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STEAME TEACHER ACADEMY

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STEAME ACADEMY
TEACHING FACILITATION LEARNING & CREATIVITY PLAN (L&C PLAN) – LEVEL2 SERVICE TEACHERS
TITLE: DESALINATION WATER TANK FOR REMOTE AREAS OF THE WORLD

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1. Overview

Title	**Desalination water tank for remote areas of the world**
Driving Question or Topic	-Can we Reuse and Recycle plastic water bottles? -Can we create a portable desalination water tank for remote areas of the world that removes salt from sea-water and removes micro-plastics as well?
Ages, Grades, …	12-15 year old students | Middle School | (Gymnasium)
Duration, Timeline, Activities	60 hours | 2 months | Various Combined Activities between Disciplines
Curriculum Alignment	**In Mathematics:** Units of measure, 2D and 3D Geometry (Metric Units and Shapes), Introduction to statistics, Probabilities and Combinatorics. **In Physics:** States of Matter: Plastics can exist in different states of matter depending on their temperature and chemical structure. Solid plastics exhibit the rigid properties of a solid, while some plastics can be melted and take on the fluid properties of a liquid. Properties of Matter: Salts can be used to demonstrate the concept of solids, liquids, and solutions. Solid table salt can be dissolved in water to create a saline solution. Mixtures and Solutions: Salt dissolving in water is a classic example of a solution formation. Students might learn how well a substance dissolves (solubility) and the factors affecting it (temperature, stirring).

Ionic Bonds: Table salt is an ionic compound, meaning it forms from the attraction of oppositely charged ions (sodium cations and chloride anions). Understanding ionic bonds is a fundamental concept in chemistry.

Density: Density is the mass per unit volume of a material. Plastics have a wide range of densities depending on their type. For instance, polyethylene terephthalate (PET), commonly used in plastic bottles, has a lower density than polyvinylchloride (PVC) used in pipes. Understanding density is important because it can influence the buoyancy of plastic objects in water. Less dense plastics will tend to float, while more dense plastics will sink.

Friction: Friction is the force that resists the relative motion between two surfaces in contact. Some plastics have low friction coefficients, making them suitable for applications like gears or bearings where minimizing friction is desirable.

Insulation: Many plastics are good electrical insulators, meaning they don't conduct electricity well. This property makes them useful for coating wires and electrical components.

Strength and Elasticity: Different plastics have varying degrees of strength and elasticity. These properties determine how a plastic object will deform or break under stress. Engineers consider these properties when designing products from plastic.

In Chemistry:

Chapter 1: The Amazing Water Molecule
This chapter would introduce students to the structure of a water molecule. They would learn that each water molecule is made up of two hydrogen atoms bonded to one oxygen atom in a bent shape.

The chapter would also discuss the concept of polarity, explaining how the uneven distribution of electrons in the molecule gives water its polar character. The oxygen atom attracts electrons more strongly than the hydrogen atoms, creating a slightly negative charge on the oxygen end and a slightly positive charge on the hydrogen end of the molecule.

Chapter 2: The Power of Hydrogen Bonding
This chapter would delve into the unique property of water called hydrogen bonding. Hydrogen bonding is a special attraction between the hydrogen atom of one water molecule and the oxygen atom of another water molecule due to their polarity.

Students would learn how hydrogen bonding gives water several important properties, including:
High surface tension: The hydrogen bonds between water molecules create a strong surface tension, allowing things like insects to skim the water's surface.

Cohesion: Hydrogen bonding allows water molecules to stick to each other, which is important for transporting water through plants and for many other biological processes.
Adhesion: Hydrogen bonding allows water molecules to stick to other polar molecules, such as glass or soil. This is why water clings to the sides of a glass and why plants can take up water from the soil.

Chapter 3: The Solvent of Life
This chapter would focus on water's ability to dissolve many different substances. Students would learn that because water is a polar molecule, it can interact with and surround ions and polar molecules of solutes (substances being dissolved). This allows the solute to disperse throughout the water, forming a solution.
The chapter might also discuss the concept of concentration, explaining how the amount of solute dissolved in a given amount of solvent determines the concentration of the solution.

Chapter 4: The Importance of Water in Chemical Reactions
This chapter would introduce students to the role of water as a reactant or product in many chemical reactions. For example, water is a product in the combustion reaction between methane and oxygen.
Students might also learn about the concept of hydrolysis, which is a chemical reaction involving water. Hydrolysis is important in many biological processes, such as the breakdown of food molecules in our bodies.

Chapter 5: Water: A Precious Resource
This chapter would discuss the importance of water conservation. Students would learn about the different ways water is used by humans and the challenges of water scarcity in some parts of the world.
The chapter might also explore methods of water conservation, such as fixing leaky faucets, taking shorter showers, and watering lawns less frequently.

