

IDENTIFICATION OF HISTORICAL CONTENTS RELATED TO STEAM SUBJECTS IN HIGH SCHOOLS' CURRICULA

WORK PACKAGE 2

Developed by Vytautas Magnus University

1. Purpose and objectives

This report has been prepared within **Work Package 2: STEAM and History in School Curriculum (WP2)** of the Erasmus+ project *Pathways Across STEAM and Time: Where History Meets STEAM (PAST)*. WP2 establishes the methodological and analytical basis for identifying, analysing, and categorising historical contents within secondary education curricula that demonstrate meaningful connections with STEAM disciplines.

The report contributes to **Activity A2.2 – Identification of historical contents related to STEAM subjects in high schools’ curricula**, which aims to examine national education systems and curriculum documents in participating countries in order to detect and analyse interdisciplinary links between history and STEAM subjects, particularly physics, biology, chemistry and geography. This activity builds upon the methodological principles defined in the **PAST Research Framework**, ensuring consistency, comparability and transparency of research procedures across partner countries.

The overall purpose of this activity is to identify curriculum contents where historical knowledge intersects with scientific discoveries, technological innovations, environmental change and societal development addressed in STEAM disciplines. By analysing secondary education curricula and related educational documents, the research seeks to reveal conceptual and thematic connections that support interdisciplinary learning and contribute to a more holistic understanding of scientific and technological progress within historical contexts.

More specifically, the objectives of this report are:

- ✓ to analyse **the structure of national education systems** and regulatory frameworks governing secondary education;
- ✓ to examine **secondary education curricula and subject standards**, focusing on history and STEAM-related subjects;
- ✓ to identify **historical themes, events, processes and case studies** within the curricula that demonstrate conceptual or thematic links with STEAM disciplines;
- ✓ to analyse **policy documents and pedagogical guidelines** that support interdisciplinary learning approaches;

- ✓ to collect and describe **examples of interdisciplinary educational practices** illustrating the integration of historical and STEAM content;
- ✓ to classify identified historical contents according to their **interdisciplinary potential and relevance for STEAM integration**.

The findings of national analyses prepared by project partners constitute the **primary data source for comparative analysis** within WP2. Through this process, the project aims to identify both **nationally specific contents**, reflecting particular historical and educational contexts, and **internationally shared contents** that appear across several partner-country curricula and demonstrate strong potential for cross-national educational application.

By systematically mapping connections between historical and STEAM contents in secondary school curricula, this activity supports the broader objectives of the PAST project: strengthening interdisciplinary approaches in school education, supporting competence-oriented learning, and providing an evidence-based foundation for the development of pedagogical recommendations and educational resources integrating history and STEAM

2. NATIONAL EDUCATION SYSTEM STRUCTURE AND REGULATIONS

2.1 LITHUANIA

The Lithuanian education system is regulated by the **Law on Education of the Republic of Lithuania**, which defines the structure, governance principles and objectives of the national education framework. According to this legislation, the education system consists of **formal education, non-formal education, self-education and educational assistance**, forming an integrated system designed to support lifelong learning and the development of key competences. Secondary education belongs to the formal education sector and is guaranteed by the state, although it is not compulsory.

Formal general education in Lithuania is organised in three main stages: **primary education, basic education and secondary education**. Secondary education represents the final stage of general education and aims to consolidate learners' academic knowledge, civic awareness and preparedness for further studies or professional pathways. The programme

typically lasts **two years and is implemented in grades 11–12 (III–IV gymnasium)**. Students usually enter this stage at the age of **16–17** and complete it at **18–19**.

The objectives of secondary education are defined in national legislation and educational policy documents. The programme seeks to enable learners to acquire **general subject-based knowledge, sociocultural and technological literacy**, while simultaneously fostering **moral, civic and national maturity**. It also aims to provide the foundations for future professional competence and higher education studies. Completion of the programme requires successful fulfilment of curriculum requirements and passing **national matriculation examinations**.

The structure of the secondary education programme combines **mandatory and optional subjects**, allowing students to personalise their learning pathways according to their interests and future academic or professional goals. In certain cases, general education programmes may also include **vocational training modules**, enabling stronger links between general education and vocational education pathways.

From a systemic perspective, this stage of education creates favourable conditions for **interdisciplinary learning and competence-based education**, which are key principles of the Lithuanian curriculum reform. Students at this level have developed sufficient cognitive and analytical abilities to engage with complex social, technological and environmental issues. As a result, secondary education provides a particularly suitable educational context for exploring **interdisciplinary connections between historical knowledge and STEAM disciplines**, including scientific discoveries, technological developments and environmental transformations.

2.2 SERBIA

The Serbian education system is regulated by the **Law on the Foundations of the Education System (Zakon o osnovama sistema obrazovanja i vaspitanja)**, which establishes the structural, organisational and normative framework of education at all levels. The law defines the objectives of the education system, the rights and obligations of participants in the educational process, and the mechanisms for quality assurance and development. Secondary education is an integral part of the formal education system and is not compulsory, although it is attended by the large majority of young people.

Secondary education in Serbia is structured into two main tracks: **general secondary education (gymnasium)** and **vocational secondary education**. The gymnasium programme lasts **four years** and is intended for students aged 14 to 18. It provides a broad academic education across the humanities, sciences, mathematics and social sciences, preparing students primarily for university studies. Vocational secondary schools offer programmes of varying duration: **four-year programmes** in technical, economic, medical and artistic fields; **three-year programmes** for craft and trade occupations; and **two-year programmes** for certain specialised vocational qualifications.

The structure of secondary education in Serbia creates varying conditions for interdisciplinary learning, depending on the type and duration of the programme. The gymnasium programme, with its extended and academically oriented curriculum, provides the most favourable context for developing **interdisciplinary connections between history and STEAM subjects**. Students in the gymnasium programme study history as a compulsory subject throughout all four or three years (depending on gymnasium type), alongside physics, chemistry, biology and geography, which provides a sustained basis for identifying and exploring thematic and conceptual overlaps.

Completion of secondary education is confirmed by passing the **final examination (matura)**, which is required for both gymnasium and four-year vocational school graduates. Students wishing to continue their education at university level are required to take the **unified admission examination**, administered centrally by the universities. This examination-oriented structure tends to influence curriculum priorities and teaching approaches, although recent educational reforms have increasingly emphasised competence development, critical thinking and active learning methods.

From the perspective of the PAST research framework, the Serbian secondary education system presents significant opportunities for integrating history and STEAM content, particularly within the gymnasium programme. The breadth of the curriculum, combined with the national emphasis on both historical literacy and scientific education, creates a favourable foundation for identifying **nationally specific and internationally shared PAST contents** that can support interdisciplinary approaches in classroom practice.

2.3 POLAND

The Polish education system is governed by the Education Law (Prawo oświatowe) and the Act on Education System (Ustawa o systemie oświaty), which together define the organisational, structural and normative foundations of schooling at all levels. These legal acts outline the aims of education, the responsibilities of institutions and participants, and the mechanisms for curriculum development, quality assurance and evaluation. Secondary education in Poland is part of the formal, compulsory education pathway until the age of 18, although the specific type of school chosen by students varies according to their interests and future plans.

Secondary education is organised into several main types of schools: general secondary schools (liceum ogólnokształcące), technical secondary schools (technikum) and sectoral vocational schools (branżowa szkoła I i II stopnia). The general secondary school programme lasts four years and provides a broad academic curriculum across the humanities, sciences and social sciences, preparing students primarily for higher education. Technical secondary schools also last five years and combine general education with specialised vocational training, enabling graduates to pursue both employment and university studies. Sectoral vocational schools offer two- or three-year programmes focused on practical skills and specific occupations, with the possibility of continuing education in the second stage of vocational schooling.

The structure of secondary education in Poland creates differentiated conditions for interdisciplinary learning, depending on the type of school and curriculum profile. The general secondary school, with its extended academic programme and the requirement to choose advanced-level subjects (przedmioty rozszerzone), offers the most favourable environment for integrating history with STEAM disciplines. History is taught as a compulsory subject, there is also possibility to continue it at the advanced level. Simultaneously, students study mathematics, biology, chemistry, physics and geography, which provides a stable foundation for identifying thematic and conceptual intersections across disciplines.

