. A total of 11 pilot projects will be executed within the framework of this initiative, each honing in on distinct facets of this transformative journey:

1. Natural Resources and Food
2. Digital and Green Renovation of study programs
3. Innovative Learning Environments
4. Sustainable Space
5. Environmental and Digital Literacy
6. Environmental Technologies
7. The Digital Future: Navigating the trajectory of our digital landscape and its impact
8. Lifelong Learning and Micro-credentials
9. Educational Ecosystem for Digital Competences
10. Strengthening Learning and Teaching for Sustainability
11. Sustainable and Digital University of Ljubljana: Pioneering sustainable and digital practices within the university itself.

This strategic venture signifies UL's resolute commitment to not only enhancing education but also to actively contributing to the advancement of a greener, digitally informed society. Through these pilot projects, the University of Ljubljana is setting the course for a



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comprehensive transformation that reverberates beyond academia, nurturing sustainable progress on various fronts.

In a world where the Green STEAM challenges are growing in complexity and urgency, the University of Ljubljana's multi-pronged approach is an embodiment of a concerted effort to surmount these challenges. However, it's essential to acknowledge that this journey is ongoing, and the University remains dedicated to continually refining and expanding its initiatives. As strides are made within each of these pillars, the vision of a harmonious coexistence between human advancement and ecological equilibrium becomes increasingly attainable.

4.5 Adult education and life-long learning

In the rapidly evolving world of green technologies, the idea of lifelong learning carries significant weight. As this field progresses swiftly, people of all ages and from diverse backgrounds are acknowledging the need to continuously update their knowledge and skills. Lifelong learning acts as a bridge that spans generations, making sure that everyone can tap into the latest insights, methods, and advancements in green technologies.

The Slovenian Institute for Adult Education stands out as a prominent institution in the field of andragogy, with a keen awareness of the importance of green practices and sustainability. They're actively involved in several ongoing projects geared toward equipping the adult generation with the emerging technologies and tools that will shape our future. These projects encompass both national and international endeavors. Two especially notable initiatives are "Education for Sustainable Development,¹⁹" which was introduced in 2007 and is still evolving, and "Lifelong Learning of Adults for Sustainable Development and Digital Breakthrough."²⁰

These projects embody Green STEAM education, epitomizing the dynamic interplay between environmental consciousness and personal growth. In a world where sustainable practices are increasingly vital, adults are enthusiastically seizing the chance to expand their knowledge. Whether it's comprehending renewable energy systems, mastering sustainable design principles, or navigating the intricacies of eco-friendly manufacturing, adult learners are



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immersing themselves in a wide range of topics that directly contribute to a more sustainable future.

What sets adult learners apart is their practical life experience, enriching the learning environment. This fusion of hands-on knowledge with formal education enhances the conversation, nurturing a holistic grasp of how green technologies can seamlessly integrate into various sectors, even within their homes. Ultimately, this approach embodies our shared dedication to nurturing a generation of environmentally conscious individuals, armed with the know-how and tools to drive positive change. This commitment extends beyond personal lives, influencing the global stage as well. The journey of lifelong learning in green technologies becomes a conduit for shaping a brighter, more sustainable future for all.

5 EDUCATION AND TRAINING MONITOR IN STEAM

Assessing the quality of education and gauging innovative methodologies within the educational sphere is an intricate and often underappreciated endeavor. Yet, within this complex landscape, there exist studies that offer statistical perspectives on ongoing efforts in the realm of STEAM education in Slovenia. The capacity to effectively measure innovation stands as a crucial cornerstone for devising educational enhancement strategies.



In the field of quantifying inventive approaches, an analysis conducted in 2014 yielded enlightening findings. This examination revealed that among 29 countries included in the study, Slovenia secured the 9th position in terms of overall innovation in education (as depicted in Figure 4). This positioning offers a quantitative glimpse into Slovenia's progressive

