Co-funded by the Erasmus+ Programme of the European Union

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LEARNING & CREATIVITY PLAN (L&C PLAN):

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1. Overview

Title Driving Question or Topic	An Education Museum in our city! • A monitoring plan of an under construction Education Museum, using security cameras of maximum efficiency that cost less or equal to €15,000.00. • What is the minimum number of security cameras needed for the museum, so that all parts could be monitored? • Where the cameras should be placed in order to offer the maximum level of security?
Ages, Grades, …	*Students's age 13-16* *Grades: 7-10*
Duration, Timeline, Activities	*10X45 muinutes*
Curriculum Alignment	Mathematics (Geometry, Algebra), Physics (Optic), Engineering, Economics
Contributors, Partners	
Abstract - Synopsis	Students study the polygon floor plan of the Education Museum, that is going to be built in their city. They try to place the minimum number of security cameras needed, so that the full area can be monitored. Within the budget of 15.000,00€, students are asked to research security options on the internet in order to propose the most effective plan (economical, practical and sufficient). They, also, develop a model of the museum, simulating the security cameras with colored LED lamps.
References, Acknowledgements	

2. STEAME Framework*

Teachers' Cooperation	• Teacher 1: Mathematics (T1) T1 is the main teacher who provides the scenario and the work plan of the project. T1 supports students to their investigation with different types of polygons and their vertices. T1 works in cooperation with T2, T3 and T4. • Teacher 2: Physics (T2) T2 supports students with physics necessary knowledge as well with the simulation model. • Teacher 3: Engineer (T3) T3 is responsible for the model construction. T3 mentors and supports the teams with necessary knowledge and skills for developing the museum model. T3 works in cooperation with T2 to support teams while they are working with the colored LED lamps in order to guide students to find the minimum LED lamps (instead of cameras) needed for lightening the whole

STEAME in Life (SiL) Organization	place, avoiding gaps or overlaps. T3 cooperates also with T1 for supporting students to generalize the relation between the maximum number of vertices of a polygon and the number of cameras needed for fully monitored. • Teacher 4: Economics/Entrepreneurship (T4) T4 supports and guide students in choosing the right cameras, keeping the purchase within the given money range.
Action Plan Formulation	**STAGE I:** Preparation by T1 (steps 1-4) **STAGE II:** Action plan formulation by T1 in cooperation with T2 (steps 1-3) **STAGE II:** Action plan implementation (steps 4-5) (guidance by T1) **STAGE II:** Action plan implementation (steps 6-11) (guidance by T1 in cooperation by T2, T3, T4) **STAGE II:** Action plan implementation (steps 12-18) (guidance by T1)

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

3. Objectives and Methodologies

Learning Goals and Objectives	Students should be able to: • Distinguish the characteristics of polygons. • Relate the number of vertices of a polygon to the number of security cameras required for effectively monitor a space. • Discover the general relationship of finding the maximum number of cameras that can be placed in an n-polygon (maximum number of cameras = $\lfloor v / 3 \rfloor$, where v is the number of vertices and $\lfloor v / 3 \rfloor$ represents the largest integer less than or equal to v / 3) • Describe the model of linear propagation of light in homogeneous optical media and apply it in everyday situations. • Determine the polar diagram of the light emitted by a lamp and represent it graphically with photometric curves or three-dimensionally with a photometric solid. • To determine the minimum number of light sources that fully illuminate a given space, while minimizing overlaps. • Formulate hypotheses and apply procedures to check their hypotheses, changing different parameters. • Make data-based arguments to support or reject a proposition. • Decide effectively about the cost of a project.
Learning Outcomes and expected Results	Students will: • Make a presentation explaining the procedures applied for completing their work and justifying why the proposed solutions are optimal. • Write a detailed proposal to the Municipality about the installation of security cameras in the Museum. • Develop a model of the Museum and the security plan (simulation with colored lamps). • Present the purchase of buying security cameras, and justifications for their options. • Develop a formula for monitoring the inside and the outside of a space at the same time (the Prison Yard Problem).
Prior Knowledge and Prerequisites	Concept / definition of a polygon (convex and non-convex) Concept / definition of the diagonal

Motivation, Methodology, Strategies, Scaffolds	Concept of angle, types and name of angles in relation to their measure (zero, acute, right, obtuse, straight, reflex and complete angle) Measuring angles with the protractor Linear light propagation-polar light diagram Phenomena caused by linear light propagation (shadow) Global market perception (comparing prices and features) The main approach of the project is the inquiry based learning, where students are encouraged to investigate relations between the number of the vertices of a polygon and the number of security cameras needed to monitor the whole space inside the polygon. Students are actively involved into the tasks, facilitating their learning. They have the opportunity to deal with a real life problem, to test ideas and to think creatively. They also make connections between different subject-matter knowledge.

