Instructing high school students in a teaching-learning sequence on the physical basis of the greenhouse effect: preliminary results

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Abstract. The collaboration of the University of Trento (Italy) with high schools in its province gave us the opportunity to test at that school level the teaching-learning sequence developed by our group on teaching the physical basis of the greenhouse effect.
The sequence had to be adapted to the new learning context: actions were taken both at the level of language, content and order of topics. In particular, some experiments were presented only qualitatively, as the main objective in this context is understanding the physical phenomenon rather than developing laboratory skills. We will present the actions taken and some preliminary results.

Introduction

For more than a decade, our research group has been developing [1–3] teaching-learning sequences (TLS) on the greenhouse effect (GHE) and climate change (CC). These TLSs have always been designed for undergraduate students in mathematics and physics degrees. But in 2024, the University of Trento has started a project (Orientamento 2026) to orient high school students in the area of civic education on sustainability. In that context, we started developing didactic actions in this broader area, but with focus on CC and the GHE. As a result, it was necessary to make a didactic transposition of the contents of the sequences.
Chevallard [4] in fact points out how this process develops on two levels:

- that of external didactic transposition, where the school knowledge to be taught is identified, within the global knowledge;
- that of internal didactic transposition, where school knowledge learnt is identified within school knowledge taught.

The transposition

The didactic transposition involves all three work plans of the model of educational reconstruction (MER) [5] (*clarification and analysis of science content*, *research on teaching and learning*, and *design and evaluation of teaching and learning environments*), which is the framework we used to design the sequence, compared to the previous ones [3,6].
The poster will present in more detail the changes that the new design has made necessary:

- on the level of language: since some physical concepts and definitions are not known by the students, a theoretical introduction of them should be provided before carrying out the related activities.
- as for content: we centred more on qualitative understanding of the physical phenomenon and less on developing laboratory skills to obtain quantitative analysis.
- finally, the order in which the course is developed has also been changed to allow the new physical concepts and definitions to be introduced as consequentially as possible.

Figure 1A

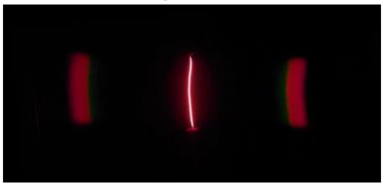

Figure 1B

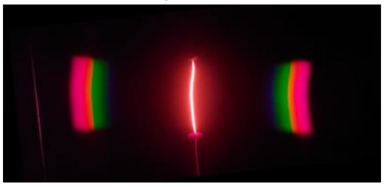

Figure 1C

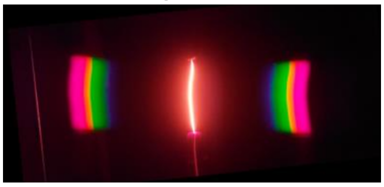

Figure 1. Experiment for qualitative testing of Wien's law, performed using a Kanthal wire, observed through a refraction grating. As the current increases, the wire becomes increasingly incandescent, and through the refraction grating, it is possible to visualize qualitatively the increasing intensity and the shift of the peak to shorter wavelengths (images [A] to [C]).

Figure 2A

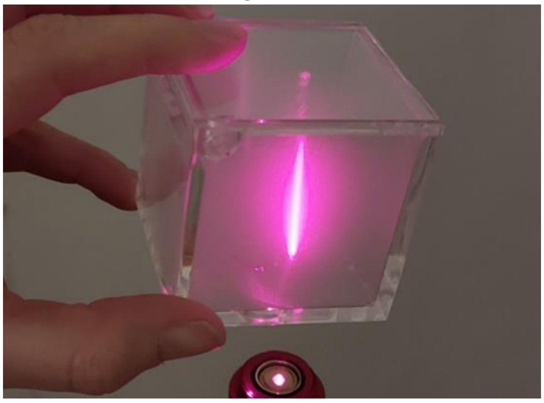

Figure 2B

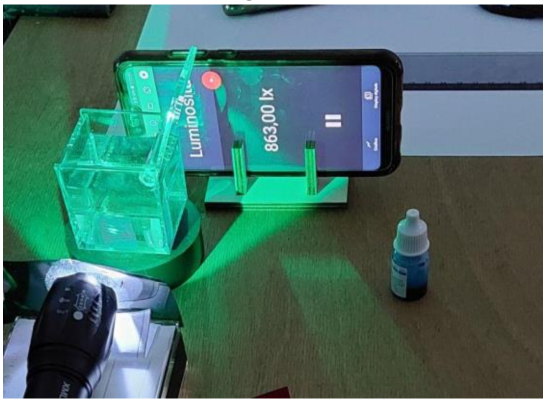

Figure 2. Examples of experiments for qualitative understanding of some physical concepts underlying the greenhouse effect. [A] Scattering of radiation from a laser source through a vessel containing water vapor fog. [B] Experimental test of Beer's law on concentration dependence, using a food dye and the bring your own device (BYOD) approach.

Conclusions

The didactic experimentation was carried out in 3 classes, with a total amount of about 50 students, who were given a set of questionnaires before and after the sequence was carried out to assess their learning. The poster will present the results obtained and show some ideas for what concerns the future redesign of the course.

References

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