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STEAME ACADEMY
TEACHING FACILITATION LEARNING & CREATIVITY PLAN (L&C PLAN) - LEVEL 2
SERVICE TEACHERS: INDEX OF REFRACTION DISAPPEARING MAGIC

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1. Overview

Title	Index of refraction disappearing magic
Driving Question or Topic	*What is Refraction? Why does it differ between different material compositions? What is the refraction index?*
Ages, Grades, …	*16-18* *K10-K12*
Duration, Timeline, Activities	*135 minutes* *3 X 45 Learning hours* *5 activities*
Curriculum Alignment	*The learning activity aligns with most EU countries' curriculum, with the subject of science, and more specifically the index refraction, which is most often addressed at ages 16-18 (K10-K12).*
Contributors, Partners	
Abstract - Synopsis	*Students will be demonstrated with the effect of the change in index refraction by inserting a laboratory tube in a bowl of oil. Students notice that the tube visually disappears. They are asked to work in teams and explore and find why this happens, and through a short presentation to present the phenomenon as they have understood it through collecting information online. Afterwards, the teacher explains the index of refraction, why it changes depending on the material or medium, the visual effect, etc. Finally, students are asked to replicate the experiment using water instead of oil, observe the phenomenon, comment on the degrees of refraction, etc.*
References, Acknowledgements	scitech Australia (https://www.scitech.org.au/experiment/disappearing-objects-refractive-index/#) Science World Society (https://www.scienceworld.ca/resource/disappearing-glass/) Nathaniel Lasry, John Abbott College, Montreal Canada " The Magic of Optics: Now you see it, now you don't", (https://serc.carleton.edu/sp/compadre/demonstrations/examples/19252.html) UNIVERSITY of WISCONSIN–MADISON, Department of Physics, (https://www.physics.wisc.edu/outreach/wonders-of-physics-outreach-fellows/activities/index-of-refraction/)

2. STEAME ACADEMY Framework*

Teachers' Cooperation	*In most EU countries, engineering is being introduced through the subjects of Technology and/or Science. Therefore, the cooperation of these two subject teachers is implied within the context of this activity.* *Cooperation is more important in the design phase of this activity meaning that both subject teachers meet the prerequisite knowledge and skills to implement the activity individually, nevertheless a cooperation/collaboration is endorsed.* *The in-service teachers should support student teachers especially in the parts of the activity that laboratory equipment is used to experiment with the refraction of an item in different type of liquids.*
STEAME in Life (SiL) Organization	*Meeting with business representatives/Applications in real world Entrepreneurship – STEAME in Life (SiL) Days*
Action Plan Formulation	*STAGE I: The activity encompasses the cooperation of two or more teachers, mainly the science teacher, with the teacher that is in charge of the school's laboratory equipment, usually a science or a technology teacher. Cooperation may be also of add on value with a mathematics teacher for phase 5 of the activity.* *STAGE II: All steps have been considered in formulating the learning activity action plan. The relation with a real-life problem occurs at the end, as the common approach has been reversed and the instruction by the teacher is at the last phases of the activities, as it starts with an experiment, and continuous with a project that aims in explaining the outcomes of the experiment, before the teacher presents the facts and knowledge related to the topic in focus.*

[*] *under development the final elements of the framework*

3. Objectives and Methodologies

Learning Goals and Objectives	*The activity aims to support students in understanding the refraction index and how and why it differs between different materials. The activity focuses on interpreting and understanding the science behind the visual effect of the change in refraction of an object going from one material to the other (e.g., air to water).*
Learning Outcomes and expected Results	*The activity aims to achieve the following learning objectives so that students, upon completion are able to:* *- Identify the effect of the change of index of refraction between air/water/oil* *- Comprehend the visual effect due to the different refraction index between different materials (water/oil/air)* *- Comprehend the link in the index of refraction with the visual effect observed* *- Be able to reconstruct the experiment to test a different material composition (water)*
Prior Knowledge and Prerequisites	*Students participating in this activity should have:* *- basic science knowledge (K7-K9)* *- been introduced to wavelength and frequency of light during its propagation* *- basic geometry knowledge (K7-K9)*
Motivation, Methodology, Strategies, Scaffolds	*This learning activity utilizes a project-based approach by engaging students to work in teams, inquire and explore online information to understand a science experiment, present the refraction phenomenon, and experiment themselves with the visual effect of water refraction.* *The activity adopts a change of the common sequence of phases, encompassing the instructional presentation of the teacher at the end, following students' own exploration and experimentation.* *Furthermore, the activity endorses an experimental learning approach.*

