SAILINTOSTEAM

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DELIVERABLE D2.2

SailingIntoSTEAM methodology and syllable

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DELIVERABLE DATA SHEET

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Deliverable summary
This document outlines the key principles and components of the methodology and provides a detailed overview of the syllabus, including learning objectives, teaching methods. It is written in Serbian and English for better dissemination.

Table of content:

Sailing into STEAM methodology and syllable

Introduction

The SailIntoSTEAM project aims to design, develop, and conduct a pilot test of a sailing course adapted for children aged 7 to 12. The goal is to use sailing as an excellent testbed to teach science, technology, engineering, art, and mathematics (STEAM) matters. This will provide an extraordinary educational experience for young students and athletes. Besides bridging the gap between theory and real-life by introducing a series of hands-on activities, the project also aims to educate young minds for the need to know better and protect nature, as an indispensable component of sailing. Such a course will provide technological and environmental skills for all the participants involved preparing the young people for the future.

In this deliverable, the teaching and learning methodology and syllabus will be briefly described. The adaptation of the methodology for different age groups and different target groups (schools/clubs) is introduced. Finally, a short overview of each module content and preliminary teaching and assessment methods. The detailed methodology and implementation is subject of a different deliverable (D2.3) to be delivered in Month 18. Those details will be defined based on the pilots to be implemented and based on the experience of those first pilots aligning directly with the involved school/club(s).

Methodology

Introduction to Methodology

The "Sailing into STEAM" project aims to merge the engaging and dynamic world of sailing with the educational principles of Science, Technology, Engineering, Arts, and Mathematics (STEAM). By leveraging the interdisciplinary nature of sailing, this project provides an effective platform for hands-on and immersive learning experiences. The primary objective is to create a holistic educational framework that bridges theoretical knowledge with practical application, preparing learners for maritime challenges and the demands of a technologically advancing world.

To ensure the activities are developmentally appropriate and engaging, students are planned to be divided into two distinct age-based groups depending on the school classes/groups and clubs needs:

Group 1: Ages 7-9

- Characteristics: Younger students in this group are at an early stage of cognitive development. They benefit from hands-on activities, visual aids, and story-based learning. Their attention spans are shorter, requiring varied and dynamic sessions.
- Learning Focus: Introduction to basic concepts, hands-on activities, visual and story-based learning, play-based learning.

Group 2: Ages 10-12

- Characteristics: Older students in this group are capable of more abstract thinking and can handle more complex tasks. They are ready for detailed explanations and can engage in project-based and analytical activities.
- Learning Focus: Detailed explanations, advanced projects and experiments, analytical and critical thinking, collaborative projects.

Educational Needs Assessment

Based on the findings from “White paper on diagnosis of sailing STEAM educational courses needs”, the following educational needs have been identified for successfully integrating STEAM into sailing courses:

- Educational Enhancement:
    - Innovative Resources: Develop innovative resources to simplify complex sailing concepts, making them more accessible and engaging for young learners.

    - Physical Education Integration: Integrate physical education to improve motor skills and coordination.
    - Practical Sailing Scenarios: Design practical sailing scenarios that effectively illustrate STEAM principles.
- Engagement Strategies:
    - Deep Engagement Methods: Create methods to deeply engage students with the physical and tactical aspects of sailing, particularly to compete with the allure of digital entertainment.
- STEAM Integration:
    - Clear Demonstrations of STEAM Concepts: Address the challenges educators and coaches face in conveying abstract STEAM concepts through sailing by developing scenarios that clearly demonstrate these principles.
- Environmental Awareness:
    - Sustainability Practices: Incorporate environmental sustainability practices into the curriculum to foster a strong commitment to ecological responsibility among students.

Methodology to be applied to Sailing Clubs

The methodology for integrating STEAM principles into sailing clubs involves a comprehensive approach that blends theoretical instruction with practical sailing experience. The following key components are essential:

- Interdisciplinary Curriculum Development:
    - The curriculum integrates scientific concepts such as physics (buoyancy, wind dynamics), technology (navigation systems), engineering (boat design), and environmental science (sustainability practices). The arts are incorporated through creative activities like sail design and maritime history.
- Hands-On Learning and Practical Application:
    - Emphasis is placed on experiential learning where students directly apply theoretical knowledge through sailing activities. This includes understanding the geometry of sails, mechanics of sailing, and the use of technological tools for navigation and analysis.
- Safety and Inclusivity:
    - Safety protocols are rigorously enforced to ensure a secure learning environment. The methodology also focuses on inclusivity, making sailing accessible to students of all backgrounds and abilities through adaptive equipment and supportive teaching practices.
- Assessment and Feedback:

- Continuous assessment methods are employed to evaluate students' understanding and skills. Feedback from both students and instructors is used to refine and improve the program.