Completion of secondary education is confirmed by the “matura” examination (egzamin maturalny), which is obligatory for liceum and technikum graduates wishing to pursue higher education. The “matura” exam consists of compulsory examinations in Polish language, mathematics and a modern foreign language, as well as at least one advanced-level subject chosen by the student. This examination-oriented structure significantly shapes curriculum priorities and teaching practices, although recent reforms have increasingly emphasised competence development, problem-solving, critical thinking and project-based learning.

From the perspective of the PAST research framework, the Polish secondary education system offers substantial opportunities for integrating history and STEAM content, particularly within the general secondary school and technical school pathways. The scope of the curriculum, combined with national priorities in both historical education and scientific literacy, creates a strong foundation for identifying nationally specific and internationally shared PAST contents. These can support interdisciplinary approaches that enhance students’ understanding of the interconnectedness of historical processes, technological development and scientific knowledge.

2.4 ITALY

The Italian education system is regulated by the Ministry of Education and Merit (Ministero dell’Istruzione e del Merito) under the framework established by the Italian Constitution and subsequent legislative decrees, particularly Presidential Decree 89/2010 (Riordino della scuola secondaria di secondo grado).

Upper secondary education (istruzione secondaria di secondo grado) is compulsory within the broader framework of ten years of compulsory education and generally covers ages 14–19. It is structured into three main pathways:

- Licei (general/academic education)
- Istituti Tecnici (technical education)
- Istituti Professionali (vocational education)

The five-year structure culminates in the State Examination (Esame di Stato), which grants access to higher education.

The Licei (particularly Liceo Scientifico, Liceo Classico, and Liceo delle Scienze Umane) provide strong opportunities for interdisciplinary work between History and STEAM subjects. Technical institutes also offer relevant intersections, particularly in technology, environmental science and industrial systems.

This structure allows significant flexibility for cross-curricular planning, especially in the final three years, where thematic depth and critical reasoning are emphasised.

3. SECONDARY EDUCATION CURRICULA AND SUBJECT STANDARDS

3.1 LITHUANIA

The Lithuanian **General Secondary Education Curricula** constitute the main national regulatory framework defining educational content, learning outcomes and subject standards for secondary education. These curricula are approved at national level and are aligned with the objectives established in the Law on Education of the Republic of Lithuania. They define the structure of learning content, competence development goals and expected student achievements across all subjects taught in secondary school.

The curricula are developed on the basis of educational research, national and international student achievement studies, and the evolving social, economic and technological needs of society. In recent curriculum reforms, particular emphasis has been placed on **competence-based education**, interdisciplinary learning and the development of critical thinking, creativity and scientific literacy. These principles create favourable conditions for identifying connections between different subject areas, including history and STEAM disciplines.

Within the framework of WP2 research methodology, curriculum mapping focuses on identifying **themes, concepts and learning contexts within secondary education curricula that demonstrate conceptual or thematic overlap between historical and STEAM contents**. The analysis therefore examines both the **history curriculum** and selected STEAM-related subjects, particularly physics, biology, chemistry and geography.

The history curriculum in Lithuanian secondary education aims to develop students' understanding of political, social, cultural and environmental processes in both national and

global contexts. It emphasises historical thinking, chronological reasoning, the analysis of historical sources and the ability to interpret historical developments in relation to contemporary societal challenges. Several thematic areas within the curriculum provide clear opportunities for interdisciplinary connections with scientific and technological topics.

In parallel, the curricula of STEAM-related subjects address scientific principles, environmental processes and technological developments that are closely connected with historical transformations. For example:

- ✓ **Physics curricula** include topics related to the history of scientific discoveries, energy systems, nuclear physics and technological innovation;
- ✓ **Biology curricula** address themes such as ecology, biodiversity, microorganisms, infectious diseases and human impact on ecosystems;
- ✓ **Chemistry curricula** analyse topics such as fossil fuels, atmospheric processes, environmental pollution and sustainable use of resources;
- ✓ **Geography curricula** focus on climate systems, natural resources, energy production, environmental change and sustainable development.

These subject areas demonstrate significant **thematic overlap with historical topics**, particularly those related to technological development, environmental change, industrialisation and public health. Such overlaps provide opportunities to analyse historical processes through scientific perspectives and to contextualise scientific developments within historical narratives.

The curriculum structure also supports **horizontal coherence between subjects**, meaning that different disciplines may address similar phenomena from complementary perspectives. For instance, topics such as industrialisation, environmental transformation or pandemics can be examined simultaneously through historical analysis and scientific explanation. This coherence strengthens the interdisciplinary potential of the curriculum and facilitates the integration of history and STEAM subjects in educational practice.

3.2 SERBIA

The secondary education curricula in Serbia are defined by the **Rulebooks on Curricula (Pravilnici o nastavnom planu i programu)**, issued by the Ministry of Education of the Republic of Serbia and published in the Official Gazette. These documents specify the educational content, learning objectives, recommended methodological approaches and expected student competences for each subject at each level of secondary education. The curricula are developed and updated by the Institute for the Improvement of Education (**Zavod za unapređivanje obrazovanja i vaspitanja – ZUOV**), in collaboration with subject specialists, teachers and academic experts.

Educational standards in secondary education in Serbia represent a key mechanism for ensuring quality and consistency in the education system. These standards define the expected learning outcomes that students should achieve at different levels of education and serve as a basis for curriculum development, teaching, and assessment. They include general achievement standards for academic subjects and qualification standards for vocational education, reflecting both educational and labor market needs. In recent years, Serbia has shifted toward an outcome-based and competence-oriented approach, aligning its standards with European educational frameworks and emphasizing critical thinking, problem-solving, and digital skills. Educational standards also play a central role in student assessment, including grading and final examinations, thereby linking teaching processes with measurable learning outcomes.

In Serbia, **educational standards** (standardi postignuća) define:

- what students should know, understand, and be able to do
- the expected level of achievement at the end of an educational cycle
- the basis for assessment and evaluation

They are established by national institutions, mainly:

- Ministry of Education
- Institute for the Evaluation of the Quality of Education (IEQE)

Standards are legally grounded in the Law on the Fundamentals of the Education System, which regulates goals, outcomes, and quality assurance in education. General achievement standards are the most important standards for secondary education and they:

- define learning outcomes for general subjects (e.g., Serbian language, mathematics, sciences)
- exist for: general secondary education (gymnasium) and vocational secondary education (general subjects)

Standards are typically structured in levels of achievement: basic level (minimum expected knowledge), intermediate level and advanced level.

Within the framework of WP2 research methodology, curriculum mapping focuses on identifying **themes, concepts and learning contexts within secondary education curricula that demonstrate conceptual or thematic overlap between historical and STEAM contents**. The analysis therefore examines both the **history curriculum** and selected STEAM-related subjects – particularly physics, biology, chemistry and geography, as these are the disciplines most directly relevant to the integration objectives of the PAST project.

The history curriculum in Serbian secondary education is structured chronologically, covering the period from prehistory to the contemporary era. It addresses political, social, cultural and technological developments in both the national and global context. Particular attention is given to Serbian medieval history, the Serbian revolutions of the nineteenth century, the World Wars and twentieth-century Yugoslav history. The curriculum emphasises **historical thinking, the analysis of primary sources** and the ability to contextualise historical processes within broader social and environmental frameworks. Several thematic areas within the history curriculum provide clear opportunities for interdisciplinary connections with scientific and technological topics.

In parallel, the curricula of STEAM-related subjects in Serbian secondary schools address scientific principles, environmental processes and technological developments that are closely connected with historical transformations. For example:

- **Physics curricula** include topics related to mechanics, thermodynamics, electromagnetism, atomic and nuclear physics, which correspond directly to historical developments such as the industrialisation of Serbia, the scientific contributions of Nikola Tesla, and the construction of Serbia's railway and infrastructure network;
- **Biology curricula** address topics such as microbiology, infectious diseases, ecology and evolutionary processes, providing clear connections with historical themes related to epidemics, public health and environmental transformation;
- **Chemistry curricula** analyse topics such as industrial chemistry, metallurgy, fossil fuels and environmental pollution, which are relevant to the history of Serbian mining, industrialisation and the environmental consequences of economic development;
- **Geography curricula** focus on physical geography, natural resources, climate systems and human–environment interactions, supporting interdisciplinary analysis of how Serbian landscapes have been transformed by historical economic and technological processes.

