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| ACTIVITY PLAN | | | | |
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| **THEME** | **SUBTOPIC** | **Activity Title** |
| Global and Local Perspectives in Environmental Education | Mathematics in Environmental Modeling and Analysis | The simplest dimensionless climate model |

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| INTRODUCTION PART (OR ACTIVITY OVERVIEW) |
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| **Introduction part (or activity overview)** | This activity is designed to deepen students' understanding of the greenhouse effect. We will create the simplest zero-dimensional climate model. Though this model is very basic, it can be used to explore how changes in solar irradiance, albedo, and emissivity could affect Earth's temperature.  Using the GeoGebra software, students will prepare a mathematical model of the energy balance that will allow them to perform calculations, visualize data, and experiment with the given data. |
| **SETTING** | Classroom. |

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| MATERIALS NEEDED |
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| **Materials Needed** | Computers (tablets) connected to the internet, GeoGebra software, pen, paper for notes. |

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| **Learning Outcomes** | Students will improve their understanding of the greenhouse effect.  They will get acquainted with the simplest zero-dimensional climate energy balance model.  They will examine the Stefan-Boltzmann law and will be able to express the parameter T from the Stefan-Boltzmann law. Using the GeoGebra program, they will perform the input of the Stefan-Boltzmann formula and the creation of parameter sliders (slider tool), write down the function, and formulate conclusions. |  |
| **Activity Contents** | **Activity1:**  **Theoretical Part (Duration: 15 minutes):**  After watching the designated video, students will become familiar with the structure of the climate energy balance model and understand the Stefan-Boltzmann law. They will note down the derived formula and the possible values of the parameters (constants) used in the formula.  **Video:**  <https://www.youtube.com/watch?app=desktop&v=zvgQ6exOklg>  Duration: Approx. 11 minutes  **Task (**Duration: 25 minutes):  Working in pairs or individually, using the Slider Tool in GeoGebra, students will create sliders for the values of parameters and constants. In GeoGebra, they will enter the expression for the parameter T (temperature) from the Stefan-Boltzmann law, using the symbols of already entered constants and parameter coefficients. They will write a function y that expresses the temperature in Kelvin (K) in degrees Celsius (°C). Using the animation of the Slider Tool, they will investigate the dependency of temperature on albedo, the solar constant, and an additional parameter ε (atmospheric absorption).  Model Creation Process (recommendations) in the GeoGebra environment:(https://www.geogebra.org/):                  Summary, Conclusions (Duration: 5 minutes)  By changing the parameters, students will test the model's operation and formulate conclusions:   * The dependency of temperature on albedo, * The dependency of temperature on the solar constant, * Why does the greenhouse effect occur? |  |
| **Assessments** | The activity is evaluated as indicated in Appendix 1. |  |
| **Key Competences** | * Cognitive competence * Creativity competence * Digital competence |  |
| **Connections with Eco STEAM** | Eco – The impact of Earth's albedo decrease on the greenhouse effect.  Science - The creation process can encourage interdisciplinary learning (physics, geography, mathematics).  Technology - Integrating technologies allows for the visualization of climate models and mathematical formulas.  Engineering - Investigation by changing the parameters in the formula.  Art - Symmetry in mathematics.  Math - Derivation and rearrangement of formulas. Writing mathematical formulas in the GeoGebra environment. |  |
| **References** | <https://denning.atmos.colostate.edu/ats150/lectures/04.LayerModel.pdf>  <https://llis.nasa.gov/lesson/693>  <https://physics.nist.gov/cgi-bin/cuu/Value?sigma>  <https://www.oxfordreference.com/display/10.1093/oi/authority.20110803100530577>  <https://www.geogebra.org/> |  |
| **Notes** | The process of model creation (recommendations) in the GeoGebra program can be provided to students who may encounter difficulties working with this software. Advanced students can create the model without recommendations (choosing parameter notations, colors). |  |

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| Appendix 1 |
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**Evaluation and Self-Evaluation Table:**

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| Vertinimo kriterijai | Points | Comments |
| Writing the required formula, notation of constants from provided sources | \_\_/2 | For correct notation of the formula, finding the values of the required constants from sources. |
| Use of the GeoGebra tool: creation of sliders, input of formula, writing the temperature function | \_\_/4 | For the application of the GeoGebra tool:  1. creation of sliders, input of formula,  2. setting the ranges for constants,  3. input of the formula t (temperature),  4. writing the function y (degrees conversion from K to °C). |
| Demonstration of the investigation process | \_\_/2 | For the demonstration of the model, i.e., the movement of function y along the Y-axis. |
| Formulation of conclusions | \_\_/2 | For correctly formulating two conclusions. |