STEM/STEAM

Curriculum mapping

National reports for educational systems

of Bulgaria, Serbia and Slovenia

and implementation of STEAM in primary education

Part of STEM/STEAM in Primary School: Mission Possible

(S.TEMPO project)

2023 – 2025

Co-funded by
the European Union

S.TEMPO

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Introduction

The specific objectives of the first part of this work package **Development of S.TEMPO methodology** in S.TEMPO project reflect our understanding that the initial important step in introducing STEM/STEAM in our primary education systems is to establish a clear, common understanding of the intersections between different subjects taught from 1st to 4th grades. These are the grades where STEM/STEAM activities can be seamlessly integrated. This determination leads to the first OBJECTIVE for this Work Package, which is to conduct Curriculum Mapping in three partner countries – Bulgaria, Serbia, and Slovenia – to identify potential areas for introducing STEM/STEAM activities.

The Curriculum Mapping report provides a clear and current overview of potential interdisciplinary areas at the primary education level (1st – 4th grades) where STEM/STEAM activities can be incorporated. This report encompasses information for all three partner countries and covers the highlighted four-year period of study.

Mapping the Curriculum in the context of STEM/STEAM enables us to identify key intervention points within our primary education systems. By intervention points, we refer to cross-sections where STEM/STEAM activities can be easily introduced without necessitating substantial changes to the curricula of the respective subjects. The map outlines national landscapes while also offering insights into commonalities across the three national systems. Each of the three countries has conducted Curriculum Mapping of their National Educational Standards, focusing on the five STEM/STEAM educational fields: Science, Mathematics, Technology, Engineering, and Arts. Key topics from the curricula of each partner country are highlighted, indicating where the integration of STEM/STEAM activities is feasible.

The research on National Educational Standards focuses on the following:

- Learning outcomes for different student age groups (6 – 7, 7 – 8, 8 – 9, 9 – 10),
- Cross-curricular integration (potential relationships with other subjects),
- Suggested STEM/STEAM activities.

This report comprises three chapters (one for each country's Curriculum Mapping results) and a conclusion that summarizes and underscores the common topics covered in all three countries' National Educational Standards, facilitating seamless STEM/STEAM integration.

It will serve as a foundation for designing a methodology to guide teachers in developing STEM/STEAM activities.

Table of Content

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WP 2. R1.2. National Curriculum Mapping Report Bulgaria

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1. Introduction about STEM/ STEAM integration in the primary education in Bulgaria

In Bulgaria, formal education commences at the age of 7 with primary schooling. Children may begin at age 6 with parental approval provided they are deemed ready. Primary education is mandatory for all Bulgarian children and constitutes the initial phase of the 12-year education system, structured into the following stages:

1. **Kindergarten** caters to children aged 3 to 6 or 7. Preschool education is now compulsory from the age of 4, provided by both kindergartens and schools offering appropriate conditions.

2. **Primary education** comprises two stages: elementary (includes grades 1st to 4th) and pre-gymnasium (includes grades 5th to 7th).

3. **Secondary education** comprises two stages: lower gymnasium (includes grades 8th to 10th) and high gymnasium (includes grades 11th and 12th).

Upon completion of 4th, 7th and 10th grade, students take the National external assessment exam. These standardised tests aim to establish the degree of achievement of the competences envisaged for the relevant stage. After graduation, students have the option to pursue higher education at a college or university.

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The Bulgarian National Educational Standard (NES) (Ordinance № 5, 2015) was introduced as part of the educational reform in 2015. It determines various curricula applicable to different subjects. Each subject's curriculum delineates specific areas of competence, concrete knowledge, skills, attitudes, and expected learning outcomes by grade. Additionally, the curricula detail specific methods and forms for assessing student achievement. All curricula incorporate guidelines for facilitating modern learning processes, including STE(A)M education – the integration of Science, Technology, Engineering, (Art), and Mathematics. Each curriculum

- is interdisciplinary in nature and includes exemplary activities for acquiring key competencies essential for lifelong learning;
- strongly advocates for the utilization of inquiry-based approaches, project-oriented learning, and various forms of experiential learning;
- facilitates the development of 21st-century skills such as creativity, critical thinking, collaboration, and communication.

The most relevant subjects for STE(A)M education, covered in Bulgarian elementary schools include:

Subject	1st grade (aged 7 – 8)	2nd grade (aged 8 – 9)	3rd grade (aged 9 – 10)	4th grade (aged 10 – 11)
Mathematics	X	X	X	X
Homeland Studies	X	X		
The Man and the Nature			X	X
The Man and the Society			X	X
Technology and Entrepreneurship	X	X	X	X
Music	X	X	X	X
Visual Arts	X	X	X	X

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Mathematics serves not only to establish fundamental arithmetic and geometric concepts but also to create the preconditions for the development of students' logical, spatial, problem-solving, and critical thinking abilities. Consequently, it is aimed at achieving mathematical and scientific literacy.

Homeland Studies (Bulgarian: родинознание) plays a vital role in the education of 1st and 2nd-grade students, as it helps them build knowledge about their natural and social environment. Interdisciplinary in nature, the subject integrates information about the child's immediate surroundings, fostering a broader understanding of reality, values, and patriotism. Educational objectives include enriching sensory-cognitive experiences, fostering a sense of belonging, developing cognitive potential, stimulating interests, and nurturing modern key competences. In 3rd and 4th grades, this subject is further enhanced and substituted by two other subjects:

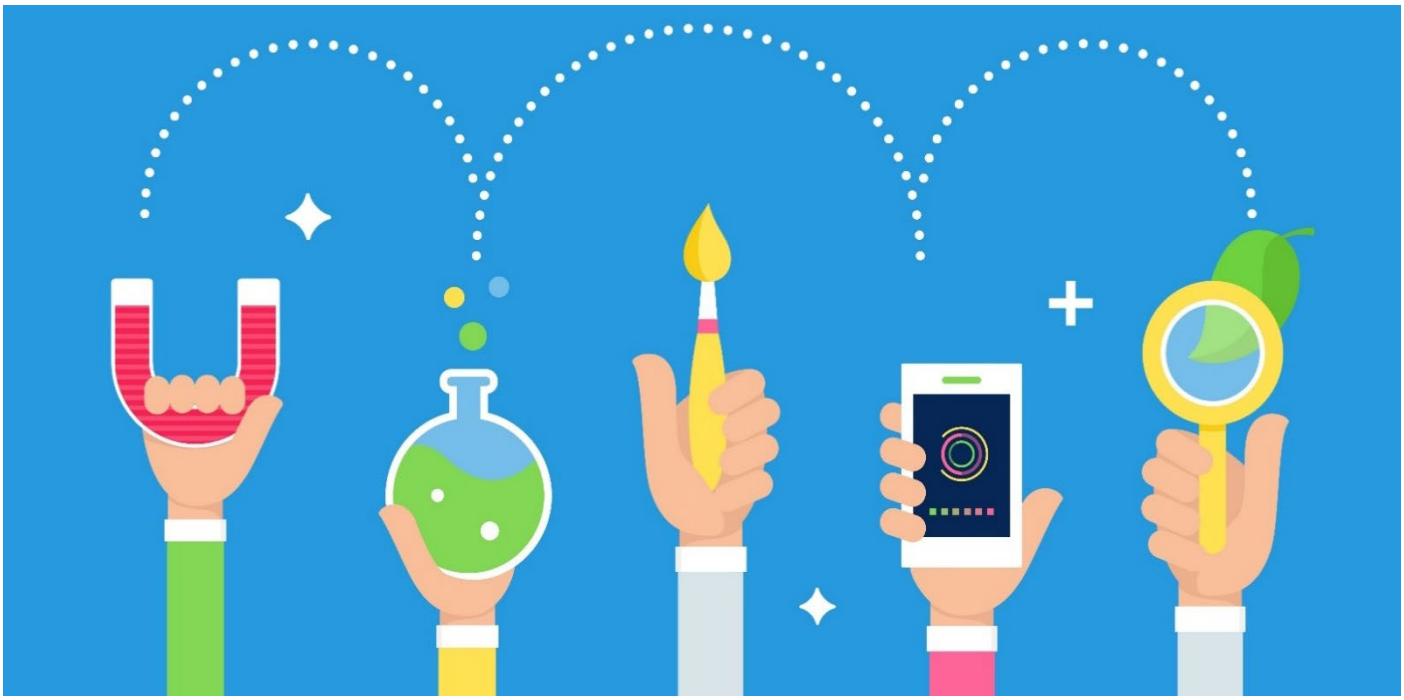
The Man and Nature curriculum focuses on building natural science knowledge, including understanding basic concepts related to both non-living and living nature. It also aims to develop awareness of measures for preserving the environment and the relationship between humans and nature, emphasizing individual responsibility for personal health.

The Man and Society curriculum integrates initial knowledge of geography, history, and civic education. It aims to enrich awareness of Bulgarian and European identity, human rights, and civic duties.

Technology and Entrepreneurship primarily aim to cultivate a positive attitude towards technology and recognize its potential for social development and environmental protection. It also aims to foster initiative and entrepreneurship skills. Students engage in various activities such as working with paper, cardboard, textiles, packaging, and waste materials. They learn to collect, store, and assess the properties of these materials, utilizing them for processing and construction purposes.

Both subjects Visual Arts and Music are directly related to the acquisition of cultural competence and creative expression skills. They offer opportunities for creatively presenting ideas and conveying experiences and emotions through various means.

The Bulgarian education system is meticulously structured to offer a sequential and comprehensive educational journey, spanning from early childhood to postsecondary education. Designed to be compulsory until primary level graduation, its aim is to prepare students for their academic and professional endeavours. The system boasts a well-rounded curriculum, characterized by its interdisciplinary nature and emphasis on inquiry-based learning. The integration of science, technology, engineering, arts and mathematics concepts is evident in various subjects, fostering creativity and innovation. Thus, by promoting learning excellence, critical thinking, and cultivation of essential 21st Century skills, students are prepared for the challenges of the modern world. While the STEM approach is gradually gaining traction within Bulgarian education, it is still in its nascent stages of. Nonetheless, the concept is gaining popularity, with many schools establishing dedicated STEM/STEAM rooms. However, there are no clear guidelines for this approach in the curriculum. Recognizing the need to provide teachers with guidance on implementing the STEM approach within primary education, the present report endeavours to present the outcomes of Curriculum Mapping of the subjects related to STE(A)M.



2. Curriculum Mapping results – Bulgaria

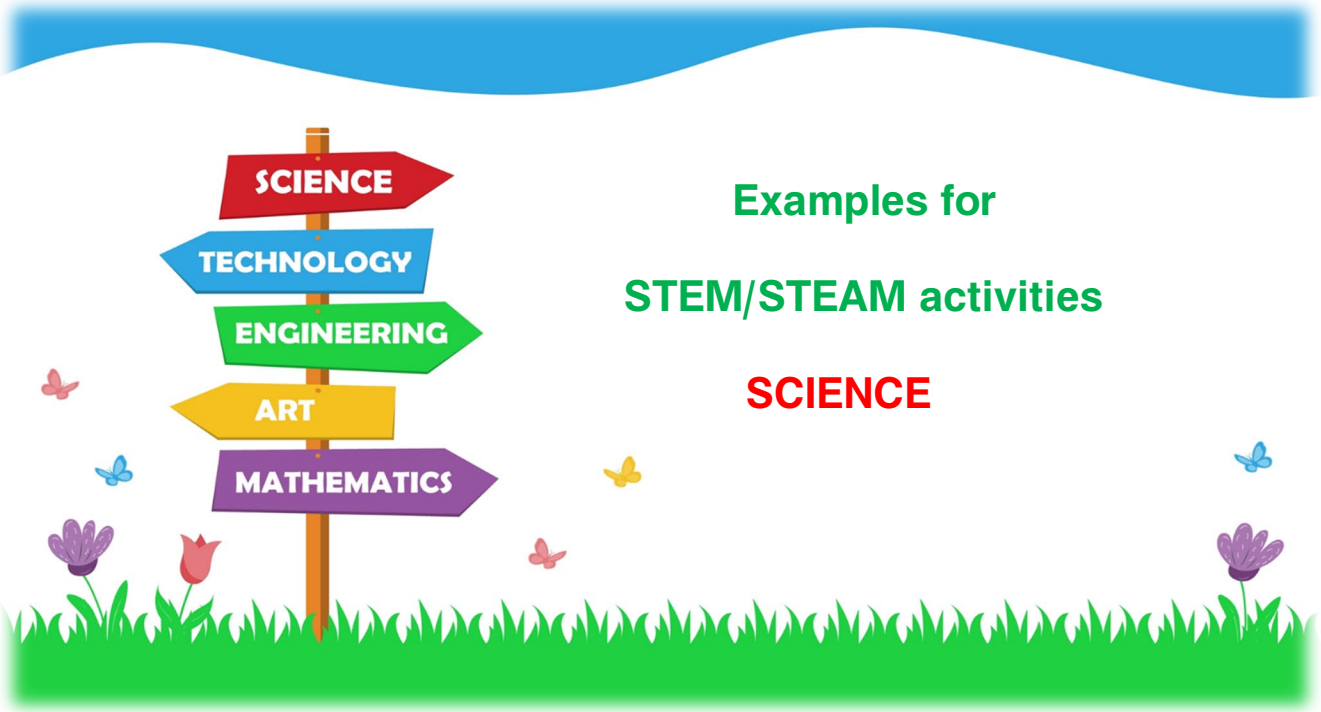
The following paragraphs present the results of Curriculum Mapping based on the National Educational Standards (NES) (Ordinance № 5, 2015) in Bulgaria. An analysis was conducted on the expected learning outcomes for the subjects Homeland Studies, The Man and the Nature, The Man and the Society, Mathematics, Technology and Entrepreneurship, Music, and Visual Arts. Learning outcomes for various age groups of students are delineated, with a focus on identifying opportunities for interdisciplinary connections. The Curriculum Mapping aims to explore possibilities for integrating STE(A)M concepts into the educational content through embedded topics.

In conjunction with science, three school subjects are encompassed within the National Educational Standard (NES) (Ordinance № 5, 2015) in Bulgaria. These subjects are Homeland

Studies (1st and 2nd grade), The Man and the Nature (3rd and 4th grade), and The Man and the Society (3rd and 4th grade).

STEM/STEAM activities can seamlessly integrate into various key components of the NES. This integration can commence as early as **Homeland Studies**, where the identification of **significant public and natural landmarks within the local community** can serve as a foundation. In this context, students can engage in material testing to explore scientific principles. They can also apply mathematical concepts by measuring length and width, employing geometric shapes, and assessing sizes. Furthermore, students can experiment with various materials, engaging in folding, cutting, and sticking to construct designs and structures, thus incorporating aspects of technology and engineering. Additionally, they can utilize visual mediums to create both tangible and abstract images, thereby integrating elements of the arts into their learning experiences.

The exploration of this theme can progress further within the school subject The Man and the Nature in 3rd and 4th grades, focusing on **Natural Phenomena and Processes**. During this stage, students can advance their understanding by **distinguishing between various bodies and substances based on their properties and uses**. They can illustrate examples showcasing the movement of certain bodies or the household energy requirements. Additionally, students can engage in scientific inquiry by testing and comparing the properties of different materials, such as transparency or magnetic attraction. In parallel, mathematical concepts can be incorporated as students measure distances or discern straight lines from curved ones. Furthermore, they can demonstrate creativity by drafting plans for creating articles and assembling parts of constructions. Moreover, they can exemplify how technology influences people's lives, highlighting the interconnectedness between technology and engineering. Lastly, in connection with the arts, students can explore the visual characteristics of objects in their surroundings, gaining an appreciation for the aesthetic elements present in everyday life. Through this interdisciplinary approach, students can develop a holistic understanding of the intersection between science, mathematics, technology, engineering, and the arts.