These subject areas demonstrate significant thematic overlap with historical topics, particularly those related to technological development, industrialisation, environmental change and public health. The history of Serbian mining and metallurgy, the role of Nikola Tesla in the development of electrical technology, the construction of the railway network in nineteenth-century Serbia, and the epidemics that affected Serbian society during the First World War all represent themes where **historical knowledge and STEAM content intersect in educationally meaningful ways**.

The curriculum structure in Serbian secondary schools also supports a degree of **horizontal coherence between subjects** – different disciplines may address similar phenomena from complementary perspectives. For instance, topics such as industrialisation, environmental transformation or epidemics can be examined simultaneously through historical analysis and scientific explanation. This coherence strengthens the interdisciplinary potential of the curriculum and facilitates the integration of history and STEAM subjects in educational practice.

3.3 POLAND

The secondary education curricula in Poland are defined by the Core Curriculum (Podstawa programowa kształcenia ogólnego), issued by the Ministry of National Education (Ministerstwo Edukacji Narodowej – MEN) and published in the Journal of Laws. The core curriculum establishes the mandatory learning outcomes, general educational goals, and subject-specific requirements for all types of secondary schools, including general secondary schools (liceum ogólnokształcące) and technical secondary schools (technikum). Based on the core curriculum, schools and publishers develop detailed teaching programmes and textbooks, which must remain aligned with national standards.

The development and revision of the curriculum is supported by expert teams composed of academics, teachers, and specialists from the Institute of Educational Research (Instytut Badań Edukacyjnych – IBE) and other national bodies. In recent years, Poland has strengthened its emphasis on competence-based education, critical thinking, problem-solving, and digital literacy, aligning its educational framework with European standards and the needs of a modern labour market.

Educational standards in Poland define:

- what students should know and be able to do at each stage of education
- the expected learning outcomes for each subject
- the basis for assessment, external examinations, and quality assurance

These standards are legally grounded in the **Education Law (Prawo oświatowe)** and related regulations. They form the foundation for:

- internal school assessment
- external examinations (e.g., Matura)
- curriculum planning and teaching practice

The Polish core curriculum defines mandatory learning outcomes that all students must achieve, while schools may extend them through additional content. The curricula of STEAM subjects in Poland address scientific principles, environmental processes, and technological developments that closely intersect with historical transformations.

Physics - covers mechanics, thermodynamics, electricity and magnetism, optics, waves and vibrations, atomic and nuclear physics. These topics connect with:

- the industrialisation of Polish lands in the 19th century
- the development of mining and metallurgy
- the contributions of Polish scientists such as Maria Skłodowska-Curie, Jan Czocharlski
- the electrification and modernisation of interwar Poland

Biology - includes microbiology, botany, zoology, genetics, ecology, human anatomy and physiology, environmental biology. These areas relate to:

- historical epidemics (e.g., cholera, typhus, Spanish flu)
- public health reforms in the Second Polish Republic
- environmental changes caused by industrialisation and agriculture

Chemistry - addresses chemical reactions, organic and inorganic chemistry, industrial chemistry, and environmental chemistry. These topics connect with:

- the history of Polish chemical industry (e.g., nitrogen plants in Mościce)
- mining and metallurgy in Silesia
- the environmental consequences of industrial development
- the contributions of Polish scientists such as Ignacy Łukasiewicz

Geography - covers physical geography, natural resources, climate systems, and socio-economic geography. These topics support interdisciplinary analysis of:

- how Polish landscapes were shaped by industrialisation, agriculture, and urbanisation
- the role of natural resources (coal, salt, metals) in economic and technological history
- demographic and environmental changes across historical periods

These subject areas demonstrate significant thematic overlap with historical topics, especially those related to:

- technological development
- industrialisation
- environmental change
- public health
- scientific discoveries and their societal impact

Examples of strong integration points include:

- the development of the Polish mining and steel industry
- the scientific legacy of Maria Skłodowska-Curie
- the construction of railways and industrial centres in the 19th century
- the environmental impact of communist-era heavy industry
- the role of epidemics in shaping Polish society and public health policies

The structure of the Polish curriculum supports horizontal coherence, allowing different subjects to address similar phenomena from complementary perspectives. This coherence strengthens the interdisciplinary potential of the curriculum and facilitates meaningful integration of history and STEAM subjects in educational practice — fully aligned with the objectives of the PAST project.

3.4 ITALY

The Italian National Guidelines for Secondary Education (*Indicazioni Nazionali per i Licei* and *Linee Guida per gli Istituti Tecnici e Professionali*) constitute the main regulatory framework defining educational content, learning objectives and subject standards for upper secondary education. These frameworks are established at national level by the Italian Ministry of Education and are aligned with the principles outlined in the Italian Constitution and national education policies. They define expected learning outcomes, key competences and subject-specific knowledge across all disciplines taught in secondary schools.

The Italian curricula are designed in accordance with European key competences for lifelong learning and are informed by educational research, international assessment frameworks (such as OECD-PISA) and evolving societal needs. Recent reforms have increasingly emphasised competence-based learning, interdisciplinarity, digital skills and the development of critical thinking, creativity and scientific literacy. These elements create favourable conditions for identifying connections across disciplines, including between history and STEAM subjects.

Within the framework of WP2 research methodology, curriculum mapping in Italy focuses on identifying thematic, conceptual and methodological links between history and STEAM-related subjects within secondary education. The analysis therefore considers both the history curriculum and key STEAM disciplines, particularly physics, biology, chemistry, geography

(as well as earth sciences), and artistic disciplines such as visual arts, design, architecture and creative expression.

The history curriculum in Italian secondary education aims to develop students' understanding of historical processes at local, national, European and global levels. It promotes the development of historical thinking, including the ability to analyse sources, understand cause-and-effect relationships, interpret change over time and critically engage with different perspectives. The curriculum places strong emphasis on connecting past events with contemporary issues, including social, economic, technological and environmental challenges. Several thematic areas offer clear opportunities for interdisciplinary connections with scientific and technological domains. In addition, artistic disciplines play a crucial role in interpreting historical contexts, as they provide visual, material and cultural representations of historical periods. Art history, architecture and design enable students to explore how scientific knowledge, technological innovation and aesthetic values have evolved together across time.

At the same time, STEAM-related subjects address scientific knowledge, environmental systems and technological developments that are closely linked to historical transformations. For example:

- **Physics curricula** include the study of energy, mechanics, electromagnetism, modern physics and the historical development of scientific theories and technological innovations;
- **Biology curricula** explore topics such as ecosystems, biodiversity, human biology, genetics, evolution and public health;
- **Chemistry curricula** focus on matter, chemical reactions, environmental chemistry, materials and sustainable resource use;
- **Geography and Earth Sciences curricula** address climate systems, natural resources, environmental change, risk management and sustainable development.
- **Artistic subjects** (including visual arts, art history, design and architecture) contribute to historical understanding by analysing visual culture, symbolic representation and material heritage. Through the study of artistic movements, architectural styles and design practices, students can interpret how societies

expressed technological progress, scientific knowledge and cultural values. Artistic production thus becomes both a historical source and a means of interdisciplinary inquiry within STEAM education.

These subject areas present significant thematic overlap with historical content, particularly in relation to industrialisation, scientific revolutions, technological progress, environmental transformations and health crises. Such overlaps allow students to explore historical phenomena through scientific perspectives while situating scientific developments within their historical, social and cultural contexts.

The Italian curriculum framework also encourages horizontal coherence across subjects, promoting interdisciplinary approaches and collaborative teaching practices. Topics such as industrial development, environmental sustainability, energy transitions and pandemics can be addressed from both historical and scientific viewpoints, enhancing students' ability to understand complex, real-world issues. This coherence strengthens the potential for integrating history and STEAM subjects within educational practice and supports the development of transversal competences essential for active citizenship.

4. POLICY DOCUMENTS AND PEDAGOGICAL GUIDELINES

4.1 LITHUANIA

In addition to formal curriculum regulations, the development and implementation of secondary education in Lithuania are guided by a range of **national education policy documents and pedagogical guidelines** that shape the overall direction of teaching and learning in schools. These documents define strategic priorities for education, promote competence-based learning and encourage interdisciplinary approaches that are relevant for the integration of history and STEAM subjects.

One of the key policy orientations of Lithuanian education policy is the transition towards **competence-based education**, which emphasises the development of transferable skills such as critical thinking, problem solving, creativity and the ability to apply knowledge in real-life contexts. Educational policy documents highlight the importance of connecting learning

content with contemporary societal, technological and environmental challenges. This orientation encourages teachers to design learning activities that link knowledge from different subject areas and support interdisciplinary learning.