Polymers: This chapter would introduce the concept of polymers, which are large molecules made by chaining together smaller repeating units called monomers. Plastics are a specific type of polymer.

Chemical Reactions: This chapter might discuss the process of polymerization, which is the chemical reaction that links monomers together to form a polymer. Different types of polymerization reactions exist for different plastics.

Properties of Materials: Plastics have a wide variety of properties depending on their chemical structure. In this chapter, students might learn about how the structure of a plastic molecule can influence its properties, such as strength, flexibility, and heat resistance.

Here are some additional topics that might be touched upon briefly in a middle school chemistry class:

Types of Plastics: There are many different types of plastics, each with its own unique chemical structure and properties. Common examples include polyethylene (PE), polypropylene (PP), and polyvinyl chloride (PVC).

Bioplastics: Bioplastics are a type of plastic made from renewable resources like corn starch. Students might learn about bioplastics as an alternative to traditional plastics derived from fossil fuels.

The Chemistry of Recycling: The recycling process relies on the chemical properties of different plastics. In some cases, chemical processes might be used to break down or modify plastics to make them easier to recycle.

Introduction to Chemical Reactions (Acids and Bases)
Neutralization Reactions: Salts are formed when an acid and a base react. Students may learn about neutralization reactions using common household examples like baking soda (sodium bicarbonate) and vinegar (acetic acid) to produce sodium acetate, water, and carbon dioxide gas.

2. Ionic Compounds and Bonding
Ionic Bonding: Sodium chloride (NaCl) is the quintessential example of an ionic compound. It forms from the attraction of oppositely charged ions: sodium cations (Na^+) and chloride anions (Cl^-). Understanding how these ions come together with their electron configurations and Lewis structures is a foundation for studying ionic compounds in general.

3. Solubility
Factors Affecting Solubility: Salts can be used to explore the concept of solubility, the extent to which a substance dissolves in a solvent (usually water). Factors like temperature, pressure, and intermolecular interactions can be investigated using salt solutions.

4. Electrolytes
Conduction of Electricity: Salts, when dissolved in water, dissociate into their constituent ions and become electrolytes. These ions allow the solution to conduct electricity, a concept important in various applications like batteries and electrochemistry.

5. Chemical Properties of Metals and Nonmetals
Reactivity of Metals: The reactivity of certain metals can be demonstrated using salt solutions. For example, placing a piece of magnesium metal in a sodium chloride solution will result in a single-displacement reaction, producing hydrogen gas and magnesium chloride.
These are some of the ways salt can be a springboard for learning core chemistry concepts throughout the high school and college curriculum. By using familiar substances like table salt, educators can make abstract ideas more relatable and engaging for students.

In Biology:

Chapter 1: The Building Blocks of Life
This chapter might introduce water as the most abundant molecule in living organisms. Students would learn that water makes up a large percentage of the mass of cells (typically around 60-70%).

Chapter 2: Cell Structure and Function
Water's role within the cell would be explored.
Transport: Water is essential for transporting nutrients, waste products, and other molecules across the cell membrane and within the cell.
Chemical Reactions: Many biological reactions occur in water, as it provides the medium for enzymes to function and facilitates the movement of reactants and products.
Regulation: Water plays a role in regulating body temperature through sweating and maintaining cell shape.

Chapter 3: Homeostasis
Homeostasis refers to the body's ability to maintain a stable internal environment. Water is crucial for achieving this balance.
Osmoregulation: This process regulates the concentration of dissolved solutes (salts and other molecules) in the body fluids. Water movement into and out of cells is critical for maintaining this balance.

Chapter 4: Macromolecules
While not the sole focus, water is important in understanding macromolecules like carbohydrates, proteins, and nucleic acids.
Hydrolysis: This process, using water, breaks down these complex molecules into simpler components, essential for energy production and cellular processes.

Chapter 5: The Importance of Water for Different Organ Systems
Depending on the curriculum, specific chapters might delve into the role of water in different body systems.
Digestive System: Water aids in digestion and the absorption of nutrients.
Excretory System: Water helps the body eliminate waste products through urine and sweat.
Circulatory System: Water is a major component of blood and plays a crucial role in transporting materials throughout the body.

Chapter 6: Ecosystems and the Environment
This chapter might discuss water as a vital resource for all living things in an ecosystem. Students could learn about the water cycle and how water availability impacts plants and animals. Ecosystems: A chapter on ecosystems might discuss plastic pollution as a threat to living organisms. Plastic debris can entangle animals, block their digestive tracts, and leach harmful chemicals into the environment.

Human Impact: A chapter on human impact on the environment might explore different types of pollution, including plastic pollution. Students might learn about the sources of plastic pollution, its effects on wildlife, and potential solutions like reducing plastic use and improving recycling.