Examples for

STEM/STEAM activities

SCIENCE

"How to Build a Modern Building in My Hometown" **(1st Grade):**

In this activity, first-grade students observe buildings with various constructions in their hometown. They then embark on constructing a model of a modern building designed to shimmer in the sunlight. Students experiment with different materials to find ones that reflect light effectively. They employ their creativity to generate innovative ideas for constructing a modern structure. Through comparative analysis, students evaluate different structures, measuring their length and weight. Additionally, they engage their imagination to create fantasy images, fostering imaginative thinking and expression.

"How to Make a Car Using a Magnet" **(4th Grade):**

In this experiment, fourth-grade students explore the properties of different materials to determine if they are attracted to magnets. They select materials that exhibit magnetic attraction and proceed to construct cars of varying lengths, widths, and shapes. Incorporating a battery into the design, students test the cars' speed and investigate whether size influences performance. Furthermore, they decorate the cars using various visual techniques and elements.

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Another idea from the NES that we can incorporate into STEM/STEAM activities is the main topic "**Natural Diversity**" (Homeland Studies 1st – 2nd grade). Within the learning outcomes, **it categorizes animals into wild and domestic and describes the results of wildlife object observations**. Here, students can distinguish between different types of animals, classifying them as wild or domestic (Science). They can also explore spatial concepts, considering how to position figures and determine dimensions (Mathematics). Additionally, they can experiment with various materials, shaping them to create flexible structures (Technology and Engineering). Students are encouraged to explore basic relationships between objects and their environment in both real and imaginative scenarios. They can identify features of objects in their surroundings (Arts).

In 3rd and 4th grade, STEM activities can focus on the main theme "**Substances, Bodies, and Organisms**" (The Man and the Nature), with the learning outcome of "**Illustrating major groups of organisms inhabiting water and land and their adaptations for life.**" Here, students can explain the significance of the environment and living conditions for organisms' survival. They can provide examples of plant adaptations to their surroundings (Science). Furthermore, they can practice spatial awareness by arranging figures and measuring length (Mathematics). Engaging in various methods of combining and connecting details (Technology and Engineering), students can explore visual characteristics of objects in their environment (Arts).

***"Create a Zoo with Domestic and Wild Animals"* (2nd Grade):**

In this activity, students are encouraged to design a zoo with enclosures suitable for both domestic and wild animals. They are motivated to consider appropriate constructions for each species, taking into account their natural habitats. Through measurement, material testing, and creative thinking, students explore the practical and aesthetic aspects of constructing animal enclosures.

"The Unknown Plant" **(3rd Grade):**

in this activity, students explore the importance of the environment and living conditions for plants. They contemplate the adaptation of an unknown plant species to its surroundings. Students then endeavour to construct a fantasy representation of the unknown plant, incorporating adaptations to its environment. Through measurement and spatial thinking, students consider the plant's placement. They experiment with different materials and shapes, explaining the functions of the plant's organs. Additionally, students employ various visual effects and techniques to enhance their representations.

Another idea from the NES is "**The Man and His Environment**" (Homeland Studies, The Man and the Society). We can begin exploring this concept from 1st and 2nd grade, focusing on main ideas such as **assessing safe places on the road and understanding the behaviour of road users**, as well **as recognizing the seasons in Bulgaria and the associated changes in nature and people's work**. This concept can then be expanded upon in 3rd and 4th grade, incorporating main ideas like providing **examples of changes in the environment and people's lives resulting from technological innovations**, and **showcasing the use of natural resources (water, soil) in human economic activities**. In 1st and 2nd grade, students can observe buildings and technological innovations in their surroundings (Science). They can engage in measurement activities (length, width, weight, segments) and observe spatial arrangements of objects. Additionally, they can identify straight and curved lines (Mathematics). Through research and experimentation, students can test materials and structures for strength, durability, and functionality, employing various methods of assembly and connection (Technology and Engineering). They can also describe the architectural environment and explore the fundamental relationship between objects and their surroundings in real-world scenarios. Furthermore, students can create visual representations based on observation and impression, fostering artistic expression (Arts).

In 3rd and 4th grade (The Man and the Society), students explore changes in people's lives resulting from technological innovations. Additionally, they conduct experiments to test how natural materials such as sand, soil, and stones can mitigate the force of water. Students learn about the dangers associated with water elements and describe their observations and findings (Science). They engage in measurement activities to quantify the amount of natural

materials used and perform actions using units of measurement. Moreover, students assess spatial arrangements of objects (Mathematics). They conduct research and experimentation to test the strength of materials and illustrate the impact of technology on people's lives with relevant examples (Technology and Engineering).

***"How to create a road or a bridge"* (1st Grade)**

Here the students can test and use different materials to build a road or a bridge for example. They will observe real objects and think about the relation of the bridge/ road and the environment. They will measure the length and the width of the construction. They can check what vehicles can pass on the bridge, what the weight of the loads can be. The students think about the form of the construction and about the decoration of the building elements.

***"Let's make a dam to stop the water"* (4th Grade)**

The students make some experiments with water, soil, sand and stones. They try to make a construction for a dam that will stop the force of the water. They try to combine the different natural materials and test if the mixture is good enough and stable and can stop the water. Students understand that water can cause a natural disaster. The students illustrate his ideas with a drawing.

Another idea from NES is **The Man and the Healthy Lifestyle** (Homeland Studies, The Man and the Nature). Here an important learning outcome is **Lists rules for a healthy lifestyle and diet**. In different STEM/STEAM activities students can explore recipes for healthy eating. They test the properties of some products and combine them in different variants (Science). Then the students divide the amount into parts, recognized as part of a whole a half and a third. They perform actions with units of measurement. They measure the mass of the products (Mathematics). The students know and use technologies for processing food products, they research, test and combine materials and different foods (Technology and Engineering). The students use visual aids. They create real and fantasy images based on observations and imaginations (Arts).

***"In the Kitchen"* (2nd Grade):**

in this activity, students have the opportunity to experiment with various materials commonly found in the kitchen, such as flour, yeast, salt, and sugar. They will mix these ingredients with water to create dough and explore its tactile qualities. To further their exploration, students can take portions of the dough and mix them with additional substances, fostering creativity and imaginative thinking. Using their newfound material, students can sculpt different figures, allowing their imagination to take flight. Finally, students will weave together a fantastic story incorporating their creations, providing a platform for storytelling and collaborative engagement.

***"Let's Create a Fantastic Zoo"* (3rd Grade):**

in this engaging activity, students embark on a culinary adventure by experimenting with various kitchen materials such as flour, yeast, salt, and sugar, which they mix with water to form a dough. Following recipes for healthy eating, they explore the culinary arts while learning about nutrition. Using the dough mixture, students unleash their creativity as they sculpt figures of unknown fantastic animals destined for the Fantastic Zoo. They consider the ideal environments for these creatures and shape the surroundings out of dough to complement their imaginative creations. Once satisfied with their designs, students bake the figures to bring them to life. Finally, they design the layout of the zoo, describing the unique environments where each species of animal resides. Through this hands-on experience, students meld fantasy with reality, utilizing their knowledge of animal diversity to craft captivating and imaginative zoo scenes.

"**Substances, Bodies, and Organisms**" (The Man and the Nature) offers rich opportunities for STEM/STEAM activities aligned with learning outcomes such as **distinguishing bodies and substances by their properties and uses, and conducting experiments with them**. In these activities, students engage in hands-on experimentation with various bodies and substances. They compare everyday substances based on properties like transparency, hardness, strength, and their behaviour with water. Additionally, they explore whether these

substances are attracted by magnets, dissolve, or float/sink (Science). To reinforce mathematical concepts, students perform measurements of length, width, and mass of bodies, honing their skills with units of measurement (Mathematics). In the realm of Technology and Engineering, students apply affordable technological operations with different materials. They utilize appropriate tools and accessible techniques for manual material processing, fostering practical problem-solving abilities (Technology and Engineering). Moreover, students delve into real and imaginative scenarios to explore basic relationships between objects and their environment. They develop their observational skills by detecting visual features of objects in their surroundings (Arts).

***"In Wind and Rain"* (3rd Grade):**

in this engaging activity, students conduct experiments with various materials, comparing their properties as used in everyday life. They investigate whether these materials are prone to leaking water, simulating the effects of wind, rain, and snow. They design and construct a house with a stable roof capable of withstanding wind and preventing water leakage during rainy and snowy conditions. They measure the distances of the house and its roof, and consider spatial arrangements to optimize functionality. Students employ technological operations with materials commonly found in everyday life, applying them to their construction project. They create real images and visual aids.

***"Let's Make a Raft"* (4th Grade):**

in this activity, students compare everyday materials to determine if they float or sink. They measure the mass, length, and width of the raft, considering spatial arrangements. Students create a step-by-step plan, applying different methods to combine details. They create tangible representations, fostering a multidisciplinary learning experience. They create real images by observation and impressions. They use visual aids.

Observations, experiments, and research (The Man and the Nature) present numerous opportunities for STEM/STEAM activities aligned with learning outcomes such as **describing results of observations of living and non-living nature objects, conducting experiments**

with bodies, substances, and plants, and **recognizing the Earth as a planet of the Solar system with the Sun as the source of light and heat**. Additionally, students can **illustrate the movement of bodies**. In these activities, students engage in observing, collecting, comparing, and utilizing natural objects, distinguishing between their uses. They also learn about the planets of the Solar system and describe the Earth's shape and movement, as well as the Sun as a star and the Moon as Earth's natural companion (Science). Mathematically, students measure dimensions using units of length and experiment with preparing various objects using different materials, considering spatial arrangements (Mathematics). In the realm of Technology and Engineering, students employ different methods to combine and connect details to construct creations. They observe and test materials and constructions for strength and functionality (Technology and Engineering). Furthermore, students research the connection between real objects and the environment in diverse situations. They express their observations and impressions through creating images and utilizing various visual means to present scientific information (Arts).

"How to Make a Refuge in Nature" **(3rd Grade):**

in this activity, students test and compare various natural objects to find the most suitable materials for constructing a refuge in nature. They aim to create a shelter that protects from cold, wind, and rain. Students research the connection between the refuge and the environment, measure length and width, and design a strong and safe construction. They conduct tests to ensure the shelter withstands water and wind, using tools, e.g. a hairdryer. Through this exploration, students learn how natural materials can help adapt to environmental conditions in critical situations.

"Let's Create the Solar System" **(4th Grade):**

n this activity, students research the planets in the Solar system and sketch it. They test materials suitable for creating the Solar system, find techniques to shape the planets, and measure distances between them and the Sun. Students create a pattern representing the Solar system, interpreting distances and connections between objects within the construction.

Mathematics is a fundamental subject in Bulgarian primary education, with approximately four study hours per week in each grade from 1st to 4th. According to the National Educational Standard (NES), Mathematics in primary school encompasses four main competence areas: Numbers, Plane Figures, Measurement, and Modelling. These areas can be effectively integrated into STEM/STEAM education.

In the "**Numbers**" competence area, students are expected to master **reading, writing, counting, comparing, adding, subtracting, multiplying, and dividing natural numbers** by the end of 4th grade. This topic is extensive and forms the foundation for various STEM/STEAM activities. Many such activities involve construction or building, which require working with numbers for counting materials or in conjunction with measurements.

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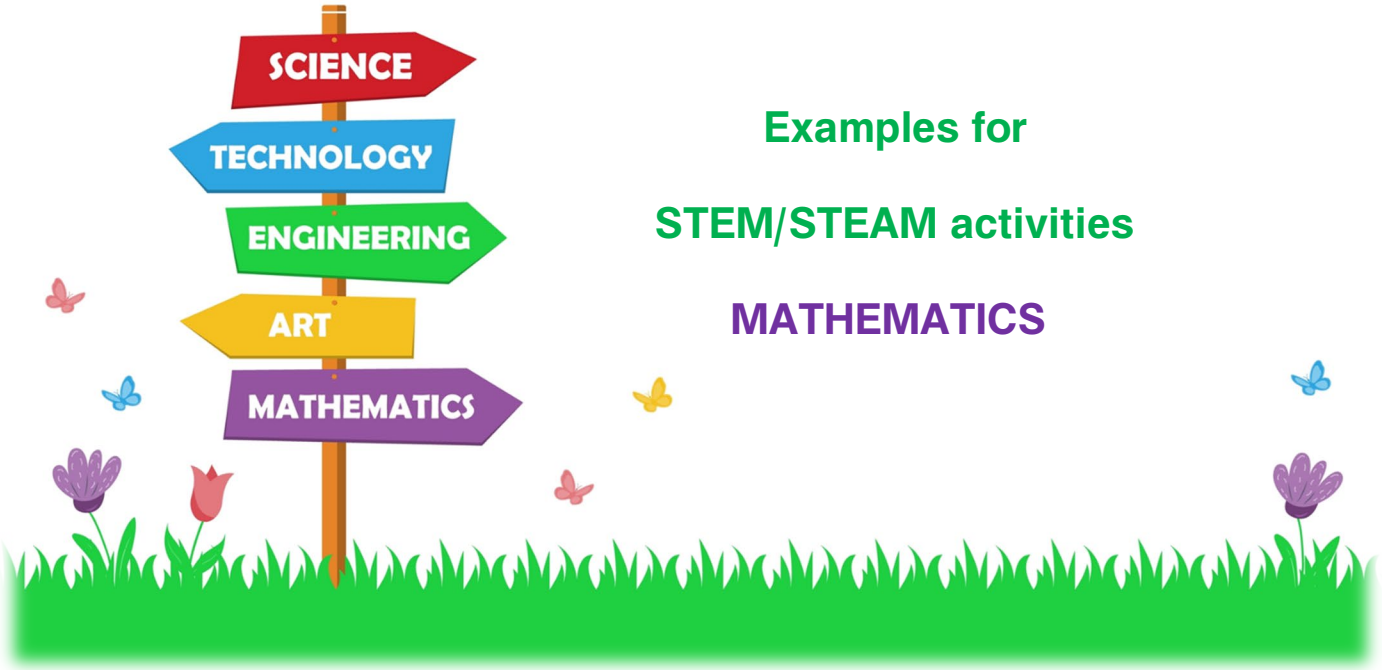

Examples for STEM/STEAM activities MATHEMATICS

Examples for STEM/STEAM activities related to "Numbers"

Students can engage in various team projects aimed at building stable structures such as bridges, monuments, towers, marble runs, or simple machines like winches, pulleys, and levers, tailored to their age level. For these projects, they will utilize materials such as toothpicks, straws, sticks, ropes, marshmallows, gumdrops, and other handy items. They will be tasked with suggesting and determining the quantity of resources needed, and will discuss within their teams the numbers of each necessary element. For instance, in 1st grade, they may work with quantities up to 20, progressing to 100 in 2nd grade, 1000 in 3rd grade, and beyond 1000 in 4th grade. Moreover, as they advance through the grades, students will refine their mathematical skills. For example, in 3rd grade, they may need to calculate fractions, determining if they require half, third, quarter, or tenth of a certain resource. Furthermore, they will compare different quantities, find totals through multiplication, and divide numbers to distribute elements equally among construction parts, especially in 2nd grade and beyond. Such projects offer rich opportunities for interdisciplinary learning, fostering teamwork, creativity, and mathematical proficiency tailored to each student's developmental stage.

