COOL IT: A Digital Game on the Greenhouse Effect for Physics Education

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The goal of ECOPOLIS is to develop and evaluate a physics education concept for the use of the digital learning game called *Cool It*. It focuses on the greenhouse effect challenging the player to remove greenhouse gases. To encourage use of *Cool It* the game was embedded into a teaching unit and learning success was measured using a mixed-method approach using questionnaires, interviews, and worksheets. We hope that the interactive and playful multi-media approach can convey a complex subject and lead to a deeper understanding. In this talk the game *Cool It* will be presented, as well as the results.

Introduction

Since 2021, secondary schools in Austria provide students with digital devices. As result, physics teachers are required to expand their teaching methods to include digital skills. At the same time, through these digital devices, teachers are able to convey complex content interactively and playfully. It is assumed that playing digital games leads to a multi-perspective learning experience and offers a fuller understanding of complex and challenging topics such as climate change [1]. The playful approach of computer games such as *Cool It* within the ECOPOLIS project holds the potential for an interactive, self-directed, and motivating physics education. This becomes even more important as the world is facing major challenges in form of climate change and related issues. This is also reflected in the amendment of the curriculum in Austria's lower secondary school level with Fall 2024 to focus on climate, weather and especially on the greenhouse effect.

The project ECOPOLIS[1] is an initiative funded as part of the Austrian Climate Research Program[2]. It aims to design, develop, and evaluate an interactive online game platform for use in Austrian secondary schools, which enables students aged 12 - 15 to experience a form of political participation while also incorporating insights on climate change research into teaching content. To adequately discuss and evaluate the complex topic climate change, its consequences and counter measures, fundamental knowledge acquisition is essential [2]. This includes understanding physical concepts [2], weighing the effects on nature and society [3] and being able to distinguish facts from myths [4]. Previous research shows that students have various difficulties with understanding the climate change, especially with the greenhouse effect. These include the belief that global warming is happening due to more irradiation and or due to less radiation as well as the mixing of different types of radiation involved (UV, IR, visible light) [4].

Research goals

The game within ECOPOLIS, *Cool It*, is dedicated to the greenhouse effect, conveying the relevant physical and chemical knowledge. The research focuses on the evaluation of the game *Cool It* and its potential for interactive, self-directed and motivation physics instruction. The main research question is: Can physics concepts focusing on greenhouse effect be sustainably learned through playful digital game approach and subsequently successfully be applied in new contexts?

[1] Establishing Climate-related Opinion-voicing and Political Participation via Online Learning and Interactive Scenarios

[2] In collaboration with the city of Linz, the University of Applied Sciences Upper Austria (FH Hagenberg), the opinion research institute SORA, and the Johannes Kepler University (JKU) Linz

Methodology

To answer the research question, a multi-phase methodology approach is taken, which is based on a pre- and post-test. The approach corresponds to a mixed method of qualitative and quantitative data collection.

The focus is on the game *Cool It*, which concentrates on the greenhouse effect. Furthermore, an accompanying teaching unit is being developed and evaluated to further the impact of *Cool It*.

In a **first phase** prior knowledge as well as the interest and motivation on climate change in general and the greenhouse effect in particular was collected in form of workshops at schools. In this workshop, pupils aged 12 – 15 had to fill out a printed questionnaire which aimed to collect the prior knowledge on the subject. Furthermore, in this questionnaire general information on their interest in physics and their gaming behaviour was collected. In addition, 8 students (2 per workshop) have been interviewed at the same time as the workshop in a separated room. The participants were chosen with respect to their interest in physics, different school types and balanced in gender and asked on their answers regarding the printed questionnaire.

Within the workshop Data on the student's interest regarding climate & environmental subjects through a digital questionnaire were also collected.

Furthermore, teachers were interviewed regarding their personal interest and whether they think, that gamification can lead to a deeper understanding of climate related topics.

In a **second phase**, revised digital questionnaires that follow the pre- and post-test model are embedded in an ECOPOLIS-Session and are asked alongside playing Cool It. To assess understanding of the greenhouse effect, individual elements of the CCCI-422 questionnaire by Schubatzky [4] were used.

The learning success was evaluated using an accompanying worksheet, which follows the idea of embedding it in a learning situation [5]. We hope this approach allows to integrate the game into physics lessons in a didactically meaningful way.

Results

First results indicate that such a playful approach is welcomed by teachers as well as students. Preliminary evaluation of the questionnaires and worksheets shows that the Students have developed the understanding for the greenhouse effect. (as shown in figure 1).

The evaluation of the questionnaire is still in progress and detailed results will be presented at the conference.

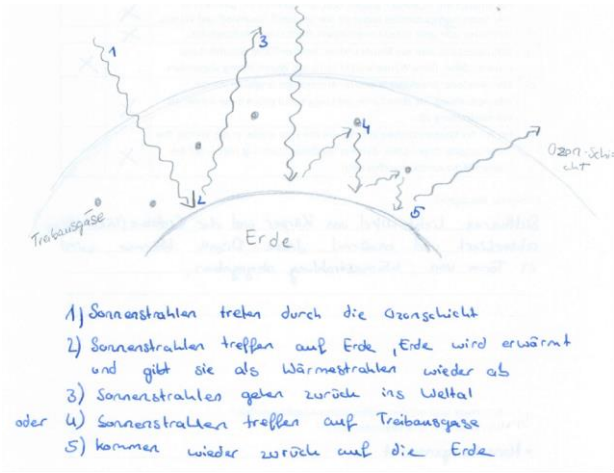

Figure 1: Drawing of an Austrian Student (12) explaining the greenhouse effect.

References

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