Pedagogical guidelines issued by the Ministry of Education, Science and Sport also emphasise the importance of **contextualised learning**, where students analyse real historical, scientific and social phenomena through multiple disciplinary perspectives. Such approaches promote deeper understanding of complex issues such as technological development, environmental change or public health, which are relevant to both historical analysis and STEAM disciplines.

Another important principle promoted in national policy documents is the development of **scientific literacy and sustainability awareness**. Educational guidelines encourage the integration of environmental, technological and societal themes across different subjects. This creates opportunities for linking historical topics, such as industrialisation, environmental transformations or historical epidemics, with scientific explanations provided in STEAM subjects.

Lithuanian pedagogical recommendations also encourage the use of **inquiry-based and problem-based learning methods**, which support interdisciplinary analysis of historical and scientific phenomena. These approaches involve the interpretation of historical sources, the analysis of scientific data and the exploration of cause-and-effect relationships between technological development, environmental change and societal transformation.

From the perspective of the PAST research framework, these policy orientations create a favourable environment for identifying curriculum contents where **historical knowledge intersects with STEAM disciplines**. The emphasis on competence development, contextual learning and interdisciplinary approaches supports the integration of historical perspectives into the teaching of scientific and technological topics, thereby reinforcing the broader educational objectives of the project.

4.2 SERBIA

In addition to formal curriculum regulations, the development and implementation of secondary education in Serbia are shaped by a range of **national education policy**

documents and pedagogical guidelines that define strategic priorities for teaching and learning. These documents promote the gradual transformation of the Serbian education system towards more competence-oriented, student-centred and interdisciplinary approaches, which are directly relevant to the integration objectives of the PAST project.

The key strategic framework for educational development in Serbia is provided by the **Strategy for Education Development in Serbia 2020–2030**. This document sets out a comprehensive vision for modernising the education system, with explicit emphasis on developing key competences, fostering critical thinking and creativity, and strengthening the connections between educational outcomes and the demands of contemporary society. The strategy promotes the integration of digital literacy, scientific thinking and civic competences across all levels of education, creating a favourable policy environment for interdisciplinary teaching approaches.

Pedagogical guidelines issued by the **Institute for the Improvement of Education (ZUOV)** emphasise the importance of contextualised and problem-based learning, where students engage with real-world phenomena and complex issues from multiple disciplinary perspectives. These guidelines encourage teachers to design learning activities that connect historical, scientific and social knowledge, thereby supporting the development of analytical and interpretive skills relevant to both history and STEAM subjects.

A particularly significant policy development is the introduction of the concept of **cross-curricular competences (međupredmetne kompetencije)** within the Serbian curriculum framework. These competences – which include scientific and technological literacy, responsible environmental behaviour, digital literacy and civic responsibility – are intended to be developed across all subjects, including history. This framework explicitly encourages teachers to identify and exploit thematic connections between different disciplines, providing a pedagogical rationale for integrating historical perspectives into the teaching of scientific and technological topics.

Serbian educational policy also promotes the use of **active and inquiry-based learning methods**, including project-based learning, research tasks and field activities. These approaches are particularly well suited to interdisciplinary teaching, as they allow students

to investigate complex phenomena that span multiple subject areas. From the perspective of the PAST research framework, such methods create practical opportunities for exploring connections between historical knowledge and STEAM disciplines in classroom settings.

From the perspective of the PAST research framework, these policy orientations create a favourable environment for identifying curriculum contents where **historical knowledge intersects with STEAM disciplines**. The emphasis on competence development, contextual learning and cross-curricular connections supports the integration of historical perspectives into the teaching of scientific and technological topics, thereby reinforcing the broader educational objectives of the project.

4.3 POLAND

Alongside official curriculum regulations, the direction and implementation of secondary education in Poland are influenced by national education policy documents and pedagogical guidelines that establish the system's strategic teaching and learning priorities. These documents emphasise competence-based education, interdisciplinary approaches and the integration of contemporary societal, technological and environmental challenges into school practice — all of which create favourable conditions for linking historical content with STEAM disciplines.

A central policy reference for Polish education is the *Core Curriculum for General Education* (*Podstawa programowa kształcenia ogólnego*), issued by the Ministry of National Education. This document outlines the expected learning outcomes for all subjects and places strong emphasis on the development of key competences, including critical thinking, problem solving, digital literacy, scientific reasoning and civic responsibility. The curriculum encourages teachers to design learning activities that connect knowledge across subject boundaries and support the application of theoretical concepts in real-life contexts. Such orientations align closely with interdisciplinary teaching approaches that integrate historical perspectives with scientific and technological themes.

Polish educational policy also promotes competence-based learning through strategic documents such as the *Integrated Skills Development Framework* and national guidelines on digital transformation in education. These documents highlight the importance of preparing students for participation in a rapidly changing, technologically advanced society. They encourage the incorporation of digital tools, data analysis and inquiry-based methods into classroom practice,

which strengthens opportunities for linking historical inquiry with scientific and technological problem solving.

Pedagogical guidelines issued by the Centre for Education Development (ORE) further emphasise contextualised and inquiry-based learning. Teachers are encouraged to engage students in analysing real historical, scientific and social phenomena through multiple disciplinary lenses. This approach supports deeper understanding of complex issues such as industrialisation, environmental change, public health or technological innovation — topics that naturally intersect with both history and STEAM subjects. The guidelines also promote project-based learning, research tasks and collaborative problem solving, which enable students to explore cause-and-effect relationships between historical processes and scientific developments.

Another important policy orientation is the promotion of environmental and sustainability education. National guidelines encourage the integration of ecological, technological and societal themes across the curriculum. This creates opportunities to connect historical topics — such as environmental transformations, industrial development or historical epidemics — with scientific explanations provided in biology, chemistry, physics and geography. Such connections support the development of scientific literacy and sustainability awareness, which are key priorities of contemporary Polish education policy.

From the perspective of the PAST research framework, these policy orientations create a supportive environment for identifying curriculum contents where historical knowledge intersects with STEAM disciplines. The emphasis on competence development, contextual learning, digital literacy and interdisciplinary approaches provides a strong pedagogical rationale for integrating historical perspectives into the teaching of scientific and technological topics. This alignment reinforces the broader educational objectives of the project and supports the development of innovative teaching practices in Polish secondary schools.

4.4 ITALY

In addition to formal curriculum regulations, the Italian education system is guided by a range of national policy documents and pedagogical guidelines that shape the overall approach to teaching and learning in secondary education. These include the *Indicazioni Nazionali per i*

Licei, the *Linee Guida per gli Istituti Tecnici e Professionali*, as well as broader strategic frameworks promoted by the Ministry of Education and aligned with European education priorities. Together, these documents define key educational objectives, promote competence-based learning and support interdisciplinary approaches relevant to the integration of history and STEAM subjects, including the interaction between scientific, technological and artistic domains.

A central orientation of Italian education policy is the progressive shift towards competence-based education, in line with the European Key Competences framework. This approach emphasises the development of transversal skills such as critical thinking, problem solving, creativity, collaboration and active citizenship. Policy documents stress the importance of linking school learning to real-world contexts, encouraging students to apply knowledge to contemporary social, technological and environmental challenges. This perspective supports the design of interdisciplinary learning pathways that connect different subject areas, including history and STEAM disciplines.

Pedagogical guidelines in Italy also promote contextualised and student-centred learning approaches. Teachers are encouraged to design educational activities that allow students to analyse complex phenomena - such as technological innovation, environmental sustainability or public health - through multiple disciplinary lenses. This approach fosters a deeper understanding of the relationships between historical developments and scientific processes, reinforcing connections between past and present.

literacy, digital competence, creativity and cultural awareness, and sustainability awareness. Initiatives such as the National Plan for Digital Education (*Piano Nazionale Scuola Digitale*) and the increasing focus on education for sustainable development encourage the integration of technological, environmental and societal themes across the curriculum. These priorities create strong opportunities for linking historical topics - such as industrialisation, energy transitions or past health crises - with scientific explanations and technological developments addressed in STEAM subjects. Furthermore, national educational priorities increasingly recognise the importance of creativity and cultural expression as key competences. This reinforces the inclusion of artistic disciplines within STEAM education, supporting

interdisciplinary approaches where historical analysis is enriched through visual interpretation, design thinking and creative production.