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Cross-curricular integration is possible with all other STEAM subjects learning outcomes, i.e. with **Technology & Entrepreneurship** which involves applying various methods to combine, connect, and assemble parts and components; testing materials for strength and functionality, understanding machine mechanisms, making models, and using tools safely;

In **Homeland Studies and The Man and the Nature (Science)**, students describe observations of living and non-living objects, including the movement of the sun and changes in the environment. **The Man and the Nature -** students illustrate various movements of bodies and the propagation of light and sound. Additionally, they demonstrate understanding of the need for energy in organisms, life, and industry. Students conduct experiments involving bodies, substances, and plants, and interpret information presented in models, diagrams, tables, and graphs.

In **Art**, students observe visual features of objects and phenomena in their environment, developing an understanding of shapes, colours, and proportions. They create both realistic and imaginative images using observation, memory, impression, and imagination. Students experiment with various materials and techniques, both individually and collaboratively. Additionally, they utilize technology from the information society to express their creativity.

Furthermore, concerning the digital competence of students, mathematics can be integrated into activities such as LEGO© Coding or other coding games. For instance, students might design board games featuring starting and finishing points, characters, and obstacles, then "write code" by labelling cards with instructions (e.g., sticky notes). In LEGO coding, students could be presented with code, such as the alphabet represented as binary code, and challenged to "write" something on a LEGO© board using blocks, which their peers must interpret. Both of these games actively engage students with numbers, requiring them to count and calculate. Such activities can be linked to the school subject of "Computer Modelling" and are particularly suitable for 4th-grade students.

The topic of "**Plane Figures**" refers to recognizing various plane figures and some solids (point, segment, triangle, rectangle, square, circle, straight and curved line, ray, angle, rectangular parallelepiped, cube, sphere, cone, cylinder, pyramid), as well as determining the types of triangles based on the lengths of their sides and their angles. Geometric shapes

are everywhere in our surroundings, so numerous activities involving environmental exploration can be linked to this topic. Some examples are provided below.

Examples for STEM/STEAM activities related to "Plane Figures"

In 1st grade, students could be encouraged to explore their environment and identify objects that correspond to specific shapes, fostering observation skills and scientific inquiry. Additionally, they could be challenged to describe shapes found in nature, such as the shapes of leaves, flowers, and animals, thereby connecting shapes to the natural world.

In subsequent grades, students could be tasked with recognizing patterns created by repeating shapes, a fundamental concept in both science and mathematics. Other activities may involve constructing shapes and structures using building materials like blocks, straws, sticks, and connectors. They could be challenged to construct a particular structure using only triangular blocks or other shapes, depending on their age and the corresponding learning content. In relation to science, students could further explore their environment and nature to identify objects that match specific shapes. They could also attempt to explain why certain shapes exist and suggest alternative shapes for objects based on their understanding.

Another activity which could be implemented is the usage of interactive apps or games that teach shapes through touchscreen activities. This could support introduction of technology while enhancing shape recognition.

Cross-curricular integration is evident with Homeland (Science) in all grades, particularly regarding the expected outcome for students to describe results of observations of living and non-living objects. In subsequent grades, there is a connection with the subject Technology & Entrepreneurship and its learning outcomes. These include students applying different methods to combine, connect, and assemble parts and components, as well as researching and testing materials and structures for strength, durability, and functionality. Furthermore, students demonstrate activity, ingenuity, and imagination while working on various topics and projects, and they utilize various information sources when constructing and modelling a product.

The topic of "**Measurement**" encompasses understanding units of measurement for length, weight, time, and money, along with their relationships, and performing operations with length, weight units, and monetary values. By the end of 4th grade, students should also be proficient in measuring segments and angles, determining the perimeter of a triangle, as well as the perimeter and area of a rectangle. This topic lends itself well to integration with other STEAM subjects, as most STEM/STEAM projects require measuring various dimensions of objects or keeping track of time.

Examples for STEM/STEAM activities related to "Measurement"

1st graders could be challenged to measure the time required to complete a certain activity or to monitor changes in a natural phenomenon or process. For example, they could observe weather changes and create a weather calendar by recording hourly observations, or they could track the phases of the moon over a period of time. Another engaging activity could involve exploring their shadows outdoors, with the task of measuring the length of their shadows and attempting to make them as long as possible. They could create their own measuring tools, such as using a rope or marking with chalk, to measure their shadows. Through these activities, students develop their math skills by measuring lengths while also gaining scientific knowledge about light and properties of materials such as transparency and opacity.

As part of a STEM/STEAM project, 2nd graders could engage in constructing the tallest tower using materials such as sticks, straws, and other available items. They could measure and compare the lengths of their towers, as well as make predictions by measuring one of its elements and multiplying the result by their quantity. Another STEM/STEAM project could involve building a marble maze on a board or cardboard, utilizing materials like LEGO© bricks or household items. Students would measure the length of the maze, dimensions of the pathways, and determine the perimeter, among other measurements.

In 3rd grade, students could be tasked with creating a birdhouse, requiring them to define its size and discuss its measurable characteristics such as height, weight, capacity, and circumference. Through this project, students would determine the optimal size of the birdhouse by considering various criteria, engaging in problem-solving and testing different options. Another idea for students is to build the fastest ramp for a car race. They would experiment with different cars and ramps, considering factors such as the ramp's height, length, and the angle at which it is positioned.

The shadows exploration activity could be enhanced in 4th grade by allowing students to explore shadows indoors using various tools such as lamps, lanterns, or candles. As part of a STEAM project, students could construct a shadow puppet theatre, engaging in an engineering design process. Through this project, students would develop their math skills by measuring lengths and performing calculations needed to create the scenes. Art can also be successfully integrated into the project, particularly if students are tasked with creating their own puppets. Similarly, the marble maze activity suggested for 2nd graders could be advanced for 4th graders by introducing additional requirements such as more complex paths and routes for the marble, including the addition of obstacles.

Cross-curricular integration can be effectively implemented across all STEAM subjects. In the first and second grades, the aforementioned STEAM activities can be linked to Homeland (Science) through its learning outcomes, where students describe observations of living and non-living objects (such as sun movement and changes), conduct studies on objects, processes, and phenomena, and recognize seasonal changes in Bulgaria's nature and people's work. For third and fourth graders, activities involve experimental testing of light propagation and properties, illustrating body movements with examples, experimenting with different objects, describing observation results, and understanding the importance of environmental protection for all living organisms. These align with the learning outcomes of "The Man & The Nature" (Science) in the NES. Art integration is facilitated through NES expected outcomes, where students utilize visual means for information and communication and apply various materials and techniques both independently and collaboratively. In STEAM projects, students can further enhance their artefacts by decorating them and creating real and fantasy images through observation, memory, impression, and imagination.

Technology & Entrepreneurship plays a significant role in all STE(A)M projects that involve the construction or creation of artefacts. This connection is evident in the subject's learning outcomes defined in the NES. Students are tasked with developing a plan for making a product in stages and activities, applying various methods to combine, connect, and assemble parts and components, as well as researching and testing materials and structures for strength, durability, and functionality. Additionally, students demonstrate activity, ingenuity, and imagination in their work on various topics and projects.

The mathematical competence area of "**Modelling**" requires students to describe real-world situations using mathematical models and to meaningfully interpret information from diverse sources to solve tasks. Furthermore, students are expected to make reasonable assumptions based on data collected from the real world. While this topic is more extensively implemented in 3rd and 4th grades, STEM/STEAM activities related to it are specifically designed for these grade levels.

Examples for STEM/STEAM activities related to "Measurement"

In 3rd or 4th grades, students can be presented with challenges that require problem-solving through the construction of specific equipment or devices. They will need to devise plans for creating or constructing the object, utilizing data from the surrounding world and describing it with a mathematical model. Examples of such problems include designing a protective casing for a raw egg to prevent it from breaking when dropped, constructing a ship that remains buoyant, or creating musical instruments capable of producing louder sounds. Projects involving the construction of structures can also incorporate these skills.

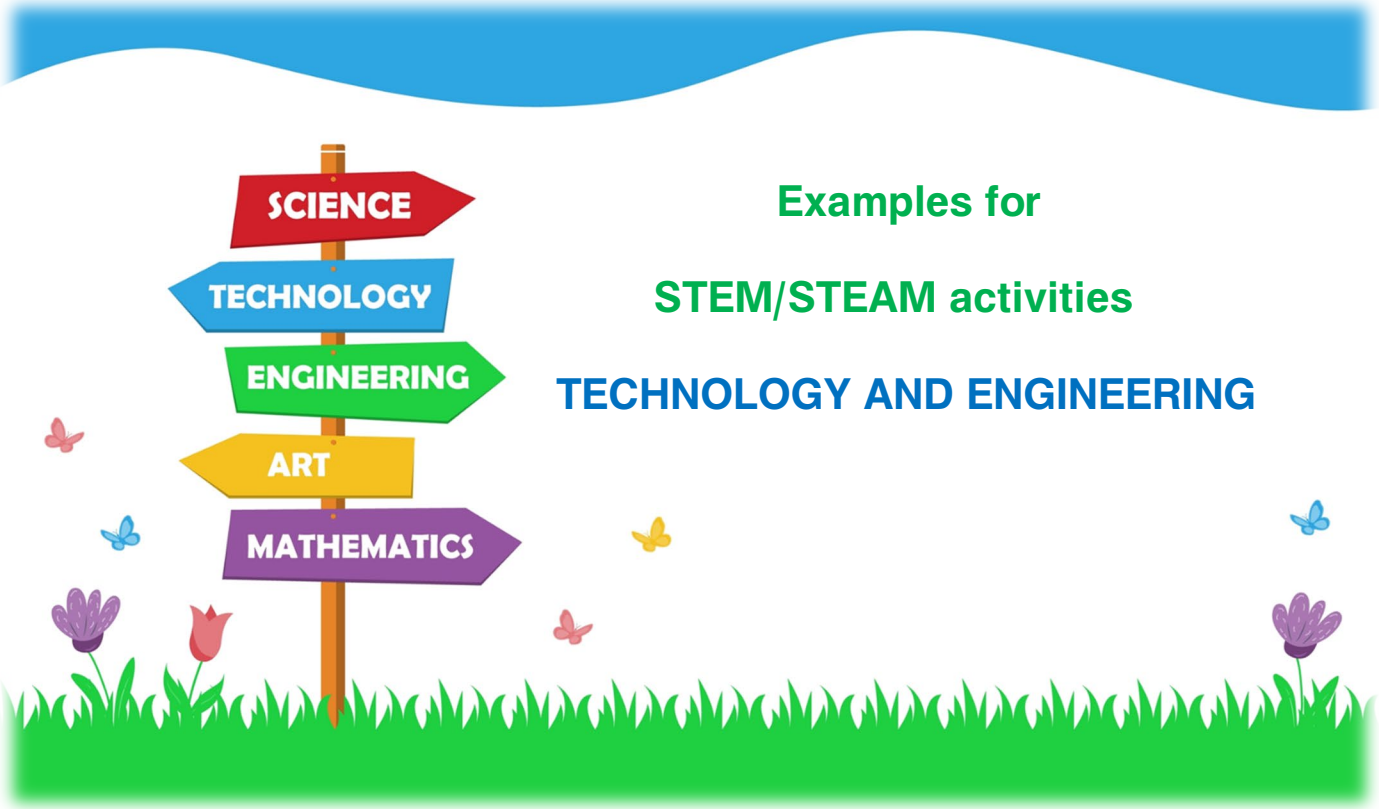
Cross-curricular integration can be achieved with science, technology, engineering, and arts (all other STEAM subjects). In the subject Technology & Entrepreneurship, the corresponding learning outcomes include students developing a plan for creating a product in stages, researching and testing materials and structures for strength and functionality, applying various methods to assemble parts and components, demonstrating creativity and ingenuity in projects, and creating models of mechanisms. In the subject The Man and the

Nature, related outcomes involve students describing observations of living and non-living objects, experimenting with bodies, substances, and plants, interpreting information from models and diagrams, and illustrating the movement of bodies and the propagation of light and sound.

Art can also be incorporated through students' abilities to detect visual features of objects and phenomena from the surrounding environment, grasp fundamental visual concepts like shapes, colour, and general proportions, utilize information technology for creative expression, and recognize acoustic musical instruments by their timbre and appearance, as outlined in the Music curriculum.

Technology and Engineering are implemented in the Bulgarian primary education mainly through the subject Technology and Entrepreneurship, studied in all four primary grades. According to the National Educational Standard (NES) there are four main competence areas of Technology and Entrepreneurship in primary school, namely Technique and Safety, Technology, Initiative and Entrepreneurship, Construction and Modelling. Three of these areas are directly related to STEM (Technology and Safety, Technology, Design and Modelling), although the fourth area – Initiative and Entrepreneurship – also could be related to some STEM/STEAM ideas, albeit more indirectly. All STEM/STEAM design challenges and activities could be linked to expected learning outcomes specifically from the Technology and Entrepreneurship subject. Technology and Engineering are integral parts of Bulgarian primary education primarily through the subject Technology and Entrepreneurship, which is studied throughout all four primary grades. The National Educational Standard (NES) outlines four main competence areas within Technology and Entrepreneurship: Technique and Safety, Technology, Initiative and Entrepreneurship, and Construction and Modelling. While the latter three areas directly align with STEM (Technology and Safety, Technology, Design, and Modelling), the fourth area – Initiative and Entrepreneurship - also holds potential connections to certain STEM/STEAM concepts, albeit indirectly. All STEM/STEAM design challenges and activities can be linked to the expected learning outcomes outlined within the Technology and Entrepreneurship subject.

Regarding the competence area of "**Technique and Safety**," by the end of 4th grade, students should **possess knowledge about the fundamental structure and functions of commonly used machines and mechanisms, including household appliances, and understand their safe usage**. They are expected **to create models of mechanisms**, emphasizing the importance of **rational organization for product quality**. Moreover, students should demonstrate **the ability to handle tools and materials safely and appropriately**. This topic presents numerous opportunities for integration into various STEM/STEAM activities, particularly those involving design and engineering challenges.



Examples for

STEM/STEAM activities

TECHNOLOGY AND ENGINEERING

Examples for STEM/STEAM activities related to “Technique and Safety”

In 1st grade, students can engage in a challenge to design the fastest car using materials of their choice. Through prototyping and conducting experiments, they will discover the functionality of simple mechanisms, such as the wheel and axle system. Additionally, they will learn to measure various elements of the car, ensuring consistency (e.g., ensuring the wheels are the same size or making the front wheels smaller). The STEM/STEAM activities suggested for the "Numbers" topic in Mathematics are also suitable for 2nd grade students and can be adapted for all primary school levels. In 3rd grade, students can undertake a project focused on energy conservation in the classroom or at home. They may plan and execute various activities, such as rearranging furniture for better energy flow, using mirrors to enhance natural lighting, or improving window insulation. These tasks require calculations and measurements to be completed effectively. For 4th graders, projects could involve creating a paper lantern with a battery-operated tea light or constructing a paper speaker using a magnet. These activities not only teach about the purpose and safe usage of appliances but also emphasize the significance of technology in daily life. Students will engage in measuring, constructing, combining, and decorating various materials as part of these projects.

