
Utilizing the GPT model to teach physics for better learning and understanding of scientific concepts

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Abstract

Artificial intelligence (AI) is increasingly shaping the landscape of education, with models such as GPT (Generative Pre-trained Transformer) offering new possibilities to enhance both teaching and learning. This paper explores the potential of GPT in teaching physics, particularly how it can assist both students and lecturers in solving complex problems while offering interactive and personalised learning experiences to gain a deeper understanding of scientific concepts. The paper highlights how GPT can generate tailored tasks, quizzes, and assignments catering to specific student competencies. Additionally, it can guide students step-by-step through solutions to difficult physics problems, offering real-time feedback and explanations that promote active learning.

Beyond problem-solving, GPT's ability to support interactive learning is investigated, allowing students to ask specific questions about topics like Newton's laws or electromagnetism and receive instant, tailored responses. The paper also discusses the potential of GPT to complement simulations and visualisations, further helping students to fathom abstract concepts. However, the challenges associated with reliability, ethics, and the evolving role of educators in the age of AI are criti-

cally analysed. GPT's limitations, potentially providing incorrect or incomplete information, underscore the importance of upholding the role of lecturers who can offer contextual guidance and foster critical thinking.

As education increasingly adopts AI, the paper emphasises the need for a balanced approach, using GPT as a supplementary tool to enhance learning while ensuring students develop a deep and thorough understanding of physics based on a combination of AI and traditional teaching methods.

Keywords: GPT, artificial intelligence, physics, education, interactive learning, personalised learning, problem-solving.

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Introduction

Technology is advancing at a remarkable pace, fundamentally transforming the approach to education in various fields. Artificial intelligence (AI) models, particularly Generative Pre-trained Transformer (GPT), are at the forefront of these changes, revolutionising the way both students and lecturers utilise educational content. GPT models are trained on vast datasets, enabling them to generate responses to questions, explain complex concepts, and assist with solving tasks in real time. Their ability to process and produce human-like text makes them valuable tools for enhancing traditional teaching methods.

This paper explores the integration of GPT into the teaching of physics, focusing on its application in the program Radiological Technology at the University of Applied Health Sciences. The goal of utilising GPT is to expand traditional approaches to education by leveraging AI to create more dynamic and interactive learning experiences. GPT can be used not only to support classroom teaching but also to assist in preparing and writing colloquiums, and generally offering a new environment for teaching and learning. The introduction of GPT to physics education has led to greater personalisation of content, helping students to receive immediate, tailored feedback and creating opportunities for deeper engagement with the learning material. By integrating GPT into the curriculum, students can ask specific questions, work step by step through problem-solving processes, and gain a clearer understanding of complex physics concepts. This paper also examines how GPT can complement traditional teaching by reducing the workload on lecturers, automating routine tasks such as assignment creation, and offering innovative ways to help students better understand the subject matter.

GPT model: What is it, and how does it work?

The GPT model is based on deep learning, specifically on the transformer architecture, which allows it to “learn” language patterns by analysing large amounts of textual data.² After completing the training, the model can generate text that sounds natural and meaningful based on the queries it receives.

GPT can perform a wide range of tasks, including:

- ▶ Help in solving mathematical and physical problems.³
- ▶ Providing immediate feedback to students.⁴
- ▶ Generating tests and quizzes.⁵
- ▶ Help in writing academic reports and research papers.⁶
- ▶ Answering questions and explaining physical concepts.⁷

GPT has found wide application in many industries and fields due to its ability to understand and generate natural language. Some of the most notable applications include:

- ▶ **Chatbots and virtual assistants:**⁸ GPT is the basis of many advanced chatbots that can interact with users naturally, answer questions, and provide support in various fields. These systems use GPT to understand user queries and generate relevant and accurate responses.
- ▶ **Content writing:**⁹ GPT generates articles, blogs, marketing materials, and other forms of content. Thanks to its ability to create coherent and informative texts, it has become a valuable tool for journalists, bloggers, and writers.
- ▶ **Automatic language translation:**¹⁰ GPT can translate texts between different languages, offering accurate and natural translations. This is useful for companies operating in the global market or users who need translations for personal use.
- ▶ **Text compression:**¹¹ A useful application of GPT is compressing long texts into shorter and more concise forms, which can help readers quickly understand larger quantities of information, such as news, reports, and research papers.

- ▶ **Generating programming code:**¹² GPT, especially in programming-friendly versions, can generate code based on a task description, which assists the programmer and helps automate coding processes.
- ▶ **Education:**¹³ GPT is used as a learning tool. It can provide explanations, solve mathematical problems, and even write essays on different topics. Pupils and students use GPT to help them learn and solve tasks.
- ▶ **Healthcare:**¹⁴ In the healthcare sector, GPT can help analyse medical data, write patient reports, or explain medical conditions. Although caution is necessary due to the potential consequences of possible misinformation, GPT can speed up some processes.
- ▶ **Data exploration and analysis:**¹⁵ GPT is used to analyse large data sets, extract key information, and generate summaries. This is especially useful in the business world, where data analysis is necessary in formulating strategies.

Using GPT in physics teaching

The integration of GPT models into physics teaching opens new avenues for enhancing educational experiences through interactive learning, personalised tasks, and guided problem-solving. As a virtual assistant, GPT enables students to ask questions and get immediate feedback on complex physics concepts, making learning more engaging. Additionally, it offers significant support to educators by generating tailored assignments and explaining complex problems step by step. Although GPT does not directly produce visual simulations, it can complement existing tools by providing clear, guided theoretical explanations, helping students better understand physics through interactive and personalised experiences.

Interactive learning

One of the key advantages of GPT in teaching physics is its ability to provide an interactive learning experience. Students can ask questions about concepts they are having difficulty understanding, such as Newton's

laws, thermodynamics, or electromagnetism, and get answers immediately. In this way, GPT becomes a virtual assistant for individualised learning.¹⁶

Generating tasks and tests

Professors can use GPT to generate problems and assignments adapted to different levels of student competency. For example, GPT can create a series of problems about forces and motion for students with very little understanding of physics. In contrast, for more advanced students, it can generate problems related to quantum mechanics or relativity. This approach reduces the lecturer's workload in preparing materials and personalises learning content.¹⁷

Simulations and visualisations

Although GPT itself does not generate visual simulations, it can help explain and guide through online tools and simulations. Combined with simulation tools (such as PhET physics simulations), GPT can help students better understand the results of simulations, predict the outcomes of experiments, and provide theoretical explanations.¹⁸

Solving problems

Physics is often perceived as a difficult subject due to the complex problems that require understanding both mathematical and physical concepts at multiple levels. GPT can help students solve tasks step by step, explaining the logic behind each step. For example, in an assignment on the law of conservation of energy, GPT can guide the student through the definition of energy, help formulate the problem and get the final solution.¹⁹

Advantages of GPT in teaching physics

Integrating GPT into physics education offers several key benefits that address longstanding challenges in the classroom. First, GPT supports individualised learning by adapting to each student's pace and interests, providing personalised feedback that promotes a deeper understanding of the syllabus. Second, it provides quick and immediate feedback, helping students

to correct mistakes and stay engaged in the learning process without delays. Finally, the interactive and adaptive nature of GPT can significantly increase student motivation and engagement, encouraging them to ask questions and explore challenging topics with confidence, ultimately leading to a more enriching educational experience.

Individualised learning

One of the main challenges in education is adapting the learning material to the individual needs of students. Students learn at different speeds and have different interests. GPT provides personalised responses that are adaptable to each individual's pace and learning style. Students can pose further questions if concepts remain unclear, ultimately providing a deeper understanding of the learning material.²⁰

Quick Feedback

GPT gives students immediate feedback. Instead of waiting for a lecturer to correct assignments or answer questions, students can get immediate explanations and guidance. It allows students to correct mistakes immediately and continue learning without interruption.²¹

Increased motivation and engagement

The interactive nature of GPT increases student engagement in physics classes. Students feel freer to pose questions to GPT, helping them to overcome shyness or the fear of asking questions in the classroom setting. Also, the ability of GPT to create challenging and creative assignments encourages students to explore topics in more depth.²²

Challenges and limitations of GPT in education

Although GPT is capable of generating complex answers, there is a risk that it may sometimes produce incorrect or incomplete information. The use of GPT in teaching should not replace the traditional role of the lecturer but should be used as a tool to stimulate learning. Professors are essential in providing context, guid-

ance and emotional support to students, which GPT is unable to do. Also, care should be taken about how artificial intelligence is used, especially in ensuring the privacy and safety of students.²³

Examples of using GPT in physics teaching

This section provides practical examples of how GPT can be effectively used in teaching various topics in physics. The flexibility of GPT helps both students and professors get explanations, solve problems, and generate tailored assignments. The examples below illustrate the ability of GPT to break down complex concepts into simpler terms, assist in solving physics problems, and even be used for assessments.

In Example 1, GPT explains Newton's first law in simple language and provides real-life applications, while in Example 2, it generates and solves problems related to Faraday's law of induction. More advanced topics, such as the Schrödinger equation in quantum mechanics, can also be elaborated with GPT, as shown in Example 3. Further on, Example 4 compares student performance in a colloquium using traditional methods versus the use of ChatGPT, highlighting how GPT impacts learning outcomes in specific academic settings.

Example 1: Newton's laws

- ▶ A student asks GPT: "How do you explain Newton's first law?"

GPT answers: "Newton's first law, also known as the law of inertia, states that an object at rest will remain at rest, and an object in motion will continue to move at the same speed and in the same direction unless acted upon by an external force."

The student can then ask additional questions to gain a deeper understanding of the law or look for examples from everyday life.

- ▶ A student asks GPT: "An example from everyday life, please?"

GPT answers: "Imagine that you are sitting in a car that is moving at a constant speed. If the driver suddenly slams on the brakes, your body will continue to move

forward even though the car is coming to a stop. This happens due to inertia – the body tends to continue moving in the direction it was moving before braking. If you are not wearing a seat belt, you can hit the dashboard or the seat in front of you because there is no force (e.g., a seat belt) to stop your movement.”

Example 2: Electromagnetism

- ▶ A lecturer can use GPT to generate problems related to Faraday’s law of induction.

For example:

Question: “What voltage is induced in a loop of 200 coils placed in a changing magnetic field of 0.05 T if the field is reduced to zero in 0.02 seconds?”

GPT generates a step-by-step solution, explaining the formula for Faraday’s law and how the voltage is induced in the coil, and shows all the formulas and arrives at the solution:

The induced voltage in the loop is 500 V.

Example 3: Quantum mechanics

More advanced students can use GPT to get explanations about quantum physics. For example:

Question: “What is the Schrödinger equation?”

GPT responds in simple terms, explaining the role of the equation in predicting the behaviour of quantum particles, with additional explanations if the student requests.

Example 4: 1st year, undergraduate program Radiological Technology, University of Applied Health Sciences

The 2023 colloquium was written in a traditional manner, whereas the 2024 colloquium was written with the help of ChatGPT;

- ▶ 87.21% of students passed the colloquium, and 52.17% of the students passed the exam written using ChatGPT (24/40 points for a passing grade).
- ▶ The mean score in the colloquium was 31, whereas for the exam written with the help of ChatGPT, it was 24.
- ▶ 13% scored excellent grades in the colloquium and 0% in the exam.
- ▶ 1 student scored 100% in the colloquium; the highest percentage of solved questions in the exam was 88%.

Interesting facts from the exam:

Question 1. Third, Newton’s law reads: 4 multiple-choice answers (**98% correct answers**)

Question 2. We call the process of a substance changing from a solid aggregate state to a liquid aggregate state:

- a) dissolution;
- b) melting;
- c) a or b (synonyms), (33% of correct answers)
- d) melting point.

Question 3. The equation of the state of an ideal gas reads:

- a) $pV=nRt$;
- b) $PV=nRT$; (**74% wrong answers because ChatGPT suggests the wrong one**)
- c) $PV=NRT$,
- d) $pV=nRT$.

Question 4. RLC circuit – which statement is correct?

- a) all statements are correct (**68% wrong answers**)

Question 5. The unit of measurement of magnetic flux (Wb) is derived from:

- a) Vs;
- b) Tm^2 ;
- c) **a or b,**
- d) T/m^2 (**91% wrong answers - ChatGPT provided no answers**)

Task 1. Two employees place boxes with medicines on the shelves of the hospital centre. The first employee lifted a 10 kg box to a height of 1 m in 5 s. The second employee lifted a 20 kg box to a height of 1 m in 10 s. Which employee has more strength?

- a) The strength of the first employee is greater than the strength of the second employee.
- b) The strength of the second employee is greater than the strength of the first employee.
- c) **Both employees have the same strength. (33% of students answered correctly)**
- d) We cannot determine from the given data.

The future of GPT in education and physics

The future of GPT in education has an immense potential for transforming the learning experience, particularly in scientific disciplines like physics. As technology advances, GPT models are likely to be further integrated with other tools, such as simulations and virtual reality, enabling students to engage in interactive and real-time physics experiments. This fusion of AI and immersive technologies could radically reshape how physics is taught. Additionally, adapting GPT specifically for educational purposes by training it on subject-specific resources could enhance its accuracy and relevance, making it an even more reliable learning tool. However, as AI becomes more prevalent, fostering critical thinking skills remains essential. Encouraging students to analyse and question GPT outputs is crucial in developing a deeper understanding of physics and avoiding over-reliance on AI for answers.

Integration with other technologies

In the future, GPT models could be even more deeply integrated with simulation and virtual reality tools, allowing students not only to ask questions and get answers but also to participate actively in real-time simulations of physics experiments. This synergy between artificial intelligence and other technologies could revolutionise the way scientific disciplines, such as physics, are taught.²⁴

Adapting the model for educational purposes

Although GPT is already a powerful tool, adapting it specifically for educational purposes could improve its use. This approach could include training the model on specific educational resources, such as physics textbooks and scientific articles, and introducing mechanisms to check the accuracy of answers to reduce the risk of incorrect information.²⁵

Development of critical thinking skills

In order to avoid dependence on artificial intelligence, professors should encourage students to think critically and analyse the answers they have taken from GPT. Instead of using GPT to get an answer, students should analyse how the model arrives at the answer, which would lead to a deeper understanding of scientific concepts.²⁶

Conclusion

The use of GPT in physics teaching offers valuable opportunities to improve both teaching methods and student learning. By providing interactive and personalised experiences, GPT helps students grasp complex physics concepts and gives immediate feedback, which can increase engagement and motivation. Additionally, it supports educators by generating customised tasks and assisting with problem-solving, making it easier to address individual student needs.

However, GPT should be seen as a helpful tool rather than a replacement for traditional teaching. While it can efficiently deliver content and solutions, it does not offer the context, emotional support, or guidance for critical thinking that lecturers provide. Careful attention is needed to ensure the accuracy of responses given by GPT and avoid an over-reliance on AI-generated solutions.

Looking ahead, the potential to integrate GPT with other technologies like virtual reality and simulations could further enhance education. This approach may lead to more dynamic and better hands-on learning experiences for students. As GPT technology continues to develop, adapting it specifically for educational purposes and encouraging critical thinking is important to ensure that students gain a strong and well-rounded understanding of physics.

In summary, while GPT can greatly enhance physics teaching, its effective use depends on a balanced approach that combines AI with the essential role of educators to support a deeper learning experience.

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PRIMJENA GPT MODELA ZA PODUČAVANJE FIZIKE ZA BOLJE USVAJANJE I RAZUMIJEVANJE ZNANSTVENIH KONCEPATA

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Sažetak

Umjetna inteligencija (AI) sve više oblikuje krajolik obrazovanja, s modelima kao što je GPT (engl. *Generative Pre-trained Transformer*) koji nudi nove mogućnosti za poboljšanje poučavanja i učenja. Ovaj rad istražuje potencijal GPT-a u nastavi fizike, posebice kako može pomoći i studentima i predavačima u rješavanju složenih problema, a istodobno nudi interaktivna i personalizirana iskustva učenja za stjecanje dubljeg razumijevanja znanstvenih koncepata. U radu se ističe kako GPT može generirati prilagođene zadatke, kvizove i zadatke koji odgovaraju specifičnim kompetencijama studenata. Dodatno, može voditi studente korak po korak kroz rješavanje teških problema iz fizike, nudeći povratne informacije i objašnjenja u stvarnom vremenu koja potiču aktivno učenje.

Osim rješavanja problema, istražuje se sposobnost GPT-a da podrži interaktivno učenje, dopuštajući studentima da postavljaju specifična pitanja o temama, kao što su Newtonovi zakoni ili elektromagnetizam, i primaju trenutačne, prilagođene odgovore. Rad također raspravlja o potencijalu GPT-a da nadopuni simulacije i vizualizacije, dodatno pomažući studentima u shvaćanju apstraktnih koncepata. Međutim, kritički se analiziraju izazovi povezani s pouzdanošću, etikom i

evoluirajućom ulogom edukatora u doba umjetne inteligencije. Ograničenja GPT-a, pružanje netočnih ili nepotpunih informacija, naglašavaju važnost održavanja uloge predavača koji mogu ponuditi kontekstualno vodstvo i poticati kritičko razmišljanje.

S obzirom na to da obrazovanje sve više prihvaća umjetnu inteligenciju, rad naglašava potrebu za uravnoteženim pristupom, primjenom GPT-a kao dopunskog alata za poboljšanje učenja, dok se osigurava da studenti razviju duboko i temeljito razumijevanje fizike na temelju kombiniranja umjetne inteligencije i tradicionalnih metoda podučavanja.

Ključne riječi: GPT, umjetna inteligencija, fizika, obrazovanje, interaktivno učenje, personalizirano učenje, rješavanje problema