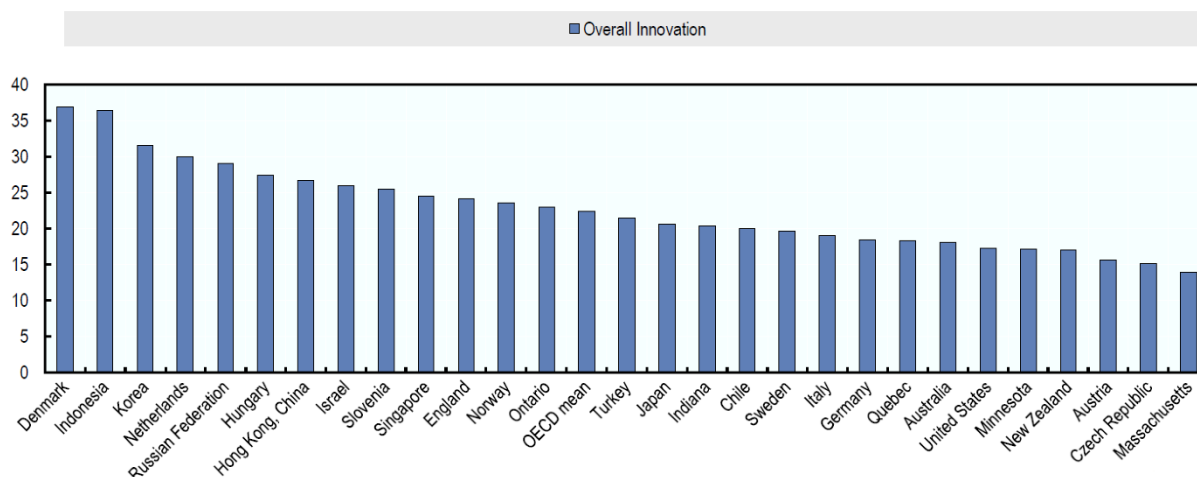


Figure 4 Overall composite innovation index, 2000-2011

strides in integrating innovation within its educational framework.²¹

Expanding on the Education and Training Monitor 2020 report,²² as well as insights gleaned from the OECD's Programme for International Student Assessment, it's evident that Slovenia has secured a remarkably high standing in terms of student performance in STEAM subjects. Delving into specifics, it's notable that Slovenian students have demonstrated exceptional prowess, particularly excelling in the domains of Science and Mathematics (Figure 5). These students have consistently outperformed their EU counterparts in these crucial disciplines, showcasing a depth of understanding and skill that surpasses the regional average. Furthermore, the proficiency of Slovenian students in Science has even surpassed the EU's predefined target, signifying an outstanding level of attainment and proficiency. This accomplishment underscores not only the dedication of educators and institutions but also the commitment of the nation to fostering a well-rounded and advanced educational landscape.



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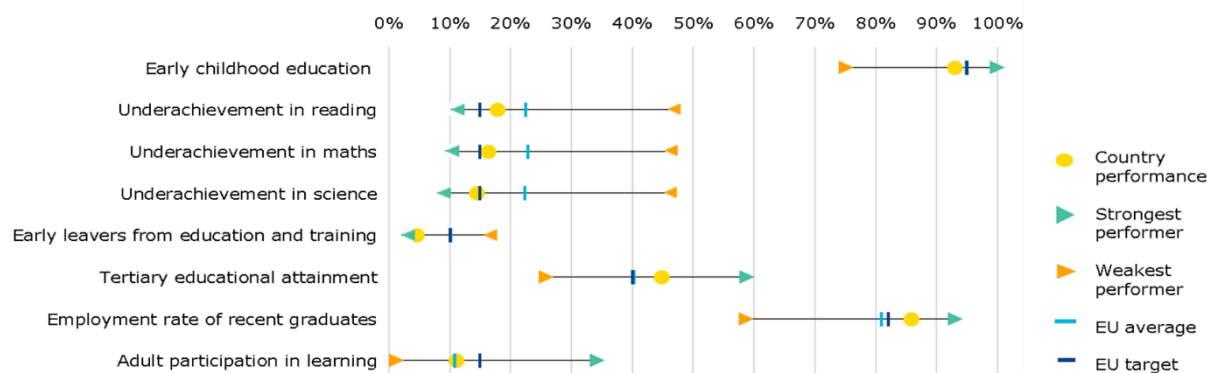


Figure 5 Position in relation to strongest and weakest performers. Slovenia position is labeled with yellow dot.

Amid these commendable achievements, it's important to acknowledge that this success is a result of concerted efforts across various sectors. Effective teaching methodologies, robust curriculum design, and the emphasis on hands-on learning experiences have all played pivotal roles in elevating the educational standards in Slovenia.

Beyond the numbers, this achievement resonates on a broader scale. It reflects the potential of a nation to equip its youth with the skills and knowledge that will shape the trajectory of future National and EU directions toward sustainable society. As the global landscape becomes increasingly reliant on STEAM disciplines, Slovenia's commitment to excellence in these subjects positions its students to become future leaders, innovators, and contributors to green fields that drive societal progress.

However, the path ahead is still unfolding, and this impressive accomplishment provides a sturdy groundwork for an unceasing journey of enhancement. As educational systems continually evolve and the requisites of the contemporary world undergo transformation, the unwavering pursuit of excellence remains a guiding principle. This unwavering commitment to nurturing critical thinking, problem-solving, and creative capacities within students ensures that Slovenia stands ready to uphold its notable standing in the domain of Green STEAM education. This positioning, in turn, contributes significantly to a future characterized by heightened technological advancements and enriched insights in pivotal areas such as Sustainable Innovation, Climate Change Mitigation, Environmental Awareness, Resilient Communities, and Global Impact.



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6 CONCLUSIONS

STEAM education in Slovenia is undeniably charting a positive trajectory, bolstered by a resolute commitment to equipping students with the essential skills, comprehensive knowledge, and adaptable mindset crucial for excelling in a technology-driven society. At the heart of this educational evolution lies a robust emphasis on experiential learning, interweaving disciplines in a manner that ignites holistic understanding. By nurturing an environment where hands-on exploration flourishes, Slovenia is cultivating a fertile ground for students to grasp complex concepts through tangible engagement.

Intriguingly, the educational landscape in Slovenia thrives on interdisciplinary approaches, transcending the conventional boundaries of courses. This methodology not only mirrors the real-world dynamics but also cultivates in students the prowess to connect ideas across seemingly disparate domains. As a result, learners are equipped to tackle multifaceted challenges by approaching them from myriad angles, fostering an innovative mindset that holds tremendous potential.

Moreover, Slovenia's strategic partnerships with industries amplify the real-world applicability of education. By bridging academia and industry, students gain access to practical insights, cutting-edge developments, and the opportunity to work on projects that mirror actual professional scenarios. This symbiotic relationship enhances the quality of education while also preparing students to make meaningful contributions as they transition into the workforce.

In essence, Slovenia's dynamic approach to STEAM education is a strategic investment that doesn't merely create proficient graduates; it shapes proactive problem solvers and forward-thinking innovators. This transformative education isn't confined to national borders—it reverberates globally. The solutions incubated within Slovenian classrooms hold the potential to address not only local challenges but also the broader spectrum of global issues, from environmental sustainability and resource management to health advancements and technological breakthroughs. In this way, Slovenia is carving a path towards systematically introducing sustainability and green transition in education that extends far beyond the classroom, shaping a future where knowledge and ingenuity act as driving forces for progress.



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8 APPENDIX



Education system in
Slovenia



Basic Education
school program



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