Integrating Problem-Based Learning in the Math Classroom

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Abstract:

This work aims to present the design and implementation of a mini Problem-Based Learning (PBL) module developed under the **ERASMUS+ Pythagoras project** as part of the **Intellectual Output** - *Toolbox for teachers on Education for Sustainable Development.*

The module integrates differential and integral calculus with environmental sustainability, focusing particularly on the analysis of real-world CO2 emissions data.

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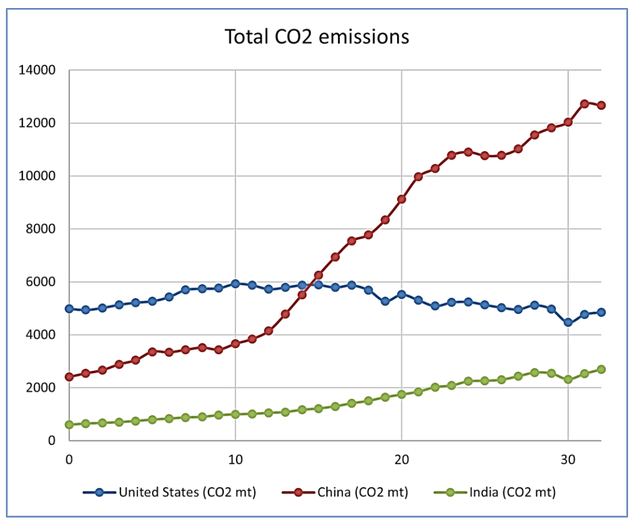
Problem-Based Learning (PBL) is an educational approach that centers around solving real-world problems. It encourages students to actively engage in solving complex problems, promoting critical thinking, collaboration, and the application of knowledge in practical scenarios.



identifying the problem or scenario → researching and gathering information → analyzing the information → proposing solutions → evaluating the outcomes

Mini-PBL project	
Teacher data sheet: Teaching Guide	
Title	Global Green Challenge: Analyzing CO2 Emissions
SDG attended	X (1, 7, 13); X (2, 8, 14); (3, 9, 15); (4, 10, 16); X (5, 11, 17); X (6, 12)
Content units	Least squares method. Polinomial fitting curves. Definite integral.
ICT tools to be used	Excel Spreadsheets for calculation
Context: project estatement	Greenhouse gases, particularly CO2, are the primary drivers of climate change. Increased levels of CO2 in the atmosphere trap heat, leading to rising global temperatures and disrupted weather patterns. This results in more frequent and severe natural disasters, such as hurricanes, wildfires, and droughts. Addressing greenhouse gas emissions is crucial to mitigating the effects of climate change and preserving the health of our planet for future generations. Implementing policies to reduce carbon emissions, transitioning to renewable energy sources, and promoting sustainable practices are all essential steps in combating climate change.
Tasks and problems	The three largest emitters of CO2 are China, the United States, and India. These countries have a significant impact on global greenhouse gas emissions and must play a key role in reducing their carbon footprint. The file CO2.xlsx contains data from 1990 to 2022 about the CO2 emissions (millions of tonnes) in China, the United States, India and World. **Task 1** Represent the trendlines of CO2 emissions in the 3 countries. Interpret the graphs and discuss any notable patterns or changes. Summarize your conclusions in a few sentences. **Task 2** For each country, use Riemann sums to calculate the total emissions from 1990 to 2022 considering intervals with range equal to 8. Use left, right, and midpoint rules. **Task 3** Repeat the previous task considering the range equal to 4. Compare the results. **Task 4** Using the Excel Solver add-ins find the best polynomial curve that fits the given data for USA applying the least squares method. Comment on the quality of the fitting. **Task 5** Based on task 4, obtain the prediction of CO2 emissions for the year 2024. **Task 6** Calculate the area under the curve obtained in task 4. Comment on the results comparing with the values in task 3. **Task 7** Do you know your carbon emission? Calculate your ecological footprint by accessing the link https://carbonfootprintcalculator.streamlit.app

Mini-PBL Model

Duration and Structure: 2-3 class sessions, incorporating autonomous activities
Content Scope: Based on a minimum of 2-3 content units.
Curriculum Design: Utilizes spiral curriculum strategies to revisit and integrate previous content with new material. The semester-end mini-PBL could encompass exercises and questions covering all program contents and potentially related subjects.
Technological Integration: Encourages the use of dynamic tools (mobile apps, Computer Algebra Systems) for high-level computational tasks, including graphics, massive evaluations, solving advanced equations and systems, and complex calculus computations.
Relevance to Real-World Issues: Aligns with the core objectives of the Erasmus+ project by focusing on real-life problems related to Sustainable Development Goals (SDG).

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