Italian pedagogical guidelines further support the use of inquiry-based, laboratory-based and problem-based learning methodologies. These approaches encourage students to investigate questions, analyse sources and data, and understand cause-and-effect relationships across different domains. In this context, students may explore how scientific and technological advancements have influenced historical processes, or how historical contexts have shaped scientific innovation and environmental change.

From the perspective of the PAST research framework, these policy orientations create a supportive environment for identifying intersections between historical knowledge and STEAM disciplines within secondary education. The emphasis on competence development, interdisciplinary learning and real-world relevance facilitates the integration of historical perspectives into scientific and technological education, contributing to a more holistic and interconnected understanding of complex societal challenges.

5. EXAMPLES OF INTERDISCIPLINARY TEACHING PRACTICES

5.1 LITHUANIA

Within the Lithuanian secondary education context, several themes included in the history curriculum provide opportunities for developing **interdisciplinary teaching practices linking historical content with STEAM subjects**. Such practices are based on contextual learning, where historical processes are analysed together with the scientific principles, technological developments and environmental transformations associated with them. This approach allows students to understand scientific progress not only as a technical process but also as a phenomenon shaped by historical, social and environmental contexts.

One example of interdisciplinary teaching practice involves the study of **human–environment relations in ancient civilizations**. Historical topics related to early river valley civilizations can be combined with geographical and physical analysis of river systems,

irrigation technologies and construction techniques. Students may explore how early societies adapted to environmental conditions and developed technological solutions such as irrigation systems, aqueducts or large-scale architectural structures. These activities may integrate historical analysis with concepts from physics (mechanics and water flow), geography (river systems and climate zones) and early technological innovation.

Another example concerns the historical impact of **infectious diseases and pandemics**. Historical case studies such as the Black Death or the spread of diseases during the Columbian Exchange can be analysed together with biological concepts related to microorganisms, immunity and disease transmission. Students may examine historical sources describing epidemics while simultaneously analysing biological mechanisms of disease spread and public health responses. Geography can also be integrated through the study of historical trade routes and migration patterns influencing the spread of diseases.

The theme of **industrialisation and technological development during the nineteenth and early twentieth centuries** provides further opportunities for interdisciplinary learning. Historical discussions of steam engines, railways and early electricity systems can be connected with physics concepts related to energy transformation and mechanics, as well as chemical processes such as combustion and fossil fuel use. Students may analyse how technological innovations influenced economic development, urbanisation and environmental transformation.

Environmental history topics also provide a strong basis for interdisciplinary teaching. Historical analysis of **ecological disasters and environmental movements**, such as nuclear accidents or oil spills, can be combined with scientific explanations related to nuclear physics, environmental chemistry and ecosystem damage. Students may investigate both the technological causes of environmental disasters and their historical, political and social consequences.

Another interdisciplinary context is the study of **global climate change as a contemporary historical and environmental issue**. Historical perspectives on industrial development and environmental policy can be integrated with scientific explanations of climate systems, greenhouse gases and energy balance. Such lessons allow students to analyse climate change both as a scientific phenomenon and as a historical process shaped by technological development and political decisions.

In addition to global themes, the Lithuanian curriculum also provides opportunities to integrate **national historical contexts** into interdisciplinary learning. Topics such as landscape transformation and demographic change in the territory of the Grand Duchy of Lithuania may be analysed together with geographical studies of land use and environmental change. Historical epidemics affecting Lithuanian society can be connected with biological explanations of infectious diseases and public health responses. The period of Soviet industrialisation also provides interdisciplinary learning opportunities through the analysis of industrial technologies, environmental pollution and landscape transformation. These examples demonstrate how national historical contexts can contribute to the integration of history and STEAM subjects.

The interdisciplinary connections identified through curriculum analysis can be summarised through the following mapping matrix.

Table 1. Mapping matrix: History topic and STEAM subjects in Lithuania

History curriculum theme	Physics	Biology	Chemistry	Geography	Arts/creative disciplines	Examples of STEAM integration
Human–nature relations in ancient civilizations	Mechanics, water flow, construction principles	Early agriculture and ecosystems	Natural materials and early technologies	River systems and climate zones	Architectural design and visual reconstruction of ancient societies	Modelling irrigation systems and analysing ancient engineering solutions
Life under the influence of pathogens	Diffusion processes	Microorganisms, immunity	Medical substances	Spread of diseases through trade routes	Historical medical illustrations and visual communication	Simulation of epidemic spread based on historical and biological data
Energy sources and transport during industrialisation	Steam engines, electricity	Environmental impact of industry	Combustion processes, fossil fuels	Industrial regions and urban development	Industrial design and railway architecture	Analysis of technological innovations and energy efficiency

Ecological disasters and environmental movements	Radiation and nuclear energy	Ecosystem damage	Chemical pollution	Environmental risk zones	Visual communication of ecological crises	Case studies of nuclear accidents and oil spills
Global climate change	Energy balance and atmospheric processes	Ecosystem responses	Greenhouse gases	Climate systems	Climate visualisation and eco-design	Climate data analysis and historical environmental policy discussions
Landscape and demographic change in Lithuania	-	Agricultural technologies, Population health	Resource extraction	Settlement patterns	Historical cartography and landscape visualisation	Historical GIS mapping of settlements and environmental change
Epidemics in Lithuanian history	Transmission processes	Epidemiology and immunity	Medical treatments	Regional disease spread	Historical public health visuals and epidemic representation	Comparative analysis of historical epidemics

5.2 SERBIA

Within the Serbian secondary education context, several themes included in the history curriculum provide opportunities for developing **interdisciplinary teaching practices linking historical content with STEAM subjects**. Such practices are based on contextual learning, where historical processes are analysed together with the scientific principles, technological developments and environmental transformations associated with them. This approach allows students to understand scientific progress not only as a technical process but also as a phenomenon shaped by historical, social and environmental contexts.

One example of interdisciplinary teaching practice involves the study of **medieval Serbian architecture and engineering**. Historical topics related to the construction of Serbian Orthodox monasteries during the Nemanjić dynasty can be combined with analysis of structural engineering principles, geometric proportions and construction materials. Students may explore how medieval builders applied the Byzantine architectural tradition while

developing locally specific solutions for vaulted structures, domes and stone masonry. These activities integrate historical analysis with concepts from physics (structural mechanics, load distribution), biology (plant-based building materials – timber, resin, fibres; ecological availability of resources), chemistry (mortar and lime composition, material durability), mathematics (geometric proportions) and geography (quarrying sites and availability of stone resources in the Raška region). The monastery of Studenica and the frescoes of Sopoćani provide particularly rich examples for such interdisciplinary analysis with the special focus on art as an integral part of STEAM disciplines.

Another example concerns the historical contributions of **Nikola Tesla and the development of electrical technology**. Tesla's life and scientific work can be directly connected with physics (electromagnetism, alternating current, electromagnetic induction), biology (bioelectricity and neural conductivity – the basis of Tesla's research into the nervous system; ecological impact of electricity networks on wildlife), chemistry (electrochemistry, electrolysis, chemical reactions in batteries and galvanic cells) and geography (distribution of electricity networks; the geostrategic role of hydroelectric power at Niagara and the Danube's Iron Gates). Students may analyse the historical context of the conflict between Tesla and Edison while exploring the physical principles underlying alternating current systems. The Tesla Museum in Belgrade offers additional resources for developing practical educational activities related to this theme as well as the artistic approach.

The theme of **the construction of Serbia's railway network and industrialisation in the nineteenth century** provides a rich interdisciplinary context. Historical discussions of the construction of Serbia's first railway lines can be connected with physics (thermodynamics, steam engines, mechanics of motion and friction), biology (ecological impact of railway routes on habitats and fauna; spread of non-native flora along railway lines), chemistry (coal combustion processes, fossil fuels, CO₂ and sulphur dioxide emissions) and geography (terrain analysis and route planning; urban development and demographic changes along railway corridors). Students may analyse how railway infrastructure transformed Serbian economic development, urbanisation and political relations.

The history of **Serbian mining and metallurgy** offers another rich interdisciplinary context. The medieval silver mines of Novo Brdo and the copper mines of Bor and Majdanpek can be analysed together with physics (physical properties of metals: conductivity, density, strength; mechanics of mining), biology (impact of mining on ecosystems; pollution bioindicators; ecotoxicology – effects of heavy metals on living organisms), chemistry (ore processing, metal extraction, reduction reactions, chemistry of mine drainage and acid waters) and geography (geological map of Serbia – distribution of mineral deposits; impact of mining on landscape transformation). Students may investigate both the historical economic significance of mining and the environmental consequences of industrial extraction.