- Age-Based Group Division:
  - Group 1: Ages 7-9
    - Learning Focus: Introduction to basic concepts, hands-on activities, visual and story-based learning, play-based learning.
    - Session Structure: Shorter, varied sessions with a mix of activities to keep students engaged.
  - Group 2: Ages 10-12
    - Learning Focus: Detailed explanations, advanced projects and experiments, analytical and critical thinking, collaborative projects.
    - Session Structure: Longer, more focused sessions allowing for deeper exploration of topics.

Methodology to be applied to Schools

Integrating the STEAM sailing curriculum into schools involves several strategic steps to ensure its effectiveness and alignment with educational standards:

- Curricular Integration:
  - The STEAM sailing curriculum is incorporated into existing school subjects. For example, physics lessons can include practical examples from sailing, such as studying forces and motion through sailboat dynamics. Mathematics can cover navigation calculations, while art classes might explore sail design and marine aesthetics.
- Teacher Training and Professional Development:
  - Educators receive specialised training to effectively deliver the STEAM sailing curriculum. This includes workshops on the principles of sailing, hands-on activities, and the use of technological tools for teaching STEAM concepts.
- Resource Allocation and Support:
  - Schools should be provided with necessary resources such as model boats, sailing simulators, and access to local sailing clubs for practical sessions. Partnerships with sailing clubs are established to facilitate regular field trips and practical learning experiences.
- Extracurricular Activities:
  - Extracurricular programs are developed to further engage students, offering more in-depth exploration of sailing and STEAM subjects. These programs include project-based learning, competitions, and collaborative projects with local sailing clubs.

- Age-Based Group Division:
  - Group 1: Ages 7-9
    - Learning Focus: Introduction to basic concepts, hands-on activities, visual and story-based learning, play-based learning.
    - Session Structure: Shorter, varied sessions with a mix of activities to keep students engaged.
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General approach

In both cases, the basic syllabus will be similar and is composed of 8 modules. Ideally, each module will be one class/session but these can be broken into more than one slot depending on availability of teachers/clubs and students' ages. For instance, according to the surveys performed as part of Task 2.1, sailing clubs are more interested in shorter lessons than what is typical for a classroom. The methodology will then be tailored to the exact school/club where the pilot will occur. This will be better detailed later in the project in the Deliverables D2.3 – Teacher's guide for implementing SailingIntoSTEAM course which will include detailed lesson plans, teaching strategies and assessment methods. In the following section, an overview of the Syllabus is provided together with short summaries for each of the modules.

Overview of the Syllabus

Introduction

The syllabus for the Sail Into STEAM course includes 8 diverse modules. These modules are being prepared by the different partners through a combination of joining partners skills and experiences with best practices in STEM education applied to STEM. In particular, Modules 1 to 5 are inspired by the REACH course (US Sailing, REACH program). and are being prepared by Sailing Club Zemun, Module 6 is based on the experience of EcoHub, Module 7 is related to the work developed by EdUman while Module 8 is provided by FER (Faculty of Electrical Engineering and Computing) based on their experience in marine robotics. The overall learning objectives are detailed hereafter followed by each module summary.

Learning Objectives

The "Sailing into STEAM" course is designed to merge the engaging world of sailing with the principles of Science, Technology, Engineering, Arts, and Mathematics (STEAM). The overarching learning objectives for this course are to:

- **Understand Fundamental Concepts:**
  - Develop a basic understanding of key scientific and engineering principles related to sailing, such as wind dynamics, buoyancy, and the mechanics of sailboats.
- **Integrate STEAM Disciplines:**
  - Foster the ability to connect and apply concepts from science, technology, engineering, arts, and mathematics to real-world contexts, specifically through sailing.
- **Enhance Practical Skills:**
  - Gain hands-on experience and practical skills in sailing, including navigation, sail handling, and the use of technology in maritime contexts.
- **Encourage Critical Thinking and Problem-Solving:**
  - Cultivate critical thinking and problem-solving skills by engaging in activities that require analysis, creativity, and the application of theoretical knowledge to practical challenges.
- **Promote Environmental Stewardship:**
  - Instil a sense of responsibility and awareness for environmental conservation, focusing on sustainable practices and the protection of marine ecosystems.
- **Facilitate Experiential Learning:**

    - Provide opportunities for experiential learning where students can test and apply their knowledge in real scenarios, reinforcing their understanding and skills through direct experience.
- **Inspire a Lifelong Interest in STEAM:**
    - Inspire enthusiasm for continued learning and exploration in the fields of STEAM, encouraging a lifelong interest and potential future engagement in these disciplines.

By achieving these objectives, students will not only gain a comprehensive education in the foundational principles of STEAM as they relate to sailing but will also develop practical skills and a greater appreciation for environmental sustainability and technological innovation.