	Students participate in the activity both as a whole class and as teams of students working on their project.

4. Preparation and Means

Preparation, Space Setting, *Troubleshooting Tips*	*Procedures, spaces, and material preparation* *Setting in classroom, outdoor activity, computer lab, hybrid environment, etc.*
Resources, Tools, Material, Attachments, Equipment	*Instructional sources and digital material with the related references needed for the implementation of the learning plan*
Health and Safety	

5. Implementation

Instructional Activities, Procedures, Reflections	*Phase 1 (classroom work) – 20 minutes* *The teacher performs the experiment by following the instructions below:* *- Pour the vegetable oil in the bowl, enough to be able to fit the test tube.* *- Place the tube in the oil without oil filling the tube.* *- Fill the tube with oil and place it in the bowl again.* *- Point out that the tube is almost invisible.* *Due to the oil having a similar refraction index as Pyrex the tube seemingly disappears as the reflection of light is the same (similar) for both materials.* *The teacher mentions that this is due to the refraction index of the medium and provides no further information to students.* *Phase 2 (teamwork) – 20 minutes* *Students are asked to work in teams of 4-5 to search their science handbooks and online information, to understand what a refraction index is, how the refraction of light depends on the material composition of the medium it travels through, etc. Their objective is to develop a 5-minute presentation to explain the science behind the disappearing tube.* *Phase 3 (teamwork) – 35 minutes* *Phase 3.1 – 15 minutes* *Students are given the bows, the testing tubes, the gloves, water, and vegetable oil to replicate the experiment and be able to make their own observations.* *Safety goggles are to be used by students while conducting the experiment.* *Phase 3.2 – 20 minutes* *Following the team experiment, students finalize their projects.* *Phase 4 (classroom work) – 40 minutes* *Phase 4.1 – 20 minutes* *All teams are asked to present their project and explain the phenomenon of refraction.* *Phase 4.2 – 20 minutes* *The teacher presents the refraction phenomenon and the refraction index.* *Phase 5 (individual work) – 20 minutes* *Teacher introduces the way of calculating the relative reflective index of an optical medium and the absolute reflective index. They will be given the speed of light in different mediums and the speed of light in vacuum and will be asked to*

	calculate the relative refractive index between different mediums as well as the absolute refractive index of each one of the given mediums.
Assessment - Evaluation	*The teacher evaluates the process of acquiring information and knowledge through working in small team projects by observing students in action and by being presented with the outcome of the project. Furthermore, the teacher may evaluate the extent to which students have achieved in describing and understanding the phenomenon based on their own exploration prior to them being presented with the information by their teacher.*
Presentation - Reporting - Sharing	*Upon completion of this activity, each student team will have developed a short presentation explaining the refraction of light and how it works. The students' presentations may be shared with their peers and with parents allowing for the recognition of their effort and accomplishments by their surrounding environment (school – family).*
Extensions - Other Information	The teacher may ask students to experiment at home and fill the tube with water instead of oil and leave the tube empty (filled with air) and then explain why the tube did not disappear as it did in class, when it was filled with vegetable oil. Their findings should be handed-in in the form of a short presentation including the references and sources that they used.

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)

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

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

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

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

12. Configure STEAME models to describe / represent / illustrate the results
13. Studying the results in 9 and drawing conclusions, using 12
14. Applications 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 - 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