Cellular Function

1.Maintaining Osmotic Balance: Salt, particularly sodium and chloride ions, are essential for maintaining a cell's osmotic balance. Osmosis is the movement of water across a semipermeable membrane from an area of low solute concentration (high water concentration) to an area of high solute concentration (low water concentration). The concentration of ions inside a cell needs to be balanced with the concentration of ions outside the cell. This balance is crucial for many cellular functions, including enzyme activity and protein structure.

2. Nerve Impulses
Action Potentials: Salt plays a vital role in nerve impulse transmission. The movement of sodium and potassium ions across the membrane of nerve cells creates electrical signals called action potentials. These action potentials travel down nerve fibers, allowing communication between different parts of the body.

3. Muscle Contractions
Muscle Function: Similar to nerve impulses, salt is involved in muscle contractions. The interaction of sodium, potassium, and calcium ions triggers the contraction and relaxation of muscle fibers.

4. Digestion
Aiding Digestion: Salivary glands in the mouth contain chloride ions that help break down starches into simpler sugars. Additionally, stomach acid, which is crucial for digestion, contains hydrochloric acid (HCl).

5. Physiology
Blood Pressure Regulation: Sodium plays a role in regulating blood pressure. The kidneys help regulate blood volume and pressure by controlling the amount of sodium reabsorbed back into the bloodstream.
By understanding how salt functions in these biological processes, we gain a deeper appreciation for its importance in maintaining health and homeostasis in living organisms.

In Computer Science: Excel sheets, Statistical analysis of data, Webpage design, building and monitoring.

In Technology/Engineering:

Chapter 1: The Challenge: Access to Clean Water

This chapter would introduce the global challenge of providing clean drinking water for everyone. Students would learn about the different sources of water (surface water, groundwater) and the issues of water scarcity and contamination.

Chapter 2: Water Treatment Technologies
This chapter would delve into the technologies used to make water safe for drinking. Students might learn about:
Filtration: Removing impurities like particles and microorganisms through various filters like sand filters and reverse osmosis systems.

Disinfection: Killing bacteria and other harmful organisms using methods like chlorination and ultraviolet light.

Desalination: Removing salt from seawater to make it suitable for drinking or irrigation. This is becoming increasingly important in areas facing water scarcity.

Chapter 3: Water Conservation Technologies
This chapter would explore technologies that help conserve water and use it more efficiently. Students could learn about:
Low-flow faucets and showerheads: These devices reduce the amount of water used without compromising performance.
Leak detection systems: These systems help identify and fix leaks in pipes, which can waste a significant amount of water.
Smart irrigation systems: These systems use sensors to water plants only when necessary, reducing water waste in gardens and lawns.

Chapter 4: Monitoring and Managing Water Resources
This chapter would introduce students to technologies used to monitor water resources and manage water use. This could include:
Remote sensing: Using satellites and other technologies to monitor water levels in rivers, lakes, and reservoirs.
Water quality sensors: These sensors can continuously monitor water quality for various parameters, helping to identify potential problems.
Water management software: Software can be used to model water usage patterns and optimize water distribution systems.

Chapter 5: Water in the Future
This chapter could be a springboard for student discussions and projects. Students might explore:
Emerging technologies for water treatment and desalination.
The role of artificial intelligence in managing water resources.
Designing sustainable communities with water conservation in mind.
Material Properties: This chapter would introduce students to the concept of material properties, focusing on how different materials like plastic possess specific characteristics that make them suitable for various applications. Students might explore properties like strength, flexibility, durability, heat resistance, and weight. They can then compare and contrast these properties of plastic to other materials like wood, metal, or glass.

Product Design: When it comes to product design, understanding the properties of plastics is crucial. This chapter might involve students

brainstorming product ideas and then selecting the most appropriate type of plastic based on the product's intended use. For instance, a designer would choose a strong and rigid plastic for a chair, while a more flexible plastic might be suitable for a phone case.

Manufacturing Processes: Plastics can be shaped and formed through various manufacturing processes. In this chapter, students might learn about common techniques like injection molding, blow molding, and thermoforming. Injection molding, for example, involves injecting molten plastic into a mold to create a desired shape.

Computer-Aided Design (CAD): Plastics are extensively used in products designed using CAD software. This chapter might introduce students to the basics of CAD and how it can be used to design and model objects made from plastic.

Sustainability: As awareness of plastic pollution grows, middle school technology classes are increasingly incorporating lessons on sustainable design practices. This chapter might explore concepts like using recycled plastics, designing products for reusability, and minimizing plastic waste during the manufacturing process.