Module contents

The following section provides a brief summary of the content of each module.

Module 1: Nature of the Wind

Summary:
This module introduces students to the science of wind and its application in sailing, with a focus on understanding wind energy, its measurement, and how it propels sailboats. Students will engage in hands-on activities to explore these concepts, integrate maths and science skills, and connect their learning to real-world applications and environmental impact.

Objectives:

- Understand the nature and behaviour of wind.
- Learn how to measure wind speed and direction.
- Explore the principles of wind energy and its applications.
- Understanding the basic principles of sailing physics.
- Developing awareness of the impact of wind on ecological sustainability and its role in renewable energy sources.

Contents:

- The nature of wind and the processes of its formation
- Wind measurement

- Wind energy and its applications
- Principles of using wind to propel various types of aircraft and vessels

Module 2: Buoyancy

Summary:
This module focuses on the principles of buoyancy and density, exploring how these concepts are crucial for understanding and designing sailboats. Through hands-on activities, students will learn about floating and sinking, water displacement, and the role of ballast in maintaining stability. The module also integrates creative and engineering challenges to enhance learning.

Objectives:

- Understand the principles of buoyancy.
- Learn about water displacement and Archimedes' principle.
- Discover the importance of ballast in sailboat stability.

Contents:

- Introduction to buoyancy
- Prediction and testing of buoyancy
- Exploring Cartesian Divers
- Understanding and application of Archimedes' principle
- Design and construction of model ships

Module 3: Sails, Sailing, and Bearings

Summary:
This module introduces students to the exciting world of sails, sailing, and navigation using bearings. Through a variety of engaging and interactive activities, students will learn about sail design, how sails work, and the basics of navigation. The module integrates STEAM concepts with practical sailing applications to spark a love for sailing and a deeper understanding of the science behind it.

Objectives:

- Understand the basic principles of sail design and function.
- Learn the techniques and physics of sailing.
- Comprehend the concept of bearings and their importance in navigation.
- Develop practical sailing and navigation skills through interactive activities.

- Connecting STEM concepts with real-world applications in sailing and fostering a passion for sailing.

Contents:

- Introduction to Sails and Their Functionality
- Using wind and sails for propulsion of sailboats
- Basic manoeuvring skills in sailing
- Comprehending Bearings for Effective Navigation
- Engaging Exercises in Interactive Navigation

Module 4: Simple machines and mechanisms on the Sailboat

Summary:

This module introduces students to various machines and mechanical systems used on sailboats. Through practical activities and demonstrations, students will learn about simple machines, their functions on sailboats, and their importance in sailing. The module also emphasizes the engineering principles behind these machines and their real-world applications. Special focus is placed on the safety aspects of using these machines and mechanisms, ensuring that students understand how to safely operate and maintain a sailboat.

Objectives:

- Understand the basic principles of simple machines.
- Learn about the specific machines used on sailboats and their functions.
- Explore the engineering and mechanical principles behind machines on sailboats.
- Connect the use of machines to the efficiency and safety of sailing.

Contents:

- Introduction to Simple Machine and mechanisms
- Key Mechanical Systems on Sailboats
- Engineering Principles Behind Sailboat Machines
- Practical Activities and Demonstrations
- Efficiency and Safety in the Use of Machines on Sailboats

Module 5: Water and Its Nature

Summary:
This module explores the various aspects of water, focusing on its properties, quality, and significance in both the environment and sailing. Through hands-on activities, students will understand the physical and chemical properties of water, learn about water quality testing, and recognize the importance of clean water for marine life and human use. Additionally, students will connect these concepts to sailing, emphasising the impact of water quality on sailing activities and marine ecosystems.

Objective:

- Comprehend the fundamental physical and chemical properties of water.
- Learn how to test and evaluate water quality.
- Understand the importance of clean water for ecosystems and human activities.
- Connect water quality and properties to sailing and maritime activities.
- Promote environmental awareness and stewardship through practical experiments and discussions.

Contents:

- Introduction to Water's Properties
- Water Quality Testing
- Hands-On Water Testing Activities
- Investigating Water Sources
- Water in the Environment
- Importance of Clean Water
- Environmental Stewardship

Module 6: Environment and sustainable sailing

Summary:
This module will help participants to gain an understanding of the importance of preserving aquatic habitats, identify the factors that put these habitats at risk, and learn methods for protecting these ecosystems. By examining ecosystem services, participants will develop an ecological perspective on sailing. The module will explore the potential negative impacts of sailing and investigate ways to mitigate these impacts, ultimately defining sustainable sailing practices.

Objective:

- Understand the basic principles of ecosystem services;

- Recognize forms of water pollution;
- Identify examples of effective water protection practices in the region;
- Learn the principles of sustainable sailing.