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The **cross-curricular integration** is achievable with all other STEAM subjects' learning outcomes. In Homeland Studies/The Man and the Nature, students conduct studies of objects, processes, and manifestations; they illustrate with examples the movement of bodies and the propagation of light; they explore the need for energy for life and industry; they identify human activities that disturb the balance in nature and suggest measures for its protection; they also measure the temperature of air and water. In Mathematics, students measure and use different units of measurement; they read, write, count, compare, add, subtract, multiply, and divide numbers from 0 to 100. They also recognize fractions as parts of a whole, including halves, thirds, quarters, and tenths. In Art, students can decorate their car models, handmade appliances, etc., and create real and fantasy images through observation, memory, impression, and imagination. They employ various materials and techniques, both individually and in groups.

The competence area of "**Technologies**" requires that by the end of 4th grade, students should be **proficient in using appropriate and accessible technological operations for manual processing of materials**. They should also **have a general understanding of technological processes, including their environment, stages, content, sequence, and end product**. Furthermore, they should be knowledgeable about **technologies for cold processing of food products during food preparation** and should be able to **list rules for keeping pets and plants**. This area of competence can be enhanced through a variety of STEM/STEAM activities, particularly those related to food processing and plants.

Examples for STEM/STEAM activities related to "Technologies"

In the first grade, students could be tasked with creating a volcano using a lemon and baking soda. This activity could be part of a larger class project focused on modelling certain natural phenomena. To enhance realism, students could colour the sliced lemons to resemble volcanoes more closely. In the second grade, students could plant bulbs in clear containers with stones and observe the roots and plants as they grow. They would measure and record their observations in a diary. Additionally, students could plant different types of bulbs and compare their growth patterns. Finally, they could plant their bulbs into pots and decorate them. For the third graders, a Mystery Paper Bag challenge could be organized. Each group

would select paper bags containing mystery products, including healthy and unhealthy foods and other artificial materials and decorations pre-selected by the teacher. The challenge would be to create healthy dishes using the provided ingredients. STEM/STEAM activities outlined in the "Numbers" topic of the Mathematics section would be well-suited for the fourth-grade students in the Technology area of competence.

The cross-curricular integration is possible with all other STEAM subjects' learning outcomes, but primarily with Science. For example, in relation to Homeland Studies (Science) studied in 1st and 2nd grades, students conduct studies of objects, processes, and phenomena, experimenting with plants; they describe the results of their observations of objects in living and non-living nature and distinguish between non-living and living nature. Students should group plants according to their stems and the type of leaves, as well as determine the importance of natural diversity for people's lives. In the following grades (3rd and 4th), in the learning outcomes for the subject The Man and the Nature (Science), students are required to list rules for a healthy lifestyle and diet and give examples of substances and effects harmful to humans. These outcomes could be effectively linked to the Technology and Entrepreneurship learning objectives for food processing in a variety of STEM/STEAM activities. In terms of Art, students create real and fantasy images through observation, memory, impression, and imagination. They also choose and apply different materials and techniques, mainly related to the decoration of students' artefacts or dishes.

Mathematics is integrated into the suggested examples primarily through measuring segments. Appropriate STEM activities and cross-curricular relations are also described in the Numbers topic in the Mathematics section, with the difference that the focus here would be on Technology and Entrepreneurship with the integration of Mathematics, Man and Nature, and Arts.

In relation to the competence area of "**Construction and Modelling**," by the end of 4th grade, students should be able to **illustrate ideas with technical drawings and sketches, compile a plan for making a product by stages and activities, use various information sources when constructing and modelling a product, apply various ways to combine, connect, and assemble parts and components, research and test materials and structures for strength, durability, and functionality, and evaluate their own work and the**

work of others according to certain criteria. It can be seen that all these learning outcomes are closely related to the engineering design process, making this competence area very appropriate for the implementation of STEM/STEAM activities with a focus on design.

Examples for STEM/STEAM activities related to "Construction and Modelling"

All the examples suggested in the Mathematics competence areas of Modelling and Numbers are related to the engineering design process and could serve as examples for covering this area of the Technology and Entrepreneurship competence.

Additionally, in 3rd grade, the Technology and Entrepreneurship curriculum requires students to have an understanding of material reprocessing – recycling. In line with this objective, students could be challenged to participate in a group project focused on reducing waste at school. The topic of recycling should be integrated into their proposals, leading to important discussions about resource reuse, reduced consumption, and related topics. As a result of the project, students could create and decorate appropriate bins for separate collection of recycling materials in the classroom or design a board with instructions on waste reduction.

The **cross-curricular integration** remains consistent with that described for the Modelling and Numbers topics in the Mathematics section. However, the focus here shifts to Technology and Entrepreneurship, with integration of Mathematics, The Man and the Nature, and Arts. The example activity for recycling could be related to The Man and the Nature (Science) expected learning outcomes, where students describe, with examples, the main pollutants of the environment and human activities that disrupt the balance in nature, along with measures for its protection. Art integration is also evident through the creation of projects involving objects and environments in both real and imaginary situations.

ARTS

In connection with Arts, two school subjects are included in the National Educational Standard (NES) in Bulgaria: Music (1st – 4th grade) and Visual Art (1st – 4th grade).

MUSIC

STEM/STEAM activities can integrate with some of the key objectives outlined in the National Educational Standard (NES). Drawing from the subject of Music, for instance, students can engage with learning outcomes such as **determining character, tempo, dynamics, repetition, resonance, and distinction in appropriate music**. In these activities, students can experiment with various objects and materials to explore sound production. They can investigate how instrument size and material composition affect the produced sounds, and they can combine different musical elements from various instruments. Moreover, students can observe natural sounds in their environment, linking this exploration to their understanding of vibrating bodies and the production of sound in science. They can identify different sounds in nature and measure the dimensions of tools, using units of length in mathematics. Subsequently, students can apply different techniques to connect and combine materials, drawing up plans for creating new imaginative constructions. They engage in accessible technological operations for manual material processing, applying their understanding of technology and engineering principles.

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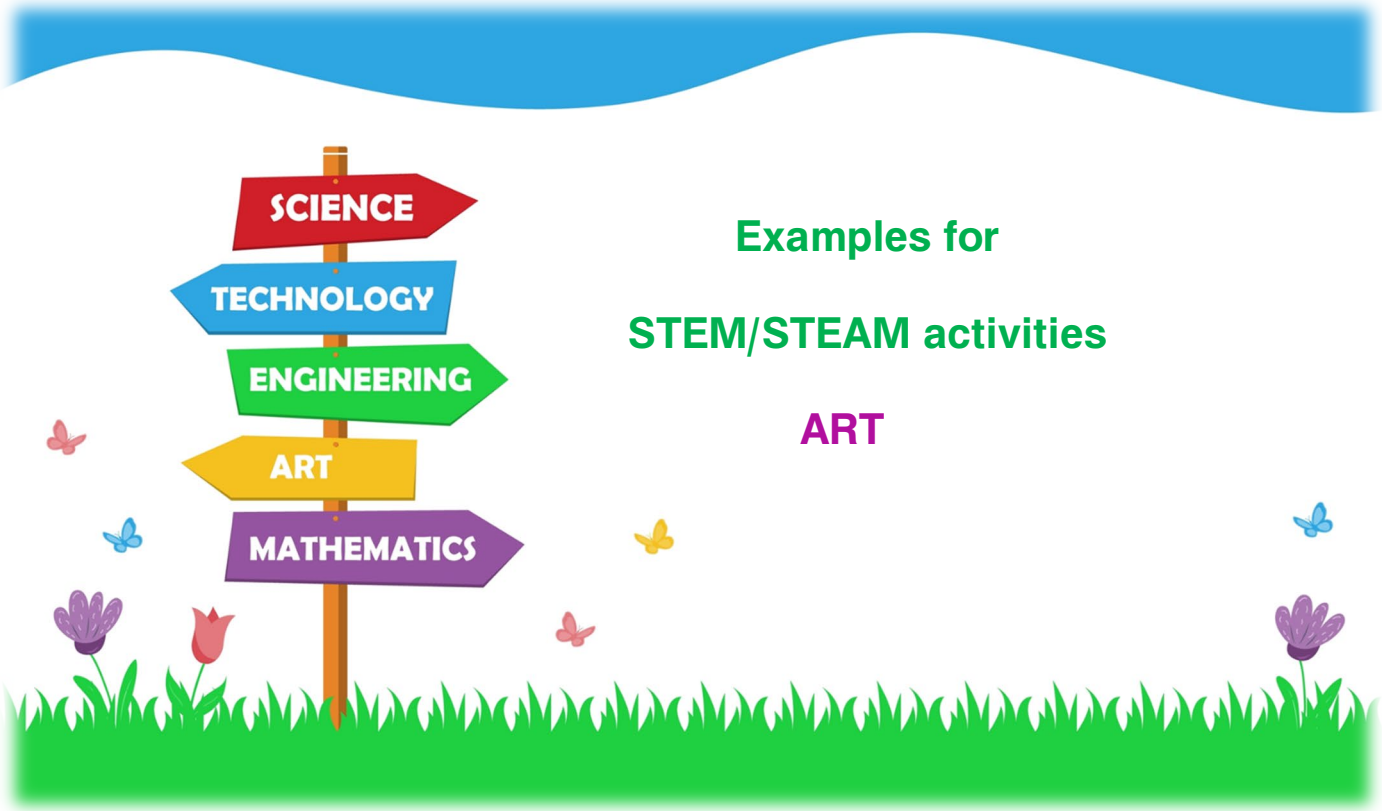

Examples for STEM/STEAM activities:

"*Let's Make Musical Instruments*" (1st Grade):

in this activity, students will craft musical instruments using various everyday materials. They will explore the mood, tempo, and intensity of musical examples, as well as identify short and long, high and low tones. Students will experiment with different objects and materials to observe their sound-producing capabilities. By measuring the dimensions of their instruments, they'll investigate whether size and material impact the produced sound. Throughout the process, students will select and combine different materials to create their unique musical instruments.

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"*Let's Catch the Sound of Nature*" (4th Grade):

in this activity, students will observe nature closely to identify and capture various sounds, such as the wind rustling through leaves, footsteps in the snow, bird songs, insect hums, and the flow of water in a river. They will conduct experiments with different objects to understand how sound is produced. Students will then design and construct instruments capable of capturing natural sounds, such as the wind. Using materials from everyday life, they'll combine various details to create these instruments. Finally, they will compose melodies that mimic the sounds of nature, effectively creating auditory landscapes or sound pictures.

VISUAL ARTS

For STEM/STEAM activities, we can use the learning outcomes from the school subject Visual Arts as well. For instance:

- Students **create real and fantasy images through observation, memory, impression, and imagination, utilizing visual means of information and communication**. Here, students have the opportunity to explore a variety of natural materials sourced from the local environment, aligning with principles from science. They can contemplate the spatial arrangement of figures, engaging mathematical concepts such as measurement and proportions. Additionally, students can select and combine different natural materials to construct artistic creations, integrating elements of technology and engineering.

- **Describes the natural and architectural environment; Explores basic relationships between objects and the environment in real and fantasy situations. Utilizes visual means of information and communication**. In this scenario, students engage in observing and experimenting with various materials found in everyday life, thereby delving into material properties aligned with scientific inquiry. They proceed to measure the dimensions of selected materials, applying mathematical concepts in spatial arrangement considerations. Additionally, students employ diverse methods to combine, connect, and assemble details, integrating principles from technology and engineering into their creative endeavours.

- **Explores basic relationships between objects and the environment in real and fantasy situations. Utilizes visual means of information and communication**. During this exploration, students contemplate the living conditions within various environments, pondering the intricate connections between organisms and their surroundings, and exploring the adaptations of different life forms, thus engaging in scientific inquiry. Subsequently, students employ mathematical concepts to measure dimensions and utilize units of measurement such as length, width, and height. They further apply mathematical reasoning to consider the spatial arrangement of construction elements. Additionally, students exercise their technological and engineering skills by selecting appropriate materials and employing diverse methods to combine, connect, and assemble construction details.

Examples for STEM/STEAM activities:

"*Let's create a fun game park*" (2nd Grade):

in this activity, students engage in observing and experimenting with various materials sourced from nature and everyday life. They explore the potential of these materials by combining them to construct imaginative structures. Students exercise their creativity in envisioning and arranging these constructions within the game park. They utilize their imagination to design and create a vibrant and enjoyable play environment - a fun game park.

"*Let's create a botanical garden of fantastical plants*" (3rd Grade):

in this activity, students explore the living conditions required by plants in their natural environment and consider the various adaptations plants undergo. They then unleash their creativity by designing and crafting fantastical plants using a variety of materials. Through this process, students combine their chosen materials to construct imaginative botanical creations for their garden.

For Curriculum Mapping – Bulgaria

The analysis of the National Educational Standard in Bulgaria reveals ample opportunities for integrating STE(A)M activities into primary school education. Across subjects such as Homeland Studies, The Man and the Nature, The Man and the Society, Mathematics, Technology and Entrepreneurship, Music, and Visual Arts, educators have a wide range of options for implementing integrative learning. By aligning STE(A)M ideas with curriculum topics, teachers can deliver a modern education that not only enhances students' knowledge but also fosters competencies essential for real-life situations. STE(A)M activities can be incorporated not only into traditional lessons but also within inquiry-based, project-based, and problem-based learning approaches. This multifaceted approach enables students to engage with learning content from various perspectives, broaden their understanding of the world, and develop a diverse set of key skills. Ultimately, this Curriculum Mapping serves as a valuable resource for both pre-service and in-service teachers, offering guidance for the successful integration of STE(A)M into the educational process.

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WP 2. R1.2. National Curriculum Mapping Report – Serbia

Prof. Dr. Sanja Blagdanić, Prof. Dr. Miroslava Ristić

1. Introduction – STE(A)M Integration in Primary Education in Serbia

The integration of STE(A)M (Science, Technology, Engineering, Arts, Mathematics) education into primary schools in Serbia aims to enhance learning through an interdisciplinary approach to problem-solving and to encourage the development of various soft skills in students. These skills include critical thinking, practicality, creativity, innovation, collaboration, a propensity for research (curiosity), project management skills, and teamwork in problem-solving.

The Serbian education system is based on four levels – preschool, primary education, secondary education, and university education. The focus of the S.TEMPO project is primary education, specifically the education of students aged 6 – 10 years. This period in the Serbian education system is defined as the First Cycle of Primary Education, namely the first four grades of primary school. At this age, students have 8 mandatory school subjects: Serbian Language (native language), Mathematics, World Around Us/Nature and Society, Musical Culture, Visual Arts, Physical Education, Digital World, Foreign Language[1]. In addition, students or their parents choose one of two elective subjects - Civic Education or Religious Education.

Serbia is in the early stages of introducing STE(A)M initiatives into the education system to adapt to societal and economic changes. Competences for lifelong learning (adopted by the European Commission) represent the framework for defining educational standards and learning outcomes in Serbia. Accordingly, some of the goals of primary education that

[1] In over 90% of schools, English is the first foreign language taught to students.

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complement the STE(A)M framework have been defined, although there is no clear emphasis on STE(A)M in national educational documents. We cite a goal that is most clearly related to the STE(A)M framework: "Developing key competencies for lifelong learning, developing interdisciplinary competencies for the needs of modern science and technology". The same document clearly states that teachers when planning lessons in the first cycle should be guided by an integrated approach where there is horizontal and vertical connectivity within the same subject and different subjects.