In Arts: Creating straws from crystal clear water bottles, making it unique, stylish and elegant. LED lights possibly inserted. Company logos, design and print. (see example below)

In Entrepreneurship: Introduction to Business and Economics (this chapter typically lays the groundwork by explaining the nature of businesses, the role of the entrepreneur, and the different forms of business ownership: sole proprietorship, partnership, corporation), Chapters on Microeconomics: Microeconomics focuses on individual decision-making by consumers, firms, and markets. Supply and Demand (this fundamental principle dictates how prices are determined based on consumer willingness to pay (demand) and producer willingness to sell (supply). Understanding this is vital for setting prices for your product or service, Market Structures (Knowing the different market structures (perfect competition, monopoly, monopolistic competition, oligopoly) helps you understand how your company will compete in the marketplace, Production and Cost Analysis (this explores how firms convert resources into outputs, considering factors like fixed costs, variable costs, and economies of scale. This knowledge helps you optimize production and pricing strategies, Chapters on Entrepreneurship (some economics textbooks might have dedicated chapters on entrepreneurship, which would directly address), Identifying a Market Opportunity (this involves recognizing a customer need that isn't being adequately met and building a business around fulfilling that need, Business Planning (this chapter would discuss creating a business plan, a roadmap outlining your company's goals, strategies, target market, financial projections, and how you'll secure funding.

In Languages and Culture: Essay writing, Research and Survey writing, contacting and drawing conclusions.

Contributors, Partners	Desalination Plants and recycling companies that can provide the used bottles and factories of the area that can provide/help with water quality tests. Also our school yard that "produces" more than 600 plastic water bottles daily (since the students of our school are around 600).
Abstract - Synopsis	Learning through a Project Based Activity. Students will perform research on recyclable and non-recyclable plastics and the amount of daily plastic waste in our school. In order to reuse the plastic water bottles, they will explore ways they can create ecological straws with filters that can be used to produce clean water from the sea or rivers. Various types of filters will be tested. With their final product the students will be able to create their own small scale business (start-up), entering an eco-friendly entrepreneurship world and discovering the basic principles of marketing. A complete STEAME+ Learning Approach that involves Mathematics, Physics, Chemistry, Biology, Technology, Engineering, Computer Science (STEM), Arts (A), Entrepreneurship (E), as well as Language and Culture (+).
References, Acknowledgements	The steps for performing our PBL procedure we written following a revised approach from the book "Project Method: Organising and Developing Cross-Thematic and Multi/Inter/ Intra- Disciplinary Projects" by Dr Chrysoulla Hadjichristou, Ministry of Education, Sport and Youth, Pedagogigal Institute – Curriculum Development Unit, Cyprus.

2. STEAME ACADEMY Framework*

Teachers' Cooperation	**Teacher 1 (Mathematics)** **Teacher 2 (Physics)** **Teacher 3 (Chemistry)** **Teacher 4 (Biology)** **Teacher 5 (Computer Science)** **Teacher 6 (Technology/Engineering)** **Teacher 7 (Arts)** **Teacher 8 (Economics/Marketing)** **Teacher 9 (Languages/Culture)** T3 cooperates with T4 regarding the general research on water quality, desalination processes, plastics and micro-plastics, reusable and non-reusable materials, the amount of daily plastic waste, natural decomposition and chemical decomposition of materials. T1 cooperates with T2 and T6 regarding the dimensions of the portable desalination water tank and the parameters of its construction. T5 cooperates with T7 and T9 regarding the artistic side of the desalination portable water tank, history of water systems, water filtering, plastic and plastic recycling in our city, colors and dimensions of the portable water tank, webpage/ Facebook/ Instagram profile creation for advertising the product as well as taking orders by clients. T1 cooperates with T5 regarding the analysis of various data, amount of salt and other microorganisms, water quality measuring data, as well as various questionnaires' results. Creation and manipulation of Excel sheets.