Public health and epidemics also provide strong interdisciplinary connections. The **typhus epidemic of 1914–1915**, which caused significant casualties among the Serbian army and civilian population during the First World War, can be analysed together with physics (diffusion processes and heat transfer – body temperature, sterilisation by heat), biology (the causative agent of typhus – *Rickettsia prowazekii*, transmission via lice, the immune response, vaccination, epidemiology), chemistry (disinfectants – carbolic acid, chlorinated lime; chemical agents for vector control) and geography (regional spread of the epidemic along military lines; role of waterways and sanitary conditions in the field). Students may examine historical sources and evaluate the effectiveness of the public health measures that were implemented.

The theme of **geographical discoveries and navigation in the Early Modern Period** also provides a rich interdisciplinary context. It can be connected with physics (astronomical measurements, spherical trigonometry, principles of navigation – compass, sextant, celestial navigation), biology (the Columbian Exchange – transfer of plant and animal species; spread of infectious diseases between continents; ecological impact of contact between civilisations), chemistry (preservation of foodstuffs on long voyages – salt, vinegar, pickling techniques; chemical composition of bronze and copper vessels) and geography (cartography and map projections; climate zones; ocean currents and wind systems on global navigation charts). This theme has high international potential and is applicable to the Serbian history curriculum. The topic is also very well-suited for a wide variety of artistic expressions.

The theme of **SFRY industrialisation and technological development (1945–1990)** provides an exceptionally rich STEAM context. It can be connected with physics (nuclear physics and the INN Vinča reactor; energy systems; principles of hydroelectric power at the Iron Gates), biology (ecological impact of industrialisation on rivers, forests and biodiversity; pollution as ecological pressure; establishment of the Derdap National Park as a response to industrialisation), chemistry (industrial chemistry – petrochemistry, Pančevo, Bor; atmospheric and soil pollution; chemistry of industrial wastewater) and geography (industrial regions; urban transformation of Belgrade and Novi Sad; rural-urban migration flows; the Iron Gates and changes to the Danube). Students may analyse GDP growth data and investigate civilian technologies originating from Cold War-era development.

The interdisciplinary connections identified through curriculum analysis can be summarised through the following mapping matrix.

Table 1. Mapping matrix: History topics and STEAM subjects in Serbia

History curriculum theme	Physics	Biology	Chemistry	Geography	Art	Examples of STEAM integration
Medieval Serbian monastic architecture (Nemanjić dynasty)	Structural mechanics, load distribution in vaults and domes	Plant-based building materials – timber, resin, fibres; ecological availability of resources	Mortar and lime composition; durability and resistance of building materials	Quarrying sites; geological distribution of building stone in the Raška region	Analysis of geometric proportions of domes including artistic approach	Field trip to Studenica or Sopoćani
Nikola Tesla and the development of electrical technology	Electromagnetism, alternating current, electromagnetic induction	Bioelectricity and neural conductivity; ecological impact of electricity networks on wildlife	Electrochemistry, electrolysis, chemical reactions in batteries and galvanic cells	Distribution of electricity networks; hydroelectric power (Niagara, Iron Gates)	Visit to Tesla Museum including artistic approach; artistic visualization	Demonstration of electromagnetic induction; debate – War of Currents (AC vs DC);
Construction of Serbia's railway network and	Thermodynamics, steam engines, mechanics of	Ecological impact of railway routes on habitats;	Coal combustion, fossil fuels, CO ₂ and sulphur	Terrain analysis and route planning;	The use of mapping network as a base for	Calculating railway gradients and friction forces;

industrialisation (19th century)	motion and friction	spread of non-native flora along railway lines	dioxide emissions	urban development and demographic change along railway corridors	artistic inspiration	mapping the network and demographic changes along railway corridors
Serbian mining and metallurgy – Novo Brdo, Bor, Majdanpek	Physical properties of metals (conductivity, density, strength); mechanics of mining	Impact of mining on ecosystems; pollution bioindicators; ecotoxicology – effects of heavy metals on living organisms	Ore processing, metal extraction, reduction reactions; chemistry of mine drainage and acid waters	Geological map of Serbia – distribution of mineral deposits; impact of mining on landscape	The use of mapping network as a base for artistic inspiration	Chemical analysis of ore samples; GIS mapping of historical mining areas using geological data
Typhus epidemic of 1914–1915	Diffusion and heat transfer (sterilisation); thermodynamics of disinfection by heat	Causative agent (Rickettsia prowazekii), transmission via lice, immune response, vaccination, epidemiology	Disinfectants – carbolic acid, chlorinated lime; chemical agents for vector control (insecticides)	Regional spread along military lines; role of waterways and sanitary conditions in the field	Epidemic spread modelling by using artistic approach	Epidemiological curve analysis; comparison of historical and contemporary epidemic responses
Geographical discoveries and navigation (Early Modern Period)	Astronomical measurements, spherical trigonometry, navigation instruments – compass, sextant, celestial navigation	Columbian Exchange – transfer of plant and animal species; spread of infectious diseases between continents; ecological impact of contact between civilisations	Preservation of foodstuffs on long voyages (salt, vinegar, pickling); chemical composition of bronze and copper vessels	Cartography and map projections; climate zones; ocean currents and wind systems	A wide variety of possibilities for artistic expressions by using old maps	Analysing historical maps and comparing with modern; calculating geographic latitude from stellar observations;
SFRY industrialisation and technological development (1945–1990)	Nuclear physics – INN Vinča reactor; energy systems; principles of hydroelectric	Ecological impact of industrialisation on rivers, forests and biodiversity;	Industrial chemistry – petrochemistry, Pančevo, Bor; atmospheric and soil pollution;	Industrial regions; urban transformation of Belgrade and Novi Sad; rural-urban	A wide variety of possibilities for artistic expressions by using	Analysing GDP growth data; researching civilian technologies from Cold War-

	power (Iron Gates)	pollution as ecological pressure; Derdap National Park	chemistry of industrial wastewater	migration; Iron Gates and the Danube	industrial map	era development; comparing SFRY and contemporary industrial maps
--	--------------------	--	------------------------------------	--------------------------------------	----------------	--

5.3 POLAND

Within the Polish secondary education context, several themes included in the history curriculum provide strong opportunities for developing interdisciplinary teaching practices that link historical content with STEAM subjects. These practices are grounded in contextual learning, where historical developments are examined alongside the scientific principles, technological innovations and environmental transformations that shaped them. Such an approach enables students to understand scientific and technological progress not only as a sequence of technical achievements but also as processes embedded in broader historical, social and environmental contexts.

One significant area for interdisciplinary integration is the **development of the Polish mining and steel industry**. Historical discussions of industrial growth in regions such as Upper Silesia or the Dąbrowa Basin can be combined with scientific explanations of mineral extraction, metallurgy and energy use. Students may analyse how geological conditions influenced the location of mines, how technological innovations in steel production transformed local economies, and how industrialisation reshaped urban landscapes. These lessons naturally connect history with chemistry (metal processing), physics (energy transfer and heat), and geography (resource distribution and industrial regions).

Another powerful integration point is the **scientific legacy of Maria Skłodowska-Curie**, whose work provides a direct bridge between historical biography and scientific discovery. Students can explore her contributions to radioactivity within both historical and scientific frameworks: analysing primary sources, understanding the social context of women in science, and studying the physical principles of radioactive decay. This interdisciplinary approach links history with physics (radiation, atomic structure), chemistry (radioactive elements) and ethics (scientific responsibility and public health).

The **construction of railways and industrial centres in the 19th century** offers further opportunities for interdisciplinary learning. Historical topics related to the expansion of railway networks can be integrated with physics concepts such as mechanical motion, energy conversion and material strength. Students may investigate how railway development accelerated economic integration, migration and urbanisation, while also examining the engineering challenges of bridge construction, track design and steam engine mechanics. Geography contributes through the study of transport corridors, regional development and spatial planning.