Nonetheless, it can be asserted that **STE(A)M education is not officially integrated into the education system in Serbia**, which predominantly relies on isolated school subjects. There is no systematic introduction of STE(A)M education. The necessity to implement STE(A)M education is further highlighted by the findings of international research such as TIMSS, as well as scientific studies that highlight conceptual misunderstandings of terms among younger students, which persist into older age groups.

Teacher education in Serbia is not clearly based on the introduction of the STE(A)M concept. Instead, it primarily concentrates on the content of individual sciences and methods to make them accessible to students. The focus remains on the content of school subjects, with less attention given to applying knowledge and fostering reasoning in instruction. Nevertheless, there are initiatives and professional development programs aimed at enhancing the competencies of STE(A)M teachers. These programs receive support from the Ministry of Education, the Center for the Promotion of Science, and the European Union. Here are a few examples:

- With the support of the Government of the Kingdom of Norway, UNICEF in Serbia launched the project *Schools for Better Air Quality: Citizen Air Quality Monitoring, STEM Education, and Youth Activism in Serbia*[2]. This project aims to raise awareness of air quality and the harmful effects of air pollution on the health and well-being of school children, parents, and teachers, by installing air quality sensors in schools.

- As part of the project *Supporting STEAM Education in Serbia*[3], implemented by the Ana and Vlade Divac Foundation and NCR Foundation in cooperation with the Ministry of Education and the Center for the Promotion of Science, nine schools received funds to

[2] https://decazavazduh.rs/o-projektu/

[3] https://www.divac.com/Vesti/2983/Kakva-je-buducnost-STEAM-obrazovanja-u-Srbiji.shtml

purchase equipment for classroom and extracurricular activities for 7,000 students in the STE(A)M area. In October 2023, the #STEAMchallenge was launched to support and reward the best student ideas for solving local problems.

- Online training of a number of educators and teachers to integrate STE(A)M concepts into teaching plans was carried out as part of the Erasmus+ project *STEAM out of the box*[4].

The training consisted of four modules: 1) Introduction – STEAM for the Future; 2) Innovative Pedagogy in STEAM Teaching; 3) STEAM skills and analytical thinking; and 4) Creating learning scenarios and motivating students.

- As part of the European Commission's Horizon Europe program, the Center for the Promotion of Science is implementing the *STEAM Learning Ecologies (SLEs)*[5] project, which aims to move STE(A)M education out of the context of the classroom to connect STE(A)M knowledge more easily with the real world and bring it closer to students.

Additionally, there are national programs for teacher professional development that address this issue, either entirely or partially. Some examples include *STEM education in the function of developing key competencies in students*, *STEM activities and challenges*. While there are suitable training programs for teachers in the STE(A)M fields, the long-term and systematic effects of these projects and programs are not monitored after their completion.

STEM in the National Educational Standard and/or in the Curricula

National Educational Standards in Serbia have been created for the end of the first and second cycles of primary education. For the S.TEMPO project, the National Educational Standards for the end of the first cycle are relevant. These standards are defined for three school subjects – Serbian Language, Mathematics, and Nature and Society. For other school subjects (Visual Arts, Digital World, Civic Education, etc.), there are no educational standards. Educational standards outline student achievements across three levels: basic, intermediate, and advanced. The basic level should be attained by at least 80% of students,

[4] https://erasmusplus.rs/mooc-stem-out-of-the-box/
[5] https://www.steamecologies.eu/

the intermediate level by at least 50%, and the advanced level by approximately 25%. The process of redefining educational standards for the end of the first cycle of primary education is ongoing. These standards will continue to exist solely for the three aforementioned school subjects, along with three levels of expected student achievement. The principal alteration lies in expressing educational standards through three specific subject competencies. The first competency dictates WHAT the student needs to learn, specifically, the knowledge they need to master. The second competency delineates HOW the student is expected to learn the subject, while the third addresses WHY it is important for the student to learn that subject. In cases where there are no educational standards for certain subjects, **Curriculum Mapping** uses topics from the teaching and learning programs corresponding to the subject/grade when formulating the *Name of the topic in the National Educational Standard*.

For all school subjects, learning outcomes are included in the teaching and learning programs for each subject and grade. These learning outcomes for the respective grade and subject were used to precisely determine cross-curricular integration (potential relationships with other subjects) in Curriculum Mapping.

The concept of STE(A)M as a method of teaching and learning is not explicitly present in the current National Educational Standards in Serbia, as they are distinctly subject-specific. However, there are sporadic instances where potential connections to the STE(A)M concept can be observed. We provide an example of such educational standards from Mathematics and Nature and Society:

- **Mathematics**: 2.4.2. The student knows units of time (second, minute, hour, day, month, year) and can convert larger into smaller and compare time intervals in simple/complex situations.

- **Nature and Society**: 1.4.4. The student knows units of time measurement: day, week, month, year, decade, and century; 1.4.5. The student can read requested information from clocks and calendars.

As previously noted, the curriculum in Serbia is oriented towards individual disciplines. Consequently, there are distinct teaching and learning programs for subjects such as Serbian Language, Mathematics, World Around Us/Nature and Society, Visual Arts, Digital World, Foreign Language, and others.

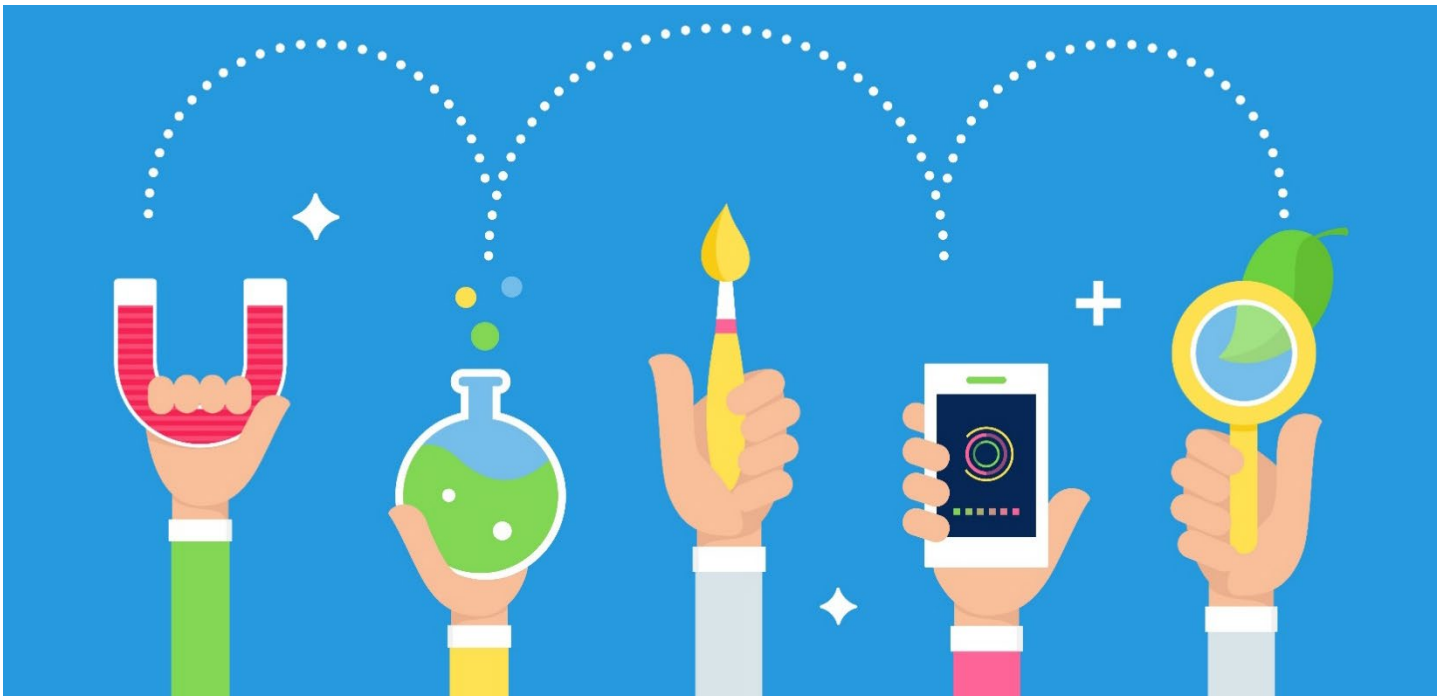
In primary schools, subjects that lend themselves well to the STE(A)M approach include: 1) World Around Us (1st and 2nd grade) and Nature and Society (3rd and 4th grade) (with **Science and Technology and Engineering** less dominant); 2) Digital World (**Technology and Engineering**); 3) Mathematics (**Mathematics**); and 4) Visual Arts (**Arts**). World Around Us/Nature and Society stand out among other school subjects due to their interdisciplinary organization. This uniqueness offers significant potential for crafting STE(A)M activities. These subjects draw content from various disciplines such as Biology, Physics, Chemistry, Geography, History, Traffic, Technology, and Sociology, all within the context of everyday life.

A graphic representation of STE(A)M school subjects in the first cycle of primary education is shown in the table below:

	S	**T**	**E**	**(A)**	**M**
School subjects	World around us/Nature and Society	Digital World (World around us/Nature and Society)		Visual Arts	Mathematics
Number of hours per week	2	1		1 or 2	5
Educational Standards (for the and of the First cicle)	Yes	No		No	Yes
Learning Outcomes (for the end of each school year)	Yes	Yes	Yes	Yes	Yes

As illustrated in the preceding text, there are opportunities for implementing STE(A)M activities for students aged 6-10 years. However, there is currently no systematic support for integrating STE(A)M areas across different school subjects in Serbia. Consequently, the incorporation of these activities in the first cycle of primary education largely depends on individual ideas and initiatives of teachers. One opportunity for such implementation is the Project-based Teaching/Learning approach, which is among the recommended methods of learning in primary schools. This approach is underscored in the programs for teaching and learning various subjects as well as for extracurricular activities. It is worth noting that while some projects focus on the STE(A)M area, they are most often limited to research on narrow topics or activities involving the creation of objects for sale or donation to charitable causes. Overall, there is a lack of clear and systematic data on the implementation of this approach or STE(A)M activities in primary schools in Serbia.

Another factor that hampers the application of STE(A)M activities stems from the lack of coordination in timing similar or complementary content across various school subjects. This lack of coordination disrupts the effective planning and execution of STE(A)M activities. For instance, consider the following examples: 1) In World Around Us classes in the second grade, finding new uses for objects made of various materials is considered a way to demonstrate responsible behaviour towards the environment. However, in Visual Arts, a year earlier (first grade), students explore the possibilities of reshaping objects and materials that are damaged or discarded items, or packaging of some products. 2) A similar situation arises with content on digital safety for children. Responding to encounters with inappropriate digital content and people who communicate inappropriately is covered in Digital World in the second grade, while in Nature and Society, it is addressed in the fourth grade.



2. Curriculum Mapping Results – Serbia

In this chapter, we will take a closer look at which school subjects in the Serbian education system are relevant to the STE(A)M concept. Additionally, we will explore specific themes within the educational standards or teaching and learning programs that are particularly conducive to STE(A)M integration.

The objective of teaching and learning in **World Around Us/Nature and Society** is to familiarize students with themselves, their natural and social surroundings, and to cultivate the ability to live responsibly within it. The educational standards for *Nature and Society* at the end of the first cycle of primary education are categorized into six themes: *Nature (living and nonliving), Ecology, Materials, Movement and spatial orientation, Society, and The country of Serbia and its history (past).* Similarly, the themes outlined in the curriculum for *World Around Us/Nature and Society* include: *The Self and Others, Materials, Diversity of Nature, Natural and Social Characteristics of Serbia, The history of Serbia,* etc.

Through analysis of the educational standards for *Nature and Society*, we have identified that among the six themes, the most conducive for planning STE(A)M activities are two themes from the natural sciences domain:

1. Nature – living and non-living.
2. Materials.

Examples of STE(A)M activities provided in Curriculum Mapping indicate that other themes can also serve as the core content of these activities but implementing them may pose slightly more challenges.

Through analysis of the teaching and learning program for *World Around Us/Nature and Society*, we have also identified themes that are particularly conducive to STE(A)M activities, having the highest integrative potential in this context. These themes include the following:

1. Diversity of Nature;
2. Materials;
3. Movement in Space and Time;
4. Health and Safety.

Considering that the themes covered in *World Around Us/Nature and Society* directly relate to students' daily lives, these themes often serve as the foundation upon which STE(A)M activities are developed during the initial stages of primary education and upbringing.

The objective of teaching and learning in the subject **Digital World** is to cultivate students' digital competence, essential for the safe and effective utilization of digital devices for learning, communication, collaboration, as well as the development of algorithmic thinking. As previously emphasized, there are no educational standards specifically outlined for this subject. Therefore, we conducted an analysis focusing on learning outcomes. Across all four grades, the learning outcomes are attained through three overarching themes: *Digital Society, Safe Use of Digital Devices*, and *Development of Algorithmic Thinking*.

Drawing from the analysis of content within the teaching and learning program for *Digital World*, we have identified specific content (primarily from the second and third themes) that are particularly suitable for STE(A)M activities and interdisciplinary integration.:

1. Breaking down problems into smaller units;
2. Designing steps that lead to the solution of a simple problem;

3. Identifying and correcting errors in an algorithm;
4. Identifying and correcting errors in a simple visual program;
5. Benefits and risks arising from communication via digital devices.

When addressing algorithmic thinking, teachers should interpret the term 'algorithm' as instructions for problem-solving or executing a procedure. Students should presented with problems to decompose and articulate their solutions as a sequence of steps, relying on their prior educational experiences. Among the encountered problems are those that require the repetition of specific steps a certain number of times or consistently.

The primary goal of teaching and learning **Mathematics** is to equip students with fundamental skills in abstract and critical thinking, foster a positive attitude towards mathematics, and enhance their proficiency in mathematical communication, both orally and in writing. This educational process aims to empower students to apply their mathematical knowledge and skills in advanced education and in addressing real-world problems, thereby establishing a strong foundation for the continued exploration and comprehension of mathematical concepts. The educational standards in Mathematics at the end of the first cycle of primary education are organized into four themes: *Natural Numbers and Operations with Them*, *Geometry, Fractions*, and *Measurement and Measures*. Similarly, the themes in the Mathematics curriculum are structured around Numbers, Geometry, Measurement, and Measures.

Upon reviewing the educational standards for *Mathematics*, we have identified two themes that are particularly well-suited for planning STE(A)M activities:

1. Measurement;
2. Geometry.

Through analysis of the teaching and learning program for all four grades in *Mathematics*, we have identified content that is particularly suitable for STEM/STEAM activities:

1. Geometric figures, symmetrical figures;
2. Measuring length (with non-standard and standard measuring units);

3. Measuring area;
4. Measuring time.

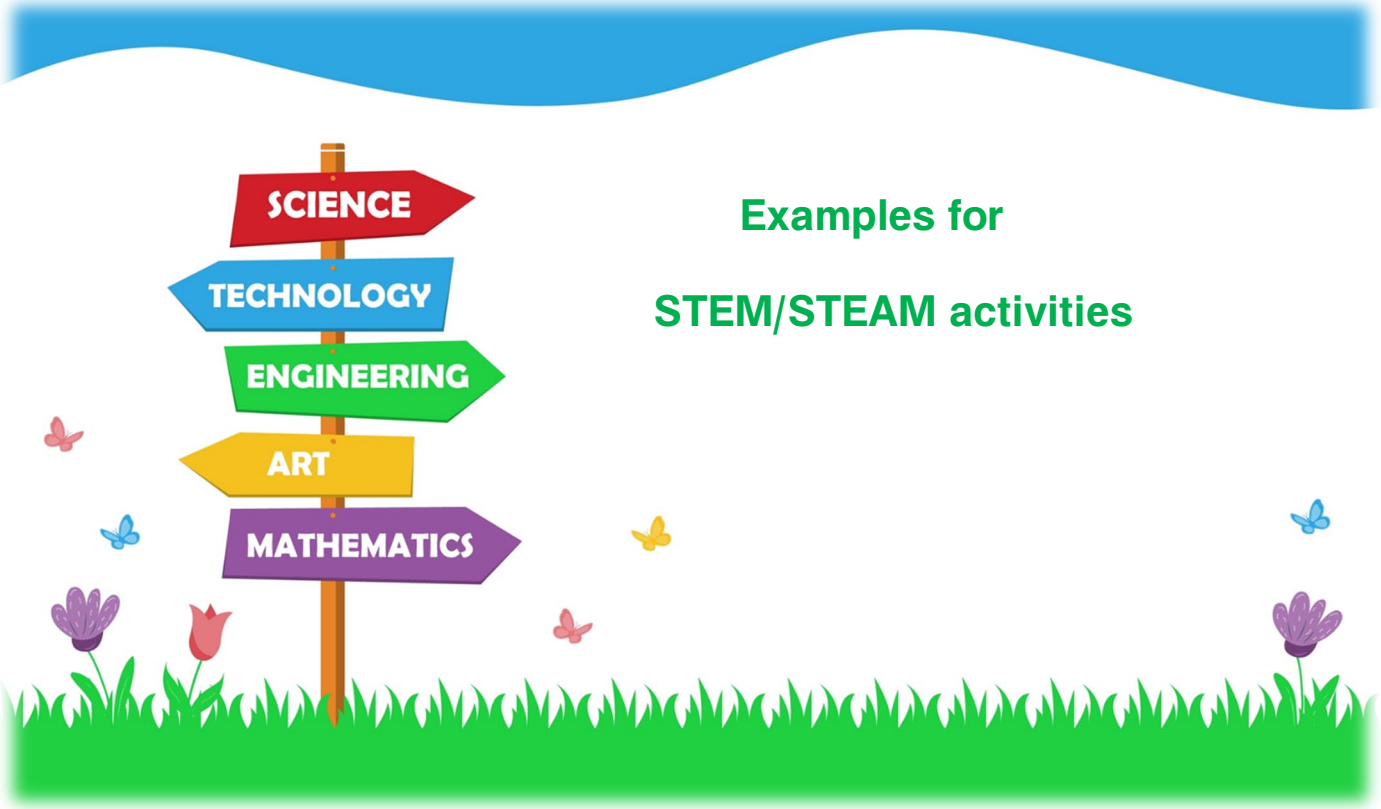
There is a notable predominance of content within the theme of *Measurement and Measures*, which is expected, as the knowledge and skills acquired through this theme are essential for activities based on the content of *Science, Art,* or the *Digital World*.

The objective of teaching and learning in the subject **Visual Arts** is to stimulate students to cultivate their creative thinking and appreciation of beauty through practical, hands-on activities. This approach assists them in becoming proficient communicators and fosters a profound appreciation for the cultural and artistic heritage of both their own and other cultures. As previously highlighted, there are no educational standards explicitly outlined for this subject. Therefore, we conducted an analysis focusing on learning outcomes. The learning outcomes, spanning all four grades, are accomplished through themes such as *Relations in the Visual Field, Shaping, Composition, Materials, Communication, Heritage, Scene*, etc.

Drawing from the analysis of content within the teaching and learning program for Visual Arts, we have identified specific content areas that are particularly conducive to STE(A)M activities and interdisciplinary integration:

1. Visual characteristics of plants and animals, signs, symbols, flags...
2. Properties of materials;
3. Ornament, symmetry;
4. Shapes, position of shapes in space and plane;
5. Transformation;
6. Reading visual information.

While *Visual Arts* provides numerous opportunities for showcasing the outcomes of STEM activities, it also plays a vital role within STE(A)M activities where *Science* and/or *Technology and Engineering* and/or *Mathematics* are integrated. It is crucial to recognize that the role of art extends beyond merely visually representing achieved results; it also supports students' creative processes, aligning with the objectives of art education in primary school.



Examples for

STEM/STEAM activities

Science – World around us/Nature and Society:
How we carry things from the store

The topic in the National Educational Standard: Ecology

Grade: 3rd

Learning outcomes: The student will be able to explain how recycling helps to preserve nature: The student will be able to collaborate with others on joint activities.

Cross-curriculum integration (possible relation with other subjects): Mathematics (The student will be able to read and use data presented by table or graphically (bar chart or pictogram)); Technology – Digital world (The student will be able to add text to an image using a text editor in an image processing program).

Co-funded by
the European Union

Activity description: Groups of students conduct research around local shops. They investigate how customers carry groceries from stores (in a cloth bag, in a plastic bag, in a paper bag, in their hands). Groups record what they observed in the table.

Type of bag					
Counting	IIII I	II	III		IIII
Sum	**6**	**2**	**3**	**0**	**4**

Presenting and comparing data collected by different groups. The data are combined into a common chart. Discussion on environmental behaviour and shopping habits of the population in our town/village.

MATHEMATICS

Mathematics: Find a symmetry in everyday things

The topic in the National Educational Standard: Geometry

Grade: 2nd

Learning outcomes: The student will be able to notice symmetrical figures; The student will be able to complete the drawing in a way that the resulting figure is symmetrical in relation to the given line.

Cross-curriculum integration (possible relation with other subjects): Arts (The student will be able to interpret simple visual information that is perceived in everyday life); World around us (The student will be able to classify plants based on the appearance of leaves and stems).

Co-funded by the European Union

Activity description: Students look at pictures of different animals and leaves of plants and spot those that have symmetrical bodies (leaves) (dragon-fly, butterfly, ant, maple leaf, oak leaf...). They determine the axis of symmetry in the image. They do a similar activity with the letters (A, M, E, B). Homework: find symmetrical cyrilic letters. Pupils receive a drawing of a glove. They draw a symmetrical (second) glove and patterns that are symmetrical.

Technology & Engineering – Digital world: A Walking robot

The topic in the National Curriculum: Algorithmic way of thinking

Grade: 1st

Learning outcomes: The student will be able to start a simple educational robot based on a procedure with symbols (forward, backward, left, right).

Cross-curriculum integration (possible relation with other subjects): The World Around Us (The student navigates space using the determinants back and forth, left-right, up-down and characteristic objects and collaborates with others in the group),

Mathematics (The student will be able to determine the mutual position of objects and beings), Arts (The student will be able to describe the visual characteristics by which he recognizes shapes and space.

Activity description: An educational game for two students. The goal of the game is to write down and follow instructions, spot problems, and come up with a solution. The game requires a board (5x5), two robot cards, a game cube and a paper to write down the code (arrows). The starting position of the robot on the board is in the lower left corner relative to the position of the student. The goal of the player is for the robot to arrive in the opponent's starting field or for the opponent's robot to be thrown out of the game. The pupil rolls a game cube. If he receives the number 3, he draws three arrows of his choice and by the written code he starts the robot.

Arts – Visual Arts: Dangerous fire, poster

The topic in the National Curriculum: Communication

Grade: 4th

Learning outcomes: The student will be able to use selected piece of art and visual information as a stimulus for creative work.

Cross-curriculum integration (possible relation with other subjects): Nature and Society (The student will be able to give examples of fire prevention and protection of fire); Math (The student will be able to calculate the surface area of squares and rectangles).

Activity description: Students research symbols that show fire danger and prevention measures. Creation of posters that will be placed in the school and will be used as a guide for students and employees on fire prevention and behaviour in situations when a fire starts. Calculating the area of posters that are the appropriate size for placement in school corridors. Students create posters in groups, in collaboration with the teacher. Information should be visually presented, large, with bright colours and limited use of words.

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For Curriculum Mapping – Serbia

The results of Curriculum Mapping provide valuable insights into the potential for interdisciplinary integration and offer ideas for creating STE(A)M activities in the lower grades of primary schools in Serbia, particularly through subjects such as *Mathematics, World Around Us/Nature and Society, Visual Arts*, and *Digital World*. These potentials are more evident in the first and second grades, while they are somewhat less pronounced in the third and fourth grades. Although it might seem logical for more STE(A)M activities to occur at older ages, given that students have more knowledge and experience, thereby increasing their potential for integration, the educational standards and teaching and learning programs in Serbia show the opposite trend. One possible explanation for this could be that in the higher grades, there is a greater emphasis on subject-specific content that distinctly belongs to particular sciences and is less focused on developing skills relevant to everyday life.

Reflecting on the themes identified by Curriculum Mapping from the educational standards and teaching and learning programs as having the greatest STE(A)M potential, it is evident that themes related to knowledge and skills essential in everyday situations, beyond the school context, are particularly prominent. These themes include *Materials* (Science), *Measurements* (Mathematics), *Safe Use of Digital Devices, Algorithmic Way of Thinking* (Digital World), and *Communication* (Visual Arts). We believe that the proposed STE(A)M activities encourage active learning, engaging students cognitively and emotionally in the learning process taking into account the student's experience.

In Serbia, teachers are more familiar with the STEM concept compared to the STEAM concept. The integration of Art into the realm of Sciences is only occasionally discussed in

scientific and professional circles, although this discourse has gained momentum in recent years. This is evident from the limited number of scientific papers published in Serbian, individual elective courses in university programs for teacher education, and some of the projects highlighted in the earlier sections of the Report. Private schools and institutions for informal education of students and teachers tend to promote the STE(A)M approach more actively, whereas the state system, which encompasses a significantly larger number of children and teachers, requires more support in this regard.

Given these circumstances, we believe that one of the crucial prerequisites for the broader implementation of STE(A)M activities is reform in university teacher education. Specifically, while methodologies of individual disciplines comprising the STE(A)M concept are currently studied at faculties educating future teachers, there is a need to establish integrative study subjects that actively promote this concept. We see this as one of the most effective ways to introduce STE(A)M education into primary schools, along with continued support for projects and professional development programs aimed at teachers already in practice.

WP 2. R1.2. National Curriculum Mapping Report – Slovenia

Dr. Gregor Torkar, Žan Rode

1. Introduction to STE(A)M integration in the primary education in Slovenia

Slovenian elementary and lower secondary education is organised in integrated primary and lower secondary education, i.e. as a single structure nine-year basic school, attended by students aged 6 to 15.

99% of students attend public schools funded by the state and 1% attend private schools. In the 2021/2022 school year, 195,414 students attended 773 nine-year basic schools and their branches as well as 48 schools for students with special needs. The nine-year basic school is divided into three educational cycles; each cycle comprises three grades. (cf. Taštanoska et al., 2022) The breakdown of Slovenian STEM subjects and the distribution across the individual grades can be seen in Table 1 and Fig. 1.

Co-funded by the European Union

Table 1: STEM subject breakdown and quantitative data (subjects concerned in this report are highlighted) (Torkar et al., 2018)

SCHOOL SUBJECT	TOTAL HOURS	YEAR	HOURS PER YEAR	LEARNING OBJECTIVES (*F*)	OPTIONAL LEARNING OBJECTIVES (*F*)	*F* (%)
ENVIRONMENTAL STUDIES	315	1	105	171	4	2.3
		2	105			
		3	105			
SCIENCE AND TECHNOLOGY	210	4	105	202	45	22.2
		5	105			
SCIENCE	175	6	70	191	25	13.1
		7	105			
BIOLOGY	116	8	52	187	NA	NA
		9	64			
CHEMISTRY	134	8	70	98	5	5.1
		9	64			
PHYSICS	134	8	70	218	30	13.8
		9	64			
DESIGN AND TECHNOLOGY	140	6	70	142	30	21.1
		7	35			
		8	35			

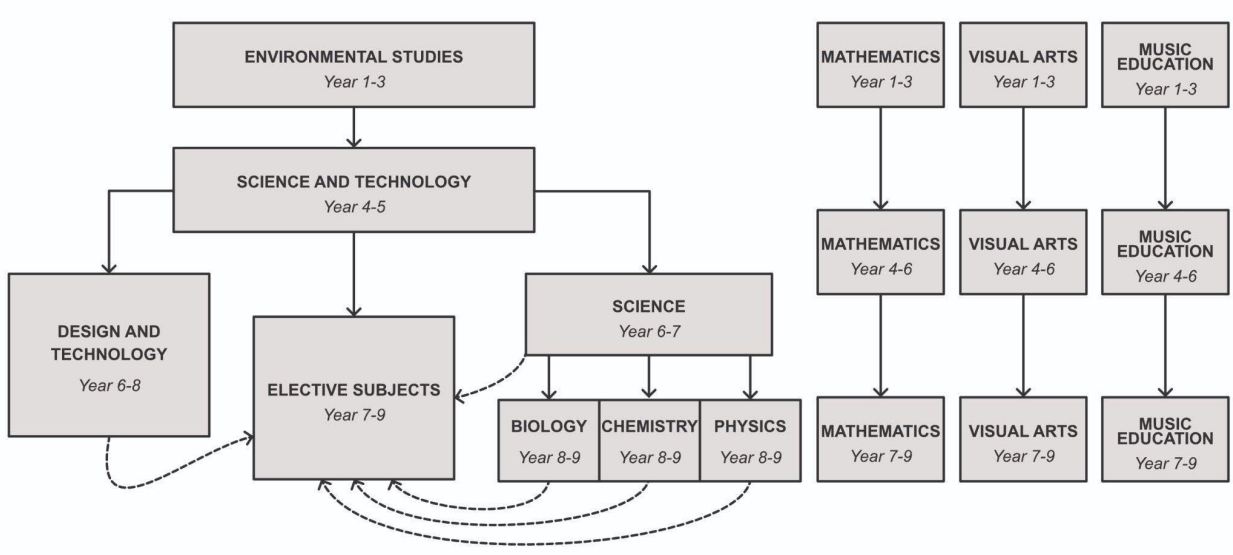


Fig. 1: Slovenian STEM subjects' flowchart (Adapted from Torkar et al., 2018, with addition of Mathematics, Visual arts and Music education)

Environmental studies (also known as Getting to know the environment) is the first subject in school that has to do with science and technology (grades 1–3). The most important overarching learning objective of the subject is an understanding of the environment. In a narrower sense, it is about familiarizing oneself with facts, design concepts and contexts that lead to knowledge, understanding and application of knowledge about the natural and

social environment (Torkar et al., 2018). Knowledge acquired through direct experience in the environment or through media is shaped and deepened in the classroom. Environmental cognition summarizes the processes, procedures, and content through which we learn about the world in which we live. The subject is a source of information, but it is also about learning and consolidating how to find out more information when needed, how to link and apply this knowledge. Therefore, knowledge about the environment is one of the cornerstones of cognitive development in the first phase of primary education. It combines the content of several scientific and technical subjects (chemistry, physics, biology, computer science, engineering, and technology) and social sciences (history, geography, communication sciences, sociology, ethnology). Environmental Studies promotes education for sustainable development and the development of sustainable environmental development by appropriately integrating the interrelated environmental, economic, and social issues. The content of the program is based on fundamental concepts that enable students to build on science and technology and society in the second phase of their education and to develop in science and society. The variety of content and activities as well as the proposed teaching and learning methods enable the integration of content and a meaningful connection with mathematics and Slovenian, music, art, and physical education (Torkar et al., 2018).