	T1 cooperates with T7 and T8 for facilitating the creation of a small business for the pupils' product. Name, Slogan, Logo, Structure of the Board (CEO, Marketing Director, Sales Director, Media Manager etc.) T6 cooperates with T2 to be able to construct various different sizes and types of portable desalination water tanks and examine their sustainability and durability over time.
STEAME in Life (SiL) Organization	-Meeting with Water Quality Lab owners, Desalination chemists / Using plastic waste from Factories, especially the plastic water bottles or other plastic related products. -Meeting with Lab Technicians ad Chemists for testing the quality of water produced using professional equipment as well as the professionals' experience and advice. -Entrepreneurship – STEAME in Life (SiL) Days: Creation of a small business for their product. Name, Slogan, Logo, Structure of the Board (CEO, Marketing Director, Sales Director, Media Manager etc.)
Action Plan Formulation	<u>Preparation (by teachers)</u> 1. Relation to the Real World – Reflection Using filters to clean water / Reuse and Recycle of plastic Creating a more eco-friendly product for desalinating/cleaning water 2. Incentive – Motivation Desalinating sea water in remote areas Using types of plastic that cannot be recycled Creating a start-up small business Learning how to promote a product (marketing techniques) 3. Formulation of a problem resulting from the above <u>Development (by students) – Guidance & Evaluation (in 9-11, by teachers)</u> 4. Research / Gather Information on desalination of water, water quality, water cleaning facilities as well as reusable and non-reusable plastics 5. Research on Salt removing tactics and processes, Water Quality, Plastics, natural and chemical decomposition and filtering 6. Designing of filter straws, research on already available cube designs in the market. Identifying additional materials that can be used (Cartons, Glues) for creating the straws or the filters used. Discovering and making contact with labs and factories that test water quality, produce plastic and also gather significant plastic waste. 7. Construction of various types of desalination tanks - Experiment - Implementation of the tanks. 8. Observation of the final products - Experimentation on their durability and soundproofing properties - Initial Conclusions 9. Documentation of results – Crash tests, Sound proofing tests - Explanation based on Existing Physics Theories and / or Empirical Results 10. Gathering of results / information based on points 7, 8, 9 11. First group presentation by students <u>Configuration & Results (by students) – Guidance & Evaluation (by teachers)</u> 12. Configure STEAME models to describe / represent / illustrate the results 13. Studying the results in 9 and drawing conclusions, using 12

14. Applications of the Sound-proof panel in Everyday Life - Suggestions for Developing 9 (Entrepreneurship - SIL Days)

Review (by teachers)

15. Review the problem and review it under more demanding conditions

Project Completion (by students) – Guidance & Evaluation (by teachers)

16. Repeat steps 5 through 11 with additional or new requirements as formulated in 15
17. Investigation - Case Studies - Expansion - New Theories - Testing New Conclusions
18. Presentation of Conclusions and the final product - Communication Tactics

3. Objectives and Methodologies

Learning Goals and Objectives	**In General:** The very definition of STEAME+ Education, the pupil to be able to research on a topic that involves all physical sciences, art, entrepreneurship as well as languages and culture and be able to combine knowledge and skills to deliver the final product/project, draw conclusions about the result, discuss feedback, remedies. The essence of metacognition, the process of thinking about one's own thinking and learning. **In Mathematics:** To be able to manipulate numbers, measurements as well as calculation of various surface areas and volumes. To be able to perform basic probability and combinatorics knowledge and skills as well as in Statistics. Collect and refine raw data, be able to analyze data, make assumptions, perform various tests and draw conclusions. The pupil should be able to use broad mathematical skills to face any problem that arises during the whole learning and creating procedure. **In Physics:** The pupils should understand and apply basic principles of pressure and be able to perform simple water quality and salt measuring tests. Have a full understanding of plastics' durability and be able to perform quality tests to the materials involved. **In Chemistry:** Students would learn about the concept of desalination and hydrolysis, which is a chemical reaction involving water. Hydrolysis is important in many biological processes, such as the breakdown of food molecules in our bodies. Students would also learn about the different ways water is used by humans and the challenges of water scarcity in some parts of the world. **In Biology:** Students learn about the water cycle and how water availability impacts plants and animals. Ecosystems: A chapter on ecosystems might discuss plastic pollution as a threat to living organisms. Plastic debris can entangle animals, block their digestive tracts, and leach harmful chemicals into the environment. **In Computer Science:** The pupils will be able to contact a full survey, record the results in Excel sheet and perform basic statistical analysis, drawing conclusions and presenting them in graphs. They will also be

	able to design a webpage for their company or to advertise/sell their product. **In Art:** Ability to use appropriate colors and shapes for best promoting their business or logo. Create various artistic styles for the product so that all customers' needs are met, and the product is successful. **In Greek Language and Culture:** A complete research on the history of the water in our country and the plastics, the present and a forecast for the plastics and similar materials used in the future. Detailed analysis on eco-friendly plastics and other materials as well as reusable and sustainable solutions. **In Technology/Engineering:** To be able to construct various types of straws of different sizes and examine their sustainability and durability over time. **In Entrepreneurship:** The pupil to be able to work as a team and cooperate with other classmates to identify the need for a product, create a basic business plan, create/design a smart logo for his product, think/write a unique company name and a clever/commercial slogan, create/agree on a board of directors and apply the four basic principles of marketing (product, price, place and promotion).
Learning Outcomes and expected Results	**In General:** The pupil will get to improve certain STEAME+ skills, such as Problem Solving, Metacognitive Practices, Creativity, Collaboration, Communication, Critical Thinking, Demonstration of STEAM knowledge, Development of an understanding of the variety of STEM careers related to different fields of study, Application of science process/engineering process/product development process, Digital Literacy and other STEM tools - Demonstrating in class and afterschool records for student assessment, Active engagement and focus during learning activities, Active inquiries into STEAM topics, concepts, or practices. In few words, the essence of metacognition, the process of thinking about one's own thinking and learning. **In Mathematics:** Easily manipulate numbers and functions, perform measurements as well as calculation of various surface areas and volumes. To be able to perform basic probability and combinatorics knowledge and skills as well as in Statistics. Collect and refine raw data, be able to analyze data, make assumptions, perform various tests and draw conclusions. The pupil should be able to use broad mathematical skills to face any problem that arises during the whole learning and creating procedure. **In Physics:** Understand and apply basic principles of desalination procedures and perform simple water quality measuring tests. Have a full understanding of plastics' durability and be able to perform quality tests to the materials involved. **In Chemistry:** Students would learn about the concept of desalination and hydrolysis, which is a chemical reaction involving water. Hydrolysis is important in many biological processes, such as the breakdown of food molecules in our bodies. Students would also learn about the