Environmental history provides another rich area for interdisciplinary teaching, particularly through the **environmental impact of communist-era heavy industry**. Historical analysis of industrial policies, central planning and rapid urbanisation can be combined with scientific explanations of pollution, ecosystem degradation and environmental monitoring. Students may examine case studies of industrial regions affected by air and water contamination, linking historical decisions with chemical processes (emissions, waste products), biology (ecosystem damage) and geography (landscape transformation). This approach encourages critical reflection on the long-term consequences of technological development.

The **role of epidemics in shaping Polish society and public health policies** also offers strong interdisciplinary potential. Historical case studies — such as cholera outbreaks in the 19th century, the Spanish flu, or post-war public health campaigns — can be analysed together with biological concepts related to pathogens, immunity and disease transmission. Students may work with historical documents describing epidemics while simultaneously studying the scientific mechanisms behind infection and the development of public health responses. Geography can be integrated through the analysis of migration patterns, urban density and regional differences in spreading diseases.

Together, these examples demonstrate how the Polish curriculum provides multiple entry points for integrating history with STEAM subjects. By connecting historical processes with scientific principles, technological developments and environmental transformations, interdisciplinary teaching helps students develop a deeper, more holistic understanding of the past and its relevance to contemporary scientific and societal challenges.

The mapping matrix below illustrates how key history curriculum themes in secondary education in Poland relate to STEAM subjects.

History Curriculum Theme	Physics	Biology	Chemistry	Geography	Art	Examples of STEAM Integration
Early Slavic settlements and medieval state formation	Material strength of wood; mechanics of fortifications	Early agriculture; forest ecosystems	Early metallurgy; iron smelting	River systems; settlement patterns	Reconstruction of material culture; ornamentation of artefacts; medieval iconography	Reconstructing <i>grodzisko</i> structures; designing models of defensive ramparts; analysing decorative motifs on archaeological finds
Epidemics in Polish history (plague, cholera, typhus)	Diffusion processes; sterilisation	Pathogens, immunity, epidemiology	Disinfectants; water contamination	Spread along trade routes and migration paths	Historical medical illustrations; visual communication in public health campaigns	Epidemic spread modelling; comparing historical and modern visual communication strategies; designing public health posters
Construction of railways and industrial centres (19th c.)	Steam engines; mechanical motion; material strength	Public health in industrial cities	Combustion; fuel chemistry	Transport corridors; urban growth patterns	Industrial architecture; railway station design; technical drawing	Modelling steam engine efficiency; mapping railway expansion; analysing industrial architecture of stations and factories
Industrialisation in Poland (19th–20th c.)	Steam engines, electricity, mechanics	Urban health; labour conditions	Combustion, fossil fuels, textile dyes	Industrial regions (Łódź, Silesia)	Textile design; factory aesthetics; photography of industrial landscapes	Mapping industrial growth; analysing energy efficiency; studying textile patterns from Łódź factories
Polish mining and metallurgy (Silesia, Kraków region)	Properties of metals; mining mechanics	Ecotoxicology; impact on ecosystems	Ore processing; acid mine drainage	Geological distribution of resources	Mining iconography; industrial sculpture;	Chemical analysis of ore; GIS mapping of mining areas;

					visual documentation of mines	creating artistic interpretations of mining landscapes
Scientific heritage (Curie, Czoehrlski, Łukasiewicz)	Radioactivity; electromagnetism	Medical applications of radiation	Chemical reactions in fuel and materials	Global scientific networks	Scientific illustration; portraiture; visualisation of scientific concepts	Recreating historical experiments; analysing scientific biographies; designing visualisations of atomic structure or crystal growth
WWII and technological innovation (Enigma, cryptography)	Electromagnetism; signal transmission	Human factors in intelligence work	Chemical inks, materials	Geopolitical mapping of intelligence routes	Graphic design; typography; visual coding systems	Cryptography simulations; decoding exercises; designing visual codes inspired by Enigma
Environmental impact of communist-era heavy industry	Energy systems; emissions; thermal pollution	Ecosystem degradation; bioaccumulation	Air and water pollution; industrial waste	Landscape transformation; polluted regions	Environmental photography; poster art; visual activism	Case studies of smog; analysing pollution data; creating visual campaigns on environmental change
Post-war industrialisation and energy policy	Nuclear Physics; energy systems	Environmental impact of industry	Pollution chemistry	Industrial regions; energy geography	Architectural design of power plants; visual culture of modernisation	Case studies of smog; analysis of energy transitions; designing visual narratives of energy change
Climate change and sustainability in Poland	Energy balance; atmospheric processes	Ecosystem responses	Greenhouse gases	Climate systems; land use	Eco-design; climate visualisation; infographics	Climate data analysis; sustainability projects; designing climate-awareness materials

5.4 ITALY

The Italian History curriculum follows a chronological progression from the ancient civilizations, through the Middle Ages and early modern period, up to contemporary history. However, beyond its chronological structure, the curriculum offers numerous thematic nodes that lend themselves to interdisciplinary integration with STEAM disciplines.

Ancient Civilizations and STEAM Connections

The study of ancient civilizations offers an initial and highly productive point of intersection with STEM subjects. Investigating early engineering feats such as Roman aqueducts, road networks, and urban planning enables students to explore principles of physics (mechanics, hydraulics), mathematics (measurement, geometry), and materials science (stone, concrete, and metallurgy), as well as artistic and architectural design. Agricultural innovations, including irrigation systems and crop rotation practices, provide further connections to biology and environmental science, illustrating how societies shaped and adapted to their natural surroundings. Monumental architecture, sculpture and urban aesthetics also allow connections with artistic disciplines, highlighting how technical knowledge and artistic expression were closely intertwined in ancient societies.

Human–Environment Relations and Pre-Industrial Societies

The study of medieval agricultural systems, land reclamation, hydraulic engineering and early urban development provides a first significant area of integration. Italian historical contexts — such as the management of river systems in the Po Valley or the environmental governance of the Venetian lagoon — allow students to analyse how societies adapted to and transformed their environments. These themes naturally intersect with geography (territorial organisation and climate zones), physics (mechanics applied to water systems and construction), biology (agricultural ecosystems) and chemistry (materials used in early technologies). In this way, environmental history becomes a bridge between humanistic and scientific knowledge. Artistic representations of landscapes and cities from the medieval period further support interdisciplinary analysis, offering insights into environmental perception, spatial organisation and cultural interpretation.

Renaissance and Scientific Revolution

One of the most powerful intersections between History and STEAM in the Italian curriculum emerges in the study of the Renaissance and the Scientific Revolution. Figures such as Leonardo da Vinci and Galileo Galilei embody the unity of artistic, technical and scientific inquiry.

The historical study of Galileo's methodological innovations, for example, can be directly linked to physics (mechanics and astronomy), mathematics (measurement and modelling) and the philosophy of science. Rather than treating scientific discoveries as isolated facts, the curriculum allows them to be examined as part of broader epistemological transformations. This approach strengthens both historical understanding and scientific literacy. Renaissance art, perspective studies and architectural innovations provide direct links to geometry, optics and design, demonstrating how artistic practices contributed to scientific development.

Industrialisation and Energy Transitions

The analysis of 19th- and early 20th-century industrialisation, including Italy's uneven regional development and the emergence of industrial districts in the North, offers another strong interdisciplinary platform. Industrialisation is not studied solely as an economic transformation but as a technological and environmental turning point.

The development of steam engines, electrification and hydroelectric power production connects directly with physics (thermodynamics and energy systems). The chemistry of combustion and industrial materials provides further links, while geography contributes through the study of urbanisation and spatial concentration of industries. Environmental consequences, including pollution and landscape transformation, introduce ecological and sustainability perspectives. Through this lens, industrialisation becomes a case study in technological innovation, environmental impact and social change simultaneously. At the same time, industrialisation influenced visual culture, design and architecture, from early industrial design to modern urban aesthetics, allowing further connections with artistic disciplines.

Epidemics and Public Health

The study of pandemics, from the Black Death to the Spanish Flu and contemporary global health crises, offers a particularly rich field for History–STEAM integration. Historical analysis of demographic collapse, social reactions and political responses can be integrated with biological understanding of pathogens, immunity and epidemiology.

Nuclear Energy, Technological Risk and Environmental Awareness

Post-war modernisation and energy policies in Italy include debates surrounding nuclear power, particularly after the Chernobyl disaster. The historical study of public referenda and energy strategies can be linked directly to nuclear physics, radiation science and environmental chemistry.