In the next stage (grades 4–5), students deepen their knowledge and experience in the subject of science and technology. This school subject focuses on the development and improvement of basic scientific and technological knowledge, skills, and attitudes, enabling students to solve various everyday situations and problems related to science and technology (Torkar et al., 2018).

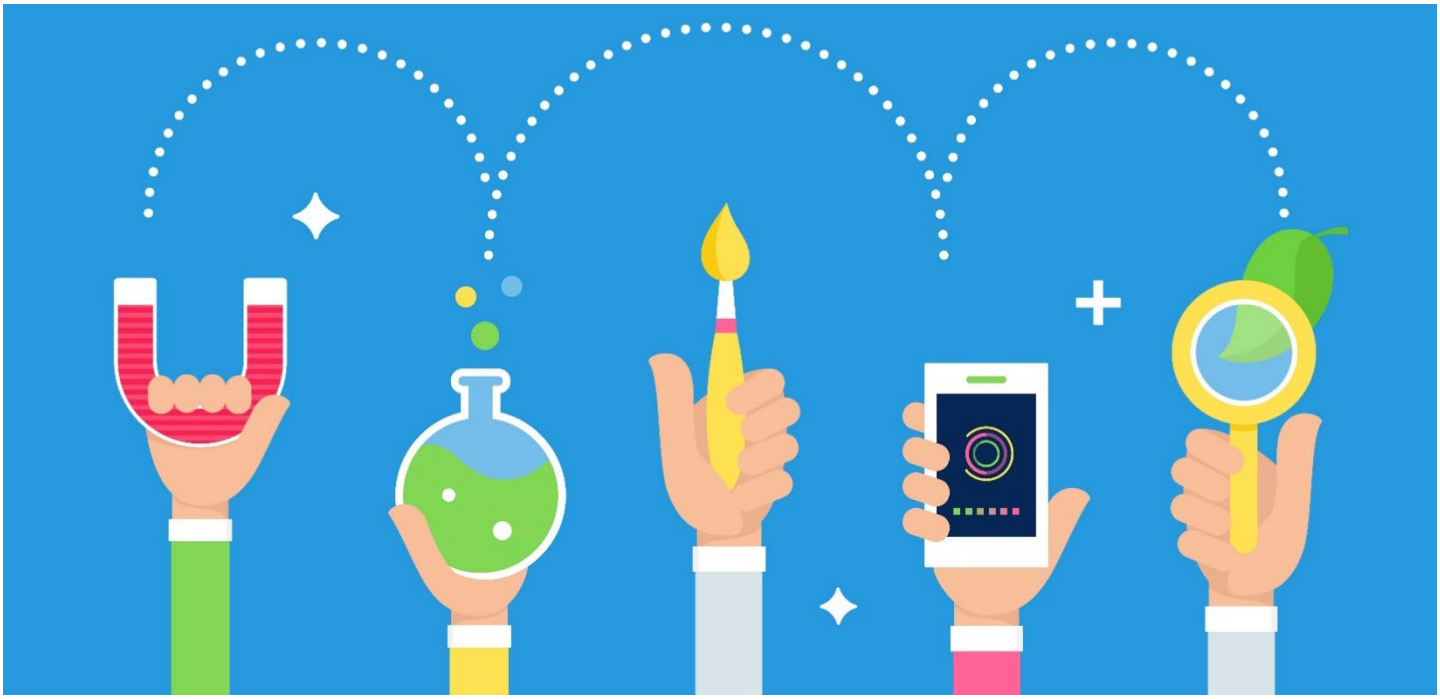
Mathematics as a subject is divided into three 3-year segments. The subject is called Mathematics in all 9 years of primary and lower secondary education. Mathematics stands as one of the fundamental subjects in primary education, encompassing numerous educational-informative, functional-formative, and educational tasks. Its pivotal role extends to providing support for other natural sciences, technical disciplines, and social-humanistic fields, making mathematics an integral part of various aspects of human life and creativity. Primary school mathematics instruction addresses fundamental mathematical concepts in ways that align with a child's cognitive development, abilities, personal characteristics, and their living environment (e.g., nature as a source for mathematical creativity and exploration)

(Učni načrt. Program osnovna šola. Matematika, 2011 *[Syllabus. Primary school program. Mathematics, 2011]*).

Visual arts and music education, like Mathematics, are divided into three 3-year segments. Art education plays a fundamental role in the development of artistic skills and understanding of visual space. It aims to cultivate creativity, innovation and visual sensitivity, as well as the ability to observe and judge. The main means of achieving these goals include practical artistic expression, the use of different thinking strategies, materials, tools and technologies, and problem-oriented tasks related to the visual arts and visual culture. Art instruction analyses and evaluates the visual world on both cognitive and expressive levels, allowing students to develop their imagination, artistic thinking and understanding of the visual environment. It also familiarises students with the heritage of the visual arts and contemporary visual and artistic culture. Art education is considered universally beneficial as it enhances spatial imagination and visualisation skills and promotes cultural awareness and visual expression, which are essential European competences.

Music education focuses on performing, creating and listening to music to develop students' musical experiences and thinking, as well as their skills, abilities and knowledge. It also promotes interdisciplinary links between music and other subjects, broadens students' cultural awareness and develops their critical and aesthetic sensibility. Music education encourages active and selective listening to music in the media and at events and supports participation in choirs and other music groups. It complements cultural and social life, contributes to a healthy soundscape and encourages self-discipline, creativity and artistic expression.

There is no official national document for implementing STEAM education in Slovenia. Still, the topic is quite active and evolving. The topics are recognised as vital and are promoted through conferences, such as STEAMColab, an event organised by the Center Digitalna UL. It aims to introduce different stakeholders in STEAM education, inspire each other, and build collaborations. The event focuses on workshops, round tables, and other activities dedicated to students and young enthusiasts of STEAM. It also presents examples of good practices of STEAM teaching and learning across the education vertical, current research findings in STEAM education, possibilities of digital support for STEAM education, and job opportunities in STEAM.



2. Curriculum Mapping results – Slovenia

In our examination of the Slovenian national curriculum, we reviewed the syllabi for the following subjects: Environmental Studies (1st to 3rd grade), Science and Technology (4th grade), Mathematics (1st to 4th grade), Musical Arts (1st to 4th grade), and Fine Arts (1st to 4th grade).

Each school subject is described as follows:

1. Subject definition
2. General subject goals
3. Operational objectives and content, knowledge standards and didactical recommendations
4. Didactical recommendations (further subdivided):

a. Achieving the objectives of the course
b. Cross-curricular integration
c. Individualisation and differentiation
d. Testing and assessment of knowledge

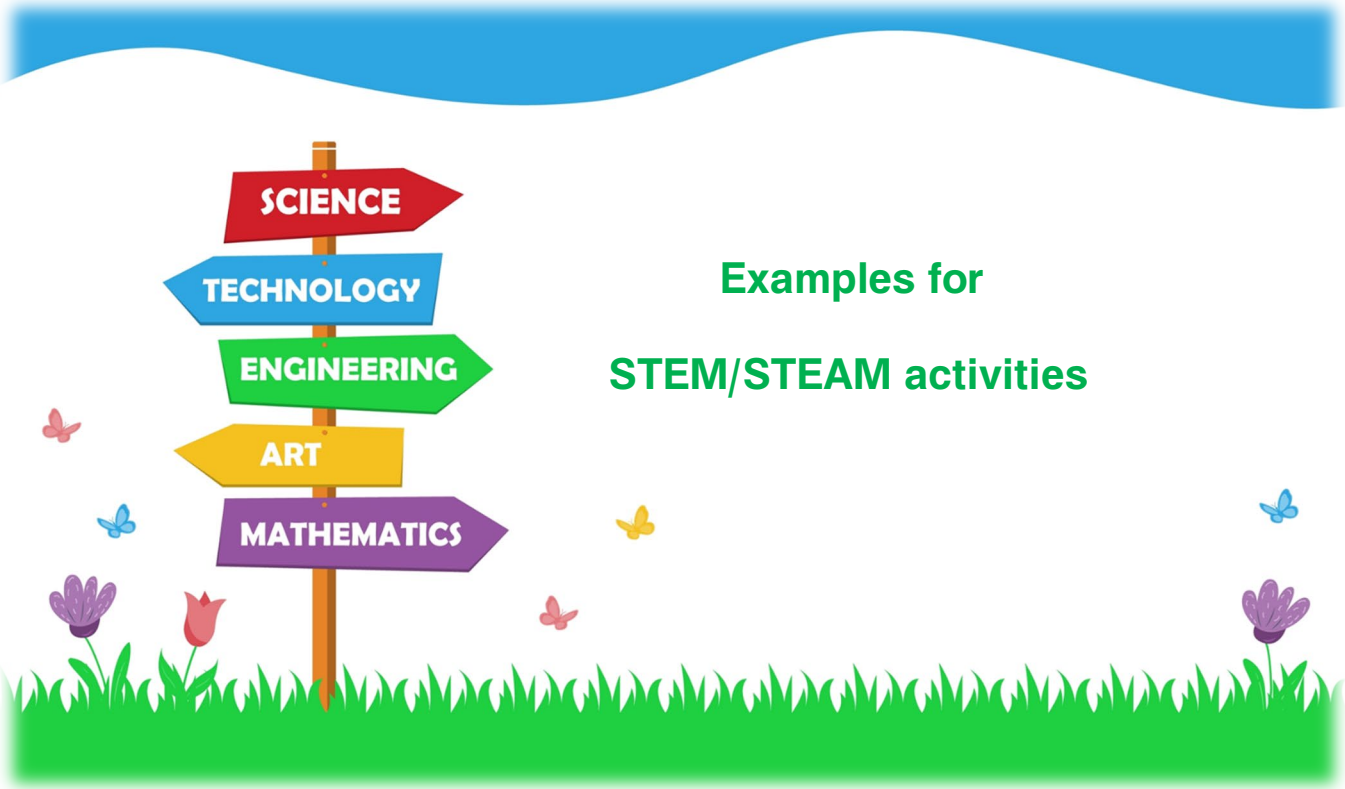
e. Digital technology

5. Teachers' required knowledge

To obtain a comprehensive understanding of the syllabi, we analysed the *Operational Objectives*, as they outline the specific learning goals for each topic. We mapped out the learning objectives for each grade level and compared them across all four years to identify any progressive objectives. This categorization into thematic groups allowed for a detailed examination of specific topics within the Slovenian curriculum. Each identified group was given a name to describe its focus. The official overarching topic from the curriculum is presented in all caps, while our custom-defined topic is presented without caps. An example of an identified group is provided below:

Table 2: Example of an identified group of operational learning objectives

NAME OF THE TOPIC IN THE NATIONAL EDUCATIONAL STANDARD	**SUBSTANCES - *safety***			
OPERATIONAL OBJECTIVES	Students know that there are substances with dangerous properties (hazardous substances: toxic, flammable, explosive, corrosive, environmentally hazardous),	Students learn the basic labels for the hazardous properties of substances,	Students understand the meaning of the basic labels for the hazardous properties of substances,	Students can explain the meaning of the symbols used to label hazardous substances and identify them on everyday products (corrosive, flammable, toxic, hazardous to the aquatic environment, etc.),



2.1 Science and Social Studies

In Science and Social Studies education, we examined the Environmental Studies subjects' curriculum in which the following themes were observed:

- LIVING THINGS: Identifying living things and environments
- LIVING THINGS: Interactions between organisms and environments
- LIVING THINGS: The differences between plants and animals
- LIVING THINGS: Conditions for life
- LIVING THINGS: Changing over time and descendants
- TIME: Universe
- TIME: Seasons
- SPACE: Orientation
- SUBSTANCES: Mixtures
- SUBSTANCES: Solids and liquids
- SUBSTANCES: Safety
- SUBSTANCES: Changing the properties of substances

- SUBSTANCES: Magnetism
- SUBSTANCES: Waste
- FORCES AND MOVEMENT
- FORCES AND MOTION: Universe
- PHENOMENA: Water
- PHENOMENA: Sound and light
- HUMAN: Health
- HUMAN: Body
- ENVIRONMENTAL EDUCATION: Human impact on the environment
- ENVIRONMENTAL EDUCATION: Environmental changes and their effects

In Science and Social Studies, we discovered opportunities for cross-curricular integration with Language, both mother tongue and foreign language, which students in Slovenia begin in the 2nd grade of primary school. This connection can be implemented in various ways, such as naming species in different languages, watching documentaries or educational videos on different topics in the mother tongue, as it is part of the curriculum (Učni načrt (posodobljena izdaja). Program osnovna šola. Slovenščina, 2018 [*Syllabus (updated edition). Primary school program, Slovenian language, 2018*]), and learning the names of plants and animals (and their parts) in a foreign language. Students could also write essays about topics they are learning in science subjects, such as Environmental Studies and Science and Technology, as essays are part of the language education curriculum (Učni načrt (posodobljena izdaja). Program osnovna šola. Slovenščina, 2018 [*Syllabus (updated edition). Primary school program, Slovenian language, 2018*]). Language can also be introduced when learning about safety and safety labels in the classroom. When studying humans and health, language could facilitate exploring how to communicate topics like health and healthy living through different media. Language can also be integrated into scientific topics using various media, which is particularly useful for enhancing environmental literacy and awareness, as this is a prominent issue today accompanied by many outreach activities that can be adapted for students and explored simultaneously from both language and scientific perspectives.

Connections can be established between STE(A)M and Sports education. When students study living things, embodied cognition can be used by imitating various objects, animals, phenomena, and concepts in nature to demonstrate morphological structures and

behaviours. Embodied cognitive science appeals to the idea that cognition heavily relies on aspects of the agent's body beyond the brain. Without the involvement of the body in both sensing and acting, thoughts would lack substance, and mental processes would not manifest the characteristics they do. Work on embedded cognition, by contrast, draws on the view that cognition deeply depends on the natural and social environment (Shapiro & Spaulding, 2021). The same approach can be applied to learning about seasons and weather, where students can mimic different weather patterns using movements, or imitate the movements of celestial objects by simulating gravitational forces through activities like holding hands and spinning, thus experiencing centripetal forces. Outdoor sports activities can also incorporate navigation and orientation, promoting physical activity and connecting it with topics of orientation Sports can further serve as a means to explore concepts of forces and movement, requiring students to describe and observe their own movements. For instance, in the 3rd year, students explore the movement of bodies in water, which could be investigated through swimming and connecting observations to physics topics such as fluids and buoyancy.

As students learn about themselves and other humans, they explore topics of health. Here sports education is crucial, as regular exercise is of utmost importance for a healthy lifestyle, therefore these topics must be incorporated. An important aspect of this is also ways to exercise correctly as to avoid injury.

2.2 Art

In the Slovenian national curriculum, Art is divided into two categories: Musical Arts and Fine/Visual Arts. We reviewed the syllabi to identify topics that could be applied to the previously identified STEM themes. The following learning objectives were identified:

- Musical arts:
  - They sing experientially, observing loud, quiet, and slower, faster singing.
  - They broaden vocal range, improve singing technique and intonation.
  - They explore the sonority of musical instruments and identify and describe differences.
  - They deepen their sense of two- and three-note metre. They perceive the relationships between the period and the first subdivision.

- They learn and use musical concepts: instruments, sound, tone, high/low, loud/quiet, short/long tones, ascending/descending, silence/pause, repeat sign and use them to express sound ideas.
- They explore sound colours and use them to express sound ideas.
- They use sounds to imitate things, animals, languages, or events in their immediate and wider environment and in nature.
- They listen to and think about sounds in nature, other sound phenomena and musical examples.
- They become accustomed to the use of modern technology.

- Visual arts:
  - They try out different drawing materials and tools.
  - They draw shapes with different drawing materials and tools on different sized drawing surfaces.
  - They observe and compare examples of lines in nature, in the environment and in works of art.
  - They learn about drawing-related concepts by looking at artworks, pupils' art products and examples from nature and the environment.
  - They draw freehand and with a ruler.
  - They use simple computer tools to draw.
  - They build a drawing from the whole to the parts.
  - They learn about the artistic concepts related to sculpture by looking at the artworks, the art products of the pupils and examples from nature and the environment.
  - They form a sculptural volume by kneading different materials.
  - They create a sculptural volume by assembling different spatial units.
  - They create a sculptural volume by bending or folding flat and flexible materials.
  - They pay attention to the stability of the sculptural product when designing.
  - They learn about the characteristics of different sculptural materials and tools.
  - They are modelling simple human and animal figures.
  - They form a figure from a single piece of soft material.
  - They use recycled materials, packaging, and natural materials for sculptural expression, and may also use various adhesives, adhesive tapes, string, wire and other materials.

- They learn about the artistic concepts related to surface design by looking at the artworks, the pupils' artwork and examples from nature and the environment.
- They gain experience of using different sizes, colours, shapes and qualities of support when designing on the surface.
- They use digital technologies alongside traditional ones in their artistic expression.
- They make stencils from different materials and print them.
- They compare the properties of different printmaking techniques.
- They understand the process of making sheet prints or prints.
- They produce a comic strip and pay attention to the relationship between writing and drawing.
- They solve selected artistic concepts, possibly with the help of digital photography.
- They learn about the concepts of design in three-dimensional space by looking at the artworks, the students' art products and examples from nature and the environment.
- They learn about concepts related to different ways of expressing themselves in three-dimensional space.
- They design a model and pay attention to the connections between spaces and to openings.
- They design a Marquette with a skeletal frame.
- They use different materials and tools to express themselves in three-dimensional space.

Art can be implemented in many ways. Many learning objectives in visual arts are focusing on students learning about art from observing nature and the environment. This can be seen in the topic of LIVING THINGS – e.g. snail shells, colours of bird feathers – and in exploring these topics from the perspective of camouflage and aesthetic presentation – leading to various forms of selection in evolution. Art is versatile and can feed into many topics – even exploring how nature can be seen as art (e.g. a beautiful sunset) and why we humans find nature scenes pleasing, why certain colour combinations are seen as aesthetic and how this relates to biology and evolution. In addition, students can create models of ecosystems and sketch organisms using their powers of observation. They can explore biological illustrations and learn about day/night cycles through painting and sculpture. As part of ORIENTATION, students could design their own maps, utilizing their visual arts skills and the knowledge they have gained in environmental studies. Art ties in perfectly with the topic of safety, as

pictograms are essential for students to be able to behave safely in a laboratory environment later. Here, students could design their own pictograms and explore why the official pictograms are designed the way they are – exploring themes of design that are also part of the visual arts curriculum (Učni načrt. Program osnovna šola. Likovna umetnost, 2011 *[Syllabus. Primary school program. Visual arts, 2011]*). Conversely, the topic of safety can also be transferred to art by examining the dangerous aspects of, for example, the solvents used in painting. In the context of MAGNETISM, artworks could be made with magnets in different configurations and iron filings, demonstrating magnetic fields and exploring the aesthetic aspects. Within the WASTE theme, numerous activities could be developed using waste to create artworks to communicate messages about sustainability and the importance of waste management and recycling. In FORCE AND MOTION, artworks could be made using pendulums and paint containers that are not only visually appealing but also convey the learning value of moving objects. In LIGHT AND SHADOW, artworks can be made from seemingly random objects that cast shadows to create images. In the context of HUMAN HEALTH, infographics could be created to promote a healthy lifestyle.

Musical arts can be integrated into topics like "Living Things". Connections could be made with the sounds of various living things, as well as why they produce sounds and how they create them. For example, bird songs could be used as an effective tool, where students try to replicate the sounds they hear using different instruments, objects, and their own voices. They can then compare the actual formation of the sound in birds to the instruments and how they produce the sound. In the context of TIME seasonal songs can be explored and connected to the cultural aspect of seasons - why certain songs are associated with certain season. The learning objective “They become accustomed to the use of modern technology.” Could be achieved with using smartphone applications, like spectroscopes, which display sounds in the form of a sound wave, where different frequencies can be observed. Thus, different sounds can be explored from a physics perspective, they can be compared and analysed.

2.3 Mathematics

In the field of mathematical education, the Mathematics subject curriculum was reviewed to identify topics that could be linked to the previously observed Science topics:

- GEOMETRIC SHAPES AND USING GEOMETRY TOOLS
- MEASURING
- LOGIC AND LANGUAGE
- DATA ANALYSIS: VISUALISATIONS

Mathematics is an essential component of scientific education, and we explored specific implementations where mathematical topics could enhance science education in meaningful ways. The topics of GEOMETRIC SHAPES AND USING GEOMETRY TOOLS are well-connected with Environmental Studies, as students need to learn to apply basic concepts related to landscape features, where geometric shapes can be observed in various objects around the school. This topic also correlates well with the concept of SPACE: orientation, where students could create custom maps and mark their walking paths to create shapes, thereby developing planning skills. In 4th grade, students learn to differentiate between cubes and squares, which can be integrated with the topic of WATER from the Science and Technology subject by introducing differently shaped containers. The topic of MEASURING can significantly contribute to science education by helping develop scientific skills. Furthermore, measuring is used in topics of FORCES AND MOVEMENT, as students in Environmental Studies describe movements of different objects, which can be complemented by measuring quantities like length. In later years, students could measure angles of slopes and compare movement on different slope angles. WATER topics could also be explored mathematically by measuring flow rates through pipes and investigating how different pipe widths influence flow rate. In the topic of LOGIC AND LANGUAGE, students learn, among other things, about different representations, more specifically Euler-Venn diagrams and tree representations. This can be demonstrated in the biological dichotomous keys where organisms are classified in a tree-like structure, based on yes or no questions dividing the group into semi-equal groups, thus enabling the organism

identification according to its observable characteristics. Tree representations can also be used in Environmental Studies to represent the tree of life, while arrow diagrams can explore connections between organisms. In 4th grade, students learn about sets and subsets, directly connecting to classifying living things into groups based on common characteristics.

Finally, in the topic DATA ANALYSIS: VISUALISATIONS of the 2nd grade Environmental studies learning objective “Students are able to prepare mixtures and apply procedures to separate mixtures, be able to describe and distinguish substances and classify them according to their properties (e.g., volatility, hardness)” is a good example for cross-curricular integration. Different mixtures can be presented in a table form, requiring students to learn about reading table data and creating mixtures according to ingredients in the table. In the 3rd grade, students learn about the composition of air, which could be presented in a chart format – thus connecting the two topics and visualising a difficult topic of air mixture composition.

2.4 Technology and Engineering

In the educational field of technology and engineering, we reviewed the Environmental Studies and Science and Technology curricula and observed the following topics:

MATERIALS: Processing
FORCES AND MOVEMENT: Making a model
PHENOMENA: Electricity
TIME: Measuring

Focusing on safety in the context of material processing is paramount and has to be integrated into the topic of MATERIALS. In Environmental Studies, students learn about the hazardous properties of substances that can also be addressed in topics of material processing. Physics themes can also be incorporated by constructing models such as carts and balls, which can then be tested in terms of physics principles and movement. The connection with physics can be further enhanced when students explore magnets,

experimenting with different uses for magnets in model creation. For example, students could construct a cart with magnetic joints to connect multiple carts, allowing for exploration and testing of these connectors. Additionally, topics like FORCES AND MOVEMENT in Environmental Studies can be linked with Mathematics, as students develop skills in measuring, recording data, and creating and interpreting graphical representations of movement, all of which align with the process of making and testing models. This integration can also be extended to include PHENOMENA: Electricity, where model trolleys could be enhanced with simple electric motors, requiring students to familiarize themselves with basic electricity concepts and circuits. Finally, the topic of TIME: Measuring, identified in the 3rd grade curriculum, can be situated within the field of Technology and Engineering, as measuring is fundamental to engineering. Projects such as creating custom timekeeping devices like sundials, hourglasses, or water clocks can be introduced to explore different methods of measuring time. Art can also be integrated into these projects, as timekeeping devices not only serve a practical purpose but also hold aesthetic value as environmental ornaments.

For Curriculum Mapping – Slovenia

To summarize, a comprehensive examination of the Slovenian national curriculum reveals a well-structured and interconnected educational framework. The curriculum evolves across the first four grades and deepens students' scientific and technical knowledge and skills. The results of the Curriculum Mapping provide some insights into cross-curricular integration and offer ideas for implementing STE(A)M activities. Cross-curricular integration opportunities emerge, for example, science and social studies with language, physical education, art, mathematics, and technology. Music and visual arts serve as versatile tools to reinforce scientific concepts, allowing students to explore the aesthetics of nature, create ecosystems models, and engage in projects that blend scientific principles with artistic expression. This integration of artistic elements enriches the learning experience and fosters creativity. Mathematics, with its focus on geometric shapes, measurement, logic, and data analysis, seamlessly complements the science curriculum. Concepts like Euler-Venn and tree diagrams find practical application in the classification of living things, illustrating the interconnectedness of mathematical and scientific thinking. In technology and engineering, topics ranging from materials processing to electricity provide students with hands-on experience and opportunities to develop technical and engineering skills. The curriculum encourages the application of scientific principles in building models, linking physics, and engineering and exploring the practical aspects of technology. Overall, the interweaving of subjects in the Slovenian curriculum shows that a holistic approach to STE(A)M education is feasible. The integration of different subjects not only improves the acquisition of knowledge, but also promotes critical thinking, problem solving and creativity – important skills for students on their academic and professional path.

Co-funded by
the European Union

For three partner countries – Bulgaria, Serbia, Slovenia

In the preceding sections of this report, we delved into the results of Curriculum Mapping pertaining to the potential integration of STEM/STEAM activities across three partner countries: Bulgaria, Serbia, and Slovenia. By scrutinizing each country's National Educational Standards and subject curricula, the report elucidated the distinct national contexts, outlined the STEM/STEAM subjects taught in schools, and identified key topics ripe for cross-curricular integration. Throughout the report, numerous ideas for STEM/STEAM activities were proposed, tailored to the varying age groups of primary school students and easily implementable within educational settings.

Based on the analysis of the Curriculum Mapping results and the national reports, several conclusions can be drawn. The research highlighted that all three partner countries – Bulgaria, Serbia, and Slovenia – incorporate school subjects that encompass the STEM/STEAM fields, including Science, Mathematics, Technology, Engineering, and Arts (see Table 1).

Table 1. School subjects, related with STEM/STEAM

STEM/STEAM areas	School Subjects in Bulgaria	School Subjects in Serbia	School Subjects in Slovenia
Science	Homeland Studies	World around Us	Environmental Studies
	The Man and the Nature	Nature and Society	Science and Technology
	The Man and the Society		
Mathematics	Mathematics	Mathematics	Mathematics
Technology and Engineering	Technology and Entrepreneurship	Digital World	(included in the Science education)
Arts	Music	Arts	Musical Arts
	Visual Arts	Musical Culture	Fine Arts

However, Bulgaria, Serbia, and Slovenia are still in the early stages of incorporating STEM/STEAM initiatives into their education systems. Despite the increasing popularity of STEM concepts in these partner countries and the provision of support from the government, such as the establishment of STEM-equipped classrooms (e.g. in Bulgaria), **STEM education is not officially included in the primary school curriculum in the three countries** where the research was conducted. As a result, the implementation of STEM/STEAM activities remains largely dependent on the individual initiatives of teachers. Without explicit inclusion in subject curricula and school documentation, many primary teachers may lack confidence and encounter difficulties in identifying opportunities to incorporate

STEM/STEAM into their teaching practices. This underscores the primary goal of the research, which is to conduct Curriculum Mapping and identify specific opportunities for integrating STEM/STEAM activities into the teaching of existing subjects. By doing so, the aim is to develop a methodology for teaching STEM in primary grades and provide guidance to teachers on effectively integrating STEM/STEAM within the existing educational context.

The analysis of the National Educational Standards across the three countries revealed that teachers are provided with a variety of options for integrative learning in primary school. These standards offer numerous avenues for incorporating STEM/STEAM activities into the educational content of various curriculum subjects. Additionally, common themes were identified among the National Educational Standards of the partner countries. Specifically, in terms of different STEAM subjects, they include:

- **Science** – Nature (Living and Non-living Things), Interaction between Organisms and Environment, Conditions for Life, Natural Phenomena and Processes, Substances, Bodies, Organisms, The Man and the Environment, Healthy Lifestyle);
- **Mathematics** – Measuring, Geometry, Numbers;
- **Technology and Engineering** – Technique and Safety, Algorithmic Way of Thinking, Construction and Modelling;
- **Arts** – Musical Expression, Visual Communication, Objects and Environment.

These topics facilitate numerous cross-curricular connections and encourage the integration of STEM/STEAM activities within the learning content of the school subjects outlined in the national educational documentation for primary schools. Through Curriculum Mapping, each topic in the educational documentation of the three countries was reviewed from various perspectives, allowing for the development of STEM/STEAM activities aligned with each topic.

Additionally, numerous specific proposals have been outlined for the implementation of STEM/STEAM activities tailored to different age groups in alignment with each country's curriculum. These activities offer abundant opportunities to enhance students' knowledge while also improving their skills, particularly in problem-solving, creativity, and critical thinking. The proposed STEM/STEAM activities hold the potential to foster active learning and actively engage students in the educational process, taking into account their individual

experiences. These proposals can be effectively executed by primary school teachers and could also serve as valuable resources in the university education of future teachers. Across the reports of the partner countries, particularly in Bulgaria and Serbia, there is a recognized need to support teachers in the implementation of STEM and to expand their knowledge and skills in this area.

Common topics in the curriculum across the three countries provide a foundation for the implementation of consistent STEM/STEAM activities and methodologies that can be utilized by teachers internationally. This presents a promising opportunity for the sustainable internationalization of teacher training in STEM education. It enables the development and delivery of joint university courses, whether online or in-person, catering to bachelor's, master's, and PhD students, as well as additional courses for in-service primary teachers. Such international teacher training initiatives are already being planned, as evidenced by the upcoming S.TEMPO project scheduled for April 2024 in Belgrade.

The findings from the Curriculum Mapping will serve as a foundation for the next phase of the project, which involves developing a methodology for STEM/STEAM teacher training. This shared methodology will establish a standardized approach to designing STEM/STEAM activities, tailored to the specific needs and contexts of the three distinct educational systems involved in the project.

S.TEMPO Project 2023/2025

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