	different ways water is used by humans and the challenges of water scarcity in some parts of the world. **In Biology:** Students learn about the properties of salt, water solutions, water cycle and how water availability impacts plants and animals. Ecosystems: A chapter on ecosystems might discuss plastic pollution as a threat to living organisms. Plastic debris can entangle animals, block their digestive tracts, and leach harmful chemicals into the environment. **In Computer Science:** Contact and run a full survey, record the results in Excel sheet and perform basic statistical analysis, drawing conclusions and presenting them in graphs. They will also be able to design a webpage for their company or to advertise/sell their product. **In Art:** Ability to use appropriate colors and shapes for best promoting their business or logo. Create various artistic styles for the product so that all customers' needs are met and the product as low cost and is a successful product. **In Greek Language and Culture:** Research on the history of the plastics, the present and a forecast for the plastics and similar materials used in the future. Detailed analysis on eco-friendly plastics and other materials as well as reusable and sustainable solutions. **In Technology/Engineering:** To be able to construct various multi-use cubes of different sizes and examine their sustainability and durability over time. **In Entrepreneurship:** Pupils work as a team and cooperate with other classmates to identify the need for a product, create a basic business plan, create/design a smart logo for his product, think/write a unique company name and a clever/commercial slogan, create/agree on a board of directors and apply the four basic principles of marketing (product, price, place and promotion).
Prior Knowledge and Prerequisites	**In General:** Basic STEAME+ Education skills at a lower level, from the elementary school (primary education) **In Mathematics:** Number manipulation, basic measurements with a ruler, basic surface areas and volumes. Simple probability and combinatorics skills. Broad mathematical skills to face any problem that arises during the whole learning and creating procedure. **In Physics:** Skills from simple sound-measuring tests. **In Chemistry:** Basic knowledge about the origin and composition of petroleum as well as be able to identify natural plastic and their components. Basics on Water. **In Biology:** Waste decomposition. Reusing and recycling materials. Basic water experiments. **In Computer Science:** Basic knowledge on Word and Excel programs.

	In Art: Create various artistic expressions using watercolors, pastels, as well as programs on the PC. **In Greek Language and Culture:** Essay writing, Creating simple polls on paper or online (Google Forms, Microsoft Forms etc.). **In Technology/Engineering:** Basic construction skills, cutting and gluing various materials. **In Entrepreneurship:** Teamwork skills, decision making at a lower (primary education) level.
Motivation, Methodology, Strategies, Scaffolds	- Project Based Learning/Activity that involves all Sciences, Mathematics, Art, Entrepreneurship and Languages (Greek) and Culture. Gamification on the same topic may follow as a very interesting extension. -Instruction differentiation for students' needs (learning styles, multi-modal representations, roles to students etc.) -Active students' engagement, individual-team-classroom work, entre-preneurship skills, fabric craftsman techniques, style.

4. Preparation and Means

Preparation, Space Setting, *Troubleshooting Tips*	Material preparation: -Collection of various filters for removing salt and cleaning water -Collection of used plastic bottles (waste) from school bins or recycle factories of our area (Outdoor activity), squash them, clean and remove any stickers. - Various glues and other bonding material, water, buckets for mixing the glues with water or petrol etc. - Cartons or other material for creating various types of portable water tank Computer lab for manipulating data in Excel sheets.
Resources, Tools, Material, Attachments, Equipment	Internet, Laptops, Projector, Padlet platform for organizing the project and communicating ideas/ brainstorming.
Health and Safety	Some filters, catalytes and glues that are not water based can be harmful. Special health and safety measures should be used by both teachers and pupils, like rubber gloves.