Contents:

- The Importance of Preserved Seas, Rivers and Oceans:
  - Ecosystem services derived from preserved seas, rivers, and oceans: According to the Millennium Ecosystem Assessment Report (2005);
  - Sailing as a unique example of an ecosystem service.
- Factors Affecting Marine and River Ecosystems:
  - Physical, chemical, and biological water pollution and their impact on biodiversity;
  - The connection between sailing and plastic waste;
  - The relationship between biological and chemical water pollution and the responsible processing of wastewater from sailboats;
  - The impact of sailing on birds and mammals.
- Positive Impacts of Sailing on River Ecosystems
  - Sustainable practices of the crew to reduce waste: Rational use of water, sorting, and proper disposal of generated waste;
  - Examples of good practices: Sailing and ecotourism, cleaning and waste collection actions during sailing activities, and the application of new technologies to reduce the Ecological footprint of sailboats and their crews.

Module 7: Understanding and Creating Technology

Summary:
This module shows students how technology works. What needs to be done so that computer games work and robots move autonomously and a 3D printer makes objects? Starting with coding without computers then moving to coding with blocks and other objects (e.g. arrows) and finishing with physical computing and 3D design, children will get a crash course in dealing with technologies “behind the scenes” - they will be beamed from being merely the users of technology to its creators.

Objective:

- Empower children to create technology not just use it
- Understand fundamental principles of technology
- Learn to code with blocks and other objects (e.g. arrows), incl.physical computing/robotics

- Learn to make simple 3D designs

Contents:

- Discussion on technology (how it is made, how it can be changed, what part do users play etc.)
- First steps in understanding coding - Coding/CS without computers
- Coding with arrows in code.org and tynker.com
- Coding with blocks in code.org, tynker.com, scratch.mit.edu
- Coding in 3D environment in kodugamelab.com
- 3D design in tinkercad.com

Module 8: Marine robotics and applications to sailing

Summary:

This module will introduce the general field of marine robotics and applications using practical examples. The focus will be in the robots and technologies that can be applied to sailing such as Remotely Operated Vehicles (ROVs), buoys and Autonomous Surface Vehicles (ASVs). As well, and given the sustainability component of the project, examples of marine robots engaged in environmental protection will be provided. Participants will be able to learn how to pilot an ROV and perform inspections in a similar fashion to what can be done for a sailing boat hull inspection.

Objective:

- To understand what are marine robots and how they can be used in a myriad of applications
- To learn what type of marine robots exist and how they can be applied specifically to sailing and environmental protection
- To learn how to pilot an ROV

Contents:

- Introduction to Marine Robotics
- Introduction to application of marine robots
- Examples of marine robots used in environmental protection
- Overview of Remotely Operated Vehicles (ROVs), buoys and Autonomous Surface Vehicles (ASVs)
- Application of ROVs, ASVs and buoys in the context of sailing
- Piloting an ROV (practical part to be done remotely or in-situ)

Teaching Methods

To effectively engage students aged 7 to 12 and foster a deep understanding of STEAM concepts through sailing, the "Sailing into STEAM" course employs a variety of teaching methods:

- Interactive Lectures: Brief, interactive lectures provide foundational knowledge on topics such as sail design, buoyancy, and navigation. Visual aids and real-life examples are used to make complex concepts accessible and engaging.
- Hands-on Activities: Practical, hands-on activities are integral to the course. Students build simple sail models, conduct buoyancy experiments, and participate in sailing simulations to apply theoretical knowledge in a tangible way.
- Group Projects: Collaborative projects encourage teamwork and problem-solving. Students work together on tasks such as designing a sailboat or mapping a navigation route, fostering communication and cooperative learning.
- Field Trips and On-Water Experiences: Field trips to sailing clubs and on-water experiences provide real-world contexts for learning. These activities help students connect classroom knowledge with actual sailing practices.

Assessment methods

The assessment of all modules will be conducted through hands-on activities in a project-based format. When applicable, short quizzes can be used, but the primary assessment method is practical and group work. Research indicates that hands-on learning and project-based assessments significantly enhance student engagement and understanding compared to traditional theoretical questions (Prince, 2004; Freeman et al., 2014). By focusing on practical and collaborative tasks, students can better grasp complex concepts and develop critical thinking and problem-solving skills, providing a more effective and enriching learning experience.

Conclusion

The "Sailing into STEAM: Methodology and Syllabus" document provides a comprehensive foundation for integrating sailing with STEAM education. It outlines the key principles, components, and detailed syllabus essential for the project's success. As the project progresses, the methodologies and resources detailed here will be tested and refined through pilot implementations, ensuring they meet the needs of learners and educators. This flexible approach allows for continuous improvement, fostering a love for sailing and a deep understanding of STEAM subjects among young learners.

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