ARTIFICIAL INTELLIGENCE IN PHYSICS LEARNING: PERCEPTION AND APPLICATION

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Abstract

In terms of learning/teaching innovation, one of the topics generating the most analysis and discussion is the application of artificial intelligence, AI. Both, in learning and assessment processes. This work analyses the application of artificial intelligence in the learning process of Physics in Engineering studies (first-year students). Complementary, surveys have been carried out among students on the perception and degree of knowledge of AI. In general, they are more favorable to its application in learning and self-assessment processes than in professor assessment. A significant percentage of students are concerned about its future impact on the labor market. The practical application of AI has been carried out in the teamwork activities and, the generation of learning material. Concerning the perception of the AI risks, the survey statistical analysis shows that: i) provide insufficiently verified information, ii) provides incorrect or incomplete bibliography or iii) AI is not prepared for scientific or technological tasks/activities (even in paid versions of AI). In the generation of learning material, it has been found that AI easily provides incorrect material and that, if the student interacting is not an expert, the self-assessment material generated can be counterproductive. Some examples are shown. The system is evolving, and intelligent tutoring systems will end up being generated. In addition, as professors, we must be aware that current students are AI users, but in a few years, first-year students will already be AI natives.

Keywords: Artificial Intelligence, physics, higher education, teamwork.

1. Introduction and objectives

Generative artificial intelligence (AI) has developed greatly in recent years, including in the field of education. One of the aspects to be analyzed is the perception of its users. In the set of perception studies, there is a bias towards those that focus on the positive aspects (Baidoo-Anu & Ansah, 2023). This fact is common in the research work on teaching/learning methodologies. Most of them are carried out by researchers who apply them and there is likely a tendency towards a positive assessment. Moreover, they tend to focus on students (Strzelecki, 2023). The most frequently highlighted positive issues are the reduction of the time needed to perform tasks and the easy accessibility of AI. More in-depth studies are needed to ascertain the perception of other aspects such as critical thinking (Darwin et al., 2023). There are expected benefits of AI in fostering the learning environment (more tailored, efficient, and analytical) (Nagy et al., 2024).

The involvement of the teaching staff and the center in learning through AI has to facilitate its correct use by the students. Some studies stress the need for academic institutions to facilitate the application of AI and mitigate associated problems, to reinforce positive experiences (Tlili et al., 2023). To this end, it is necessary to provide training tools for both teachers and students. It is also necessary to analyze the ethical issues of the educational field. There are risks such as the bias or the privacy remarked by professors and institutions. It is also mandatory financial support for specific AI applications. Nevertheless, most current studies are based on the experiences of a small group of teachers.

The students commonly use ChatGPT. It is known, that this application has problems: non-accurate answers to complex questions, wrong references, numerical mistakes (mathematics, information), