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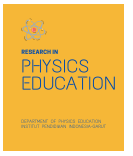

ARTICLE

Physics teaching, climate change issues, and generative artificial intelligence (GenAI)

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Abstract

Physics education has traditionally focused on conceptual understanding and real-world applications. However, integrating climate change issues into physics teaching is crucial for fostering environmental awareness. Climate change significantly impacts global sustainability, yet it remains inadequately addressed in formal education due to the absence of dedicated courses and interdisciplinary challenges. Many fundamental physics concepts, such as thermodynamics and measurement, are directly applicable to understanding climate change. By embedding climate-related discussions into physics instruction, educators can enhance students' scientific literacy and moral responsibility toward environmental issues. Meanwhile, the rapid development of Generative Artificial Intelligence (GenAI) presents new opportunities for education, including physics instruction. GenAI can serve as a personalized learning assistant, helping students engage with complex topics such as climate change while improving their critical thinking skills. Thus, leveraging GenAI to address climate change within physics education offers a promising pathway to enhance students' learning experiences and environmental consciousness.

Keywords: Physics education, Climate change, Generative Artificial Intelligence

1. Description

Traditionally, physics teaching and learning have focused on imparting physics knowledge to students, helping them understand scientific concepts and apply them to real-world contexts. However, as physics teacher educators, we recognize that physics education goes beyond merely sharing information and developing thinking skills; it also plays a crucial role in fostering environmental awareness. Global climate change has led to unexpected and disruptive environmental patterns, making seasonal cycles in tropical regions—typically marked by a predictable rainy season from October to March and a dry season during the remaining months—more unpredictable. Due to rising global temperatures and shifting climate patterns, it is now increasingly difficult to forecast these seasonal changes with certainty. As physics and social studies teacher educators, we have a responsibility to address these challenges and contribute to solutions for global climate change by integrating this critical issue into our teaching and encouraging students to become more

environmentally conscious. Some reasons why physics teaching have to take actions in addressing climate change issues because of characteristic of contents, no specific course of climate change, and lack of mandatory class of climate change (Singh 2023).

One key reason for integrating physics with climate change issues is that many physics concepts are directly relevant to understanding climate science. For instance, in the topic of units and measurement, students can be introduced to temperature units, which are fundamental in physics and part of the International System of Units (SI). A practical example is presenting temperature units—Kelvin, Celsius, and Fahrenheit—in the context of global warming trends. In 2023, the global hottest temperature reached 14.98°C, which was 0.17°C higher than in 2016. This data helps students see how temperature measurements are used to track climate change. Another relevant unit is carbon dioxide (CO) concentration, which represents greenhouse gas emissions. The unit parts per million (ppm) is commonly used in chemistry, but in physics education, students may not always encounter it, even when studying thermodynamics. Physics teachers can highlight how increasing CO concentrations, measured in ppm, contribute to climate change. Additionally, length measurements such as meters and millimeters can be introduced to discuss sea level rise, which results from ice melting in the polar regions. By connecting these fundamental units to climate change, physics teachers can help students understand global sustainability challenges in a simple yet meaningful way.

With regard to the second reason, we acknowledge that there is no specific subject in high schools dedicated to exploring global climate change. One challenge is that climate change is not an issue that can be addressed solely from the perspective of a single discipline (Metzger, Leemans, and Schröter 2005), making it difficult to find educators with expertise across multiple fields. A practical approach would be to integrate climate change as a component within various subjects, ensuring that awareness of this issue is widespread. In a physics classroom, for instance, teachers can explain the interplay between physics and climate change, allowing them to confidently apply their knowledge and expertise. However, this approach also has limitations—physics teachers, for example, may struggle to accurately incorporate perspectives from other disciplines, potentially leading to misconceptions if they lack sufficient interdisciplinary knowledge, data, or expertise. More importantly, physics teachers should emphasize the moral dimensions of climate change as an additional objective in physics education. While physics instruction typically focuses on conceptual understanding and the development of critical thinking skills, positioning climate change as a key issue within physics education can encourage teachers to foster environmental awareness among students. This aligns with the objectives of international assessments such as PISA, developed through collaboration among OECD countries, which emphasize scientific competence, the ability to explain phenomena scientifically, critical thinking, and informed decision-making.

The third reason is the lack of a mandatory class on climate change, not only in physics education but also across other disciplines. Integrating climate change issues into physics can play a crucial role in raising students' awareness of environmental concerns. To address the absence of a dedicated climate change course, physics education should take the lead in making climate change an essential topic, incorporating both scientific concepts and moral values. For example, tenth-grade students in Indonesian senior high schools are required to learn about global warming, demonstrating that physics already engages with climate change topics. However, merely including climate change in the curriculum does not guarantee that physics teachers will fully emphasize its importance. The challenge lies in ensuring that climate change is not just treated as another topic but as a means to influence students' behaviors, encouraging them to be more environmentally conscious in their daily lives. Whether climate change is taught as a mandatory or elective class is not the main issue; what truly matters is that physics teachers actively promote awareness and understanding of this critical subject.

How we can connect a hot issue of climate change to race development of generative artificial

intelligence. We may forget it because race of making generative artificial intelligence between two big countries in economics (e.g., China and USA) has shifted the crucial issue of climate to be forgotten. The emergence of GenAI has risen some questions such as how impacts of GenAI to education is and how to put GenAI in education as personalized assistant for students (Tang and Cooper 2024). The world of publication, for instance, in education has exploited how benefits of GenAI in education. Some researchers in physics education have tried to work with GenAI in solving physics problems. Mostly, they agree that GenAI is beneficial and it can be optimized to improve students' thinking skills and acquisition of content knowledge. How do we achieve the goals. In fact, when I tried to observe Indonesia physics teachers to put GenAI in physics teaching, they did not know what they should do with GenAI because they think GenAI only just help their administrative works. This is problematic because physics teachers themselves just focus on finishing their own works not to focus on improving students' thinking skills. With the GenAI power that connect to large data, it provides potential benefits how to it should be positioned as assistant for students in understanding concepts of science, including fostering students' awareness to global climate change issue.

Positioning GenAI as a medium to expose students to socio-scientific issues may be a rational approach in the post-truth era, particularly through holistic reading activities (Cheung, Pun, and Li 2024). Climate change, as a significant socio-scientific issue, demands urgent attention and action from society. To instill moral values and awareness of environmental challenges, education must start from an early age. In this context, integrating GenAI into science education, including physics teaching, could serve as a powerful tool to engage students with pressing global issues. We believe that aligning physics education with climate change discourse and GenAI applications may offer an effective solution in the era of artificial general intelligence and artificial superintelligence—technologies that surpass human capabilities in creativity, problem-solving, and social intelligence. As users of GenAI in a developing country, our best strategy to participate in this technological race is to leverage GenAI to address critical issues that threaten human sustainability in the future.

2. Conclusion

Integrating climate change issues into physics education is essential for fostering students' environmental awareness and scientific literacy. Many fundamental physics concepts, such as thermodynamics, and measurement, are directly applicable to understanding climate science. However, the absence of a dedicated climate change course in most curricula poses a challenge. To address this gap, physics educators must take the initiative to incorporate climate change topics into their lessons, ensuring that students develop both conceptual understanding and a sense of moral responsibility toward global sustainability.

Furthermore, the rapid advancement of Generative Artificial Intelligence (GenAI) presents both opportunities and challenges for physics education. While discussions on GenAI often focus on economic and technological development, its role in education—particularly in addressing socio-scientific issues like climate change—remains underexplored. GenAI can function as a powerful learning assistant, helping students engage with complex scientific topics, enhance their reasoning skills, and develop a deeper understanding of climate-related issues. However, many physics teachers, especially in developing countries, are still unfamiliar with the effective integration of GenAI beyond administrative tasks.

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