4. Preparation and Means

Preparation, Space Setting, Troubleshooting Tips	A real life scenario about a museum security plan is the main context of the project. According to lesson activities, students could work individually, in pairs or in groups of 4-5 students. Tablets or laptops will be necessary for investigating the market. Furthermore, an engineering school lab could be utilized while students develop the museum model.
Resources, Tools, Material, Attachments, Equipment	Worksheets, LED lamps, materials for model construction (e.g pieces of thin wood, or thick paper, etc.)
Safety and Health	

5. Implementation

Instructional Activities, Procedures, Reflections	**Activity 1:** (whole class discussion) A scenario about the effort of the Municipality to create an Education Museum in their city is presented to the students. In this museum, you can find reading and schoolbooks from all over the world, children's books and school supplies (notebooks, boxes, stationery, archives, supervision material, etc.). The architectural design of the museum has been selected through a competition and the Municipality is working on a security plan for monitoring and protecting the museum and its exhibits. Students study the floor plan of the museum (worksheet 1) and discuss about the use of security cameras, their possibilities as well as their limitations. **Activity 2:** (work in pairs) (a) Students search the internet for security camera's information and features and make a list about cameras specifications. They choose the type of the camera that is more suitable for placement in the various parts of the museum regarding their rotation and inclination. They use arguments to justify their choice. (b) Then, each pair works on the floor plan of the museum (non-convex polygon with n-sides, where each side corresponds to a wall of the three-dimensional space) (worksheet 1), trying to mark the places where security cameras should be placed, so that the space is fully monitored. **Activity 3:** (individual work and work in pairs)

(a) For facilitating students work, we simplify the previous task. Students are asked to place the minimum number of cameras required in each of the nine given rooms (convex and non-convex polygons-worksheet 2) for full monitoring. For this activity, students consider that the cameras can be rotated 360° and infinite range, without losing image quality. In addition, the cameras may be placed on walls or ceilings, but the height of the camera is not concern because of the range of motion. Students use different colored pencils to show the different areas monitored by each camera. They are encouraged to avoid overlaps and gaps since the purpose of this activity is to find the minimum number of cameras needed to cover the entire space in each shape. Then, students work in pairs. They discuss their results and present them in plenary.

(b) Working in pairs, they try to find a relationship between the number of vertices of the polygons and the number of security cameras required to fully monitor the space/shape. Then, they are asked to use this relation in order to find the maximum number of cameras required to monitor a polygon with given number of vertices. Students could list different pairs consisted of the number of the vertices of a polygon and the number of the required cameras. They are encouraged to design different polygons with the same number of vertices in order to identify patterns related to the number of the vertices of a polygon and the number of the required cameras (Maximum number of cameras = $\lfloor v / 3 \rfloor$, where v is the number of vertices and $\lfloor v / 3 \rfloor$ represents the largest integer less than or equal to $v / 3$). Students study the list and write their observations on worksheet 2. We expect them to realize that the problem of maximizing vertices is solved by maximizing the number of non-convex angles of a polygon.

Activity 4: (develop a model-work in groups of 4-5 students)

(a) Each group of students develop a model of the museum, using simple materials. Taking into account that the scale of the drawing in the worksheet 1 is 1: 100, each group is free to decide the scale of the model to be constructed. The height of the walls will be decided accordingly. In the model, students will place colored LED lamps to observe the points of space each lamp illuminates. The LED lamps simulate the security cameras. The aim of the task is to determine the minimum number of light sources required to fully illuminate the space, while minimizing overlaps. Colored lamps will facilitate this procedure.

(b) Based on the model, students are asked to prepare a presentation in ppt, explaining the procedures they applied to complete their project and justifying why the solution or solutions they propose are optimal.

Activity 5:

Students do internet market research on the various options available for different types of security cameras. Given the maximum amount that can be spent for this purpose, they prepare a detailed proposal for the purchase of cameras, listing all the features of the cameras and the corresponding prices. They justify their choice or any alternative using appropriate arguments. The proposal and the costing will be addressed to the Municipality of their city.

Activity 6:

(a) Students are challenged to develop a formula for monitoring the inside and the outside space of the Education Museum at the same time. The expansion activity corresponds to the Prison Yard Problem.

(b) Students design polygons-spaces that require a given minimum number of security cameras for fully monitoring.

	(c) Students explore different types of security cameras and point out how solutions change if we use static cameras or cameras with limited distance view.
Assessment-Evaluation	Individual and group **formative assessment**, providing ongoing feedback during the development of the project. Students are working backwards, designing polygons-spaces that require a given minimum number of security cameras for full monitoring.
Presentation - Reporting - Sharing	A presentation by each group takes place, explaining the procedures applied for completing their work and justifying why the proposed solutions are optimal. Also, a detailed proposal/report about the installation of the security cameras in the Museum could be forwarded to the Municipality. A developed model of the museum following by the security plan could be presented and described. Different colors of LED lamps could be used, simulating the security cameras plan.
Extensions - Other Information	(a) Students can expand the specific project by presenting how the internal and external space of the Education Museum can be monitored simultaneously. The expansion activity corresponds to the Prison Yard Problem. (b) Students explore different types of security cameras and point out how solutions change if we use static cameras or cameras with limited distance view.