This topic is particularly valuable for developing critical thinking about technological risk, scientific uncertainty and democratic decision-making. It encourages students to analyse how scientific knowledge interacts with political choices and social perceptions. Links between STEM subject curricula and history themes

Climate Change and Sustainability

Contemporary history addresses globalisation, environmental movements and international climate negotiations. These topics offer one of the most comprehensive intersections between History and STEAM subjects.

The greenhouse effect (physics), atmospheric chemistry, ecosystem responses (biology) and climate systems (geography) can all be contextualised historically, demonstrating how industrial development and energy consumption patterns have shaped current environmental challenges. Students can thus understand climate change not only as a scientific issue but as a historical process rooted in economic and technological transformations.

Artistic practices, including visual communication and environmental art, can also be integrated to explore how climate change is represented and communicated in contemporary society.

Links between STEAM and History

In Italian upper secondary education, STEAM subjects are closely connected to historical analysis, particularly when addressing modern and contemporary transformations.

Physics provides the conceptual tools to understand major technological shifts examined in History. Through the study of mechanics, thermodynamics, electromagnetism and nuclear physics, students can contextualise key historical processes such as the Scientific Revolution — exemplified by figures like Galileo Galilei — as well as industrialisation, electrification and the development of energy systems. Modern physics also supports historical reflection on nuclear energy policies and events such as the Chernobyl disaster, helping students interpret technological progress alongside its risks and societal implications.

Biology contributes to historical understanding by explaining the scientific mechanisms behind demographic and environmental change. Topics such as infectious diseases, immunity, ecosystems and biodiversity allow students to analyse pandemics, agricultural revolutions, industrial pollution and environmental movements not only as social phenomena but also as biological processes. In this way, biological knowledge deepens the interpretation of historical crises and long-term transformations.

Chemistry, similarly, offers insight into the material foundations of industrial and environmental history. By studying combustion, fossil fuels, synthetic materials and atmospheric processes, students can better understand the Industrial Revolution, urbanisation, pollution and climate change. Chemical principles clarify how industrial growth reshaped both society and the natural environment, and how environmental policies emerged in response to these transformations.

Geography reinforces the spatial and environmental dimensions of historical processes. Through the analysis of climate systems, migration patterns, resource management and sustainable development, students explore how industrial districts, colonial trade networks, energy strategies and global inequalities developed over time. Geography thus provides the territorial framework within which historical, scientific and economic processes unfold.

History Curriculum Theme	Physics	Biology	Chemistry	Geography	Arts / Creative Disciplines	Examples of STEAM Integration
Ancient Civilisations	Mechanics (structures, forces), hydraulics	Early agriculture, domestication	Materials (stone, metals, early concrete)	Settlement patterns, river systems	Architecture, sculpture, urban design	Study of Roman aqueducts and roads; reconstruction of irrigation systems; analysis of ancient urban planning; visual reconstruction of ancient cities and architectural design projects
Agricultural Revolutions	Agricultural technologies	Crop systems, ecosystems	Soil chemistry	Rural land-use patterns	Rural landscapes in art, traditional design	Study of productivity and environmental impact
Scientific Revolution	Mechanics, astronomy, experimental method	Early scientific observation	Materials and instruments	Exploration routes	Scientific illustration, perspective drawing	Reconstruction of Galilean experiments; analysis of scientific instruments; study of scientific drawings and perspective techniques in Renaissance art
Industrialisation (19th century)	Thermodynamics, steam engines, electricity	Urban health impacts	Combustion, fossil fuels	Industrial regions and urban growth	Industrial design, urban visual culture	Energy efficiency analysis; mapping industrial districts; analysis of industrial design and visual transformation of urban spaces
Pandemics and Public Health	Diffusion models	Pathogens, immunity	Vaccines and pharmaceuticals	Spread routes and demographic impact	Visual communication, public awareness campaigns	Epidemiological simulations; demographic data analysis
Nuclear Energy Debate	Nuclear physics, radiation	Biological effects of radiation	Radioactive isotopes	Energy geography	Media representation, ethical art	Risk assessment case study
Environmental Movements (20th century)	Energy systems	Ecosystem disruption	Pollution chemistry	Affected regions	Environmental art, activism visuals	Comparative analysis of industrial areas
Climate Change	Energy balance	Ecosystem response	Greenhouse gases	Climate systems	Data visualisation, eco-art	Climate data interpretation; historical emission trends

Artistic disciplines complement this framework by providing interpretative and expressive tools that support historical understanding. Through visual analysis, design processes and creative production, students can explore how technological and scientific developments have

been represented, communicated and culturally embedded. This integration strengthens critical thinking and fosters a more holistic understanding of historical change.

Taken together, STEAM subjects in the Italian upper secondary curriculum do not function in isolation from History; rather, they offer complementary perspectives that enable students to interpret technological innovation, environmental change and social transformation as interconnected phenomena.

Mapping matrix: History topics ↔ STEAM subjects

The mapping matrix below illustrates how key history curriculum themes in secondary education are systematically connected with STEAM subjects. The matrix supports interdisciplinary lesson design and highlights concrete learning intersections *where History meets STEAM*.

References:

Ministry of Education, Science and Sport of the Republic of Lithuania. (2022). *General Curricula for Secondary Education*. Vilnius. (in Lithuanian).

Seimas of the Republic of Lithuania. (2011). *Law on Education of the Republic of Lithuania*. Vilnius. (in Lithuanian).

Ministry of Education, Science and Sport of the Republic of Lithuania. (2023). *Upper Secondary Education Curriculum Framework*. Vilnius.

Ministry of Education of the Republic of Serbia. (2023). Rulebooks on Curricula for Secondary Schools. Official Gazette of the Republic of Serbia.

Institute for the Improvement of Education (ZUOV). (2023). Curricula for Secondary Schools – History, Physics, Chemistry, Biology, Geography. Belgrade: ZUOV.

Ministry of Education, Science and Technological Development. (2021). Strategy for Education Development in Serbia 2020–2030. Belgrade.

Trifunović, Đ. (1990). *Srpska manastirska arhitektura [Serbian Monastic Architecture]*. Belgrade: Prosveta.

Ćurčić, S. (2010). *Architecture in the Balkans from Diocletian to Süleyman the Magnificent*. New Haven: Yale University Press.

Tesla, N. (1919). *My Inventions*. Electrical Experimenter.

Jonnes, J. (2003). *Empires of Light: Edison, Tesla, Westinghouse, and the Race to Electrify the World*. New York: Random House.

Dinić, M. (1955). *Za istoriju rudarstva u Srbiji i Bosni [On the History of Mining in Serbia and Bosnia]*. Belgrade: SANU.

Stanojević, V. (1925). *Istorija srpskog vojnog saniteta [History of the Serbian Military Health Service]*. Belgrade: Vojnoizdavački zavod.

Gnjatović, D. (2008). *Razvoj srpske železničke mreže do 1918 [Development of the Serbian Railway Network up to 1918]*. Zbornik Matice srpske za istoriju.

Tesla Museum Belgrade – educational materials. Available at: tesla-museum.org

Geological Survey of Serbia – geological map. Available at: gsrbije.rs

Institute of Nuclear Sciences Vinča. Available at: vinca.rs

Council of the European Union. (2018). *Council recommendation of 22 May 2018 on key competences for lifelong learning (2018/C 189/01)*. Official Journal of the European Union.

Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate change 2023: Synthesis report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*.

Italian Government. (2021). *Piano nazionale di ripresa e resilienza (PNRR)*.

Italian Republic. (1948). *Constitution of the Italian Republic*.

Legislative Decree No. 61/2017. (2017). *Revisione dei percorsi dell'istruzione professionale*. Gazzetta Ufficiale della Repubblica Italiana.

McNeill, J. R. (2000). *Something new under the sun: An environmental history of the twentieth-century world*. W. W. Norton.

Ministry of Education, University and Research. (2010). *Indicazioni nazionali per i licei*.

Ministry of Education, University and Research. (2010). *Linee guida per gli istituti*

Ministry of Education, University and Research. (2010). *Linee guida per gli istituti professionali.*

Mokyr, J. (1990). *The lever of riches: Technological creativity and economic progress.* Oxford University Press.

OECD. (latest edition). *Education at a glance: Italy country note.*

Presidential Decree No. 89/2010. (2010). *Regolamento recante revisione dell'assetto ordinamentale, organizzativo e didattico dei licei.* Gazzetta Ufficiale della Repubblica Italiana.