5. Implementation

Instructional Activities, Procedures, Reflections	General research on desalination processes, water quality, water filtering, micro-plastics in water, plastics, reusable, non-reusable and possibly decomposable plastics, the amount of plastic waste, natural decomposition and chemical decomposition of materials. Measuring the dimensions of the filter straw and the parameters of its

construction. Exploiting the artistic side of the desalination tank, history of desalination plants in our country, water cleaning, water quality, plastic and plastic recycling in our city, colors and dimensions of the cube, webpage/ Facebook/ Instagram profile creation for advertising the product as well as taking orders by clients. Analysis of various data, sound measuring data, as well as various questionnaires' results. Creation and manipulation of Excel sheets. Testing various glues and how the apply on various fabrics, concluding on the final/optimal selection and preparing the mix of glue and fabric to be applied on the carton base.

Assessment - Evaluation

Project-based learning (PBL) thrives on a strong foundation of assessment and formative evaluation. An approach/system to effectively measure student abilities in PBL is provided further below. PBL goes beyond rote memorization.

We assess a combination of skills and knowledge acquisition:

- Content Knowledge: Ensure students grasp the core concepts explored in the project.
- 21st Century Skills: Assess critical thinking, problem-solving, collaboration, communication, and creativity throughout the project.
- Project Management Skills: Evaluate how students plan, organize, manage time, and adapt during the project.
- Learning Process: Reflect on how students approach challenges, learn from mistakes, and demonstrate self-directed learning.

Formative Evaluation Strategies for PBL:

- Checklists & Progress Reports: Provide ongoing feedback with checklists outlining key milestones and rubrics for specific tasks. Students complete progress reports reflecting on their contributions and challenges.
- Peer Reviews & Group Discussions: Facilitate peer reviews where students analyze each other's work based on rubrics. Organize group discussions to share ideas, troubleshoot, and refine approaches.
- Exit Tickets & Minute Papers: Use short exit tickets or minute papers at the end of each session to gather student understanding of concepts covered and identify areas needing clarification.

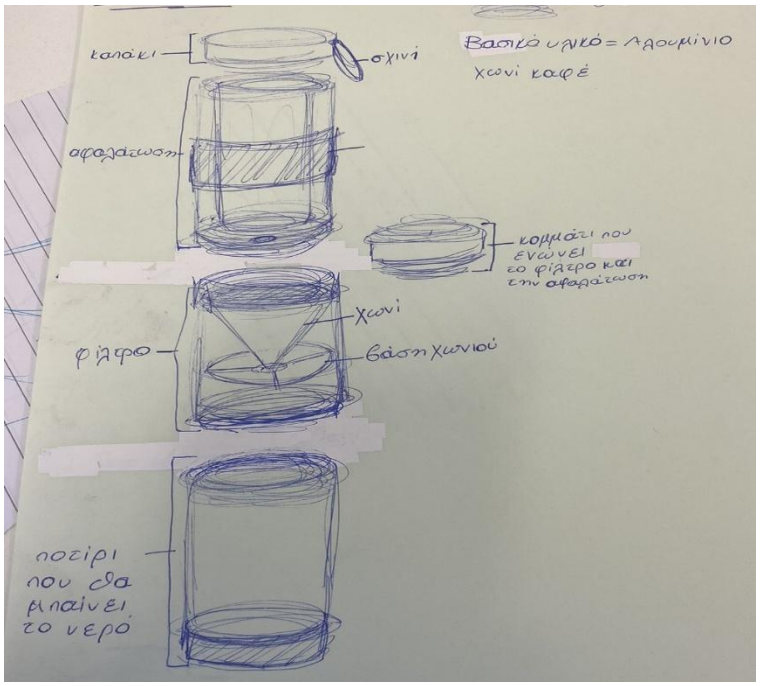
Rubrics are crucial for PBL as they translate project goals into clear expectations. Here's a breakdown for a science project on water quality:

Criteria	Exceeds Expectations	Meets Expectations	Needs Improvement
Content Knowledge	Demonstrates a deep understanding of the properties of	Shows a solid grasp of principles of desalination of water, water	Understanding of desalination of water, water quality and water filtering/

	desalination of water, water quality and water filtering/ cleaning as well as plastic recycling/reuse concepts, citing relevant data and scientific principles.	quality and water filtering/ cleaning as well as plastic recycling/reus e concepts, applying them correctly in the project.	cleaning as well as plastic recycling/reuse concepts is limited, with some inaccuracies in application.
Collaboration & Communicati on	Works effectively within the team, actively participating in discussions, delegating tasks, and resolving conflicts constructively. Communicates ideas clearly and concisely, both verbally and in writing.	Contributes to the team, listens to others, and helps manage tasks. Communicates ideas with some clarity, but may require prompting.	Struggles to collaborate effectively, hindering the team's progress. Communication is unclear or infrequent.
Problem-Solving & Critical Thinking	Identifies and analyzes problems effectively, proposing creative solutions and adapting strategies when needed. Demonstrates critical thinking by questioning assumptions, evaluating evidence, and drawing sound conclusions.	Identifies and solves problems with some guidance. Uses critical thinking to a moderate extent.	Has difficulty identifying or solving problems. Limited use of critical thinking skills.
Project Management	Meets all deadlines, manages time effectively, and stays organized throughout the project. Adapts	Completes most tasks on time, demonstrates decent organization. May need	Frequently misses deadlines due to poor time management and organization.

		to unforeseen challenges and adjusts the plan accordingly.	some reminders to stay on track.	Struggles to adapt to challenges.
	Learning Process & Reflection	Demonstrates strong self-directed learning skills, actively seeking and utilizing resources. Reflects deeply on the learning experience, identifying strengths, weaknesses, and areas for personal growth.	Shows initiative in learning, utilizing available resources. Reflects on the experience, acknowledging learning gained.	Limited self-directed learning. Reflection on the experience is shallow or absent.

Presentation - Reporting - Sharing	Essays from pupils on their whole experience, Microsoft PowerPoint Slides showing all their journey (construction and entrepreneurship section), Padlet platform (see link below) containing all the initial brainstorming and further discussions, ideas and actions, documents, outputs, artifacts, products produced by the students with references, web links etc.), for sharing to media. Photo albums of the procedure and final product. https://padlet.com/yiannislazarou/4-yimp6of5q8ws5cwk
Extensions - Other Information	Participate in various national and international competitions on Junior Achievement, or Recycling and Sustainability.



Resources for the development of the STEAME ACADEMY Learning and Creativity Plan Template
In the case of learning through project-based activity

STEAME ACADEMY Prototype/Guide for Learning & Creativity Approach
Action Plan Formulation

Major steps in the STEAME learning approach:

STAGE I: Preparation by one or more teachers

1. Formulating initial thoughts on the thematic sectors/areas to be covered
2. Engaging the world of the wider environment / work / business / parents / society / environment/ ethics
3. Target Age Group of Students - Associating with the Official Curriculum - Setting Goals and Objectives
4. Organization of the tasks of the parties involved - Designation of Coordinator - Workplaces etc.

STAGE II: Action Plan Formulation (Steps 1-18)

Preparation (by teachers)

19. Relation to the Real World – Reflection
20. Incentive – Motivation
21. Formulation of a problem (possibly in stages or phases) resulting from the above

Development (by students) – Guidance & Evaluation (in 9-11, by teachers)

22. Background Creation - Search / Gather Information
23. Simplify the issue - Configure the problem with a limited number of requirements
24. Case Making - Designing - identifying materials for building / development / creation
25. Construction - Workflow - Implementation of projects
26. Observation-Experimentation - Initial Conclusions
27. Documentation - Searching Thematic Areas (AI fields) related to the subject under study – Explanation based on Existing Theories and / or Empirical Results
28. Gathering of results / information based on points 7, 8, 9
29. First group presentation by students

Configuration & Results (by students) – Guidance & Evaluation (by teachers)

30. Configure STEAME models to describe / represent / illustrate the results
31. Studying the results in 9 and drawing conclusions, using 12
32. Applications in Everyday Life - Suggestions for Developing 9 (Entrepreneurship - SIL Days)

Review (by teachers)

33. Review the problem and review it under more demanding conditions

Project Completion (by students) – Guidance & Evaluation (by teachers)

34. Repeat steps 5 through 11 with additional or new requirements as formulated in 15

35. Investigation - Case Studies - Expansion - New Theories - Testing New Conclusions
36. Presentation of Conclusions - Communication Tactics.

STAGE III: STEAME ACADEMY Actions and Cooperation in Creative Projects for school students

Title of Project: _____
Brief Description/Outline of Organizational Arrangements / Responsibilities for Action

STAGE	**Activities/Steps** Teacher 1(T1) Cooperation with T2 and student guidance	**Activities /Steps** **By Students** Age Group: ___	**Activities /Steps** Teacher 2 (T2) Cooperation with T1 and student guidance
A	Preparation of steps 1,2,3		Cooperation in step 3
B	Guidance in step 9	4,5,6,7,8,9,10	Support guidance in step 9
C	Creative Evaluation	11	Creative Evaluation
D	Guidance	12	Guidance
E	Guidance	13 (9+12)	Guidance
F	Organization (SIL) STEAME in Life	14 Meeting with Business representatives	Organization (SIL) STEAME in Life
G	Preparation of step 15		Cooperation in step 15
H	Guidance	16 (repetition 5-11)	Support Guidance
I	Guidance	17	Support Guidance
K	Creative Evaluation	18	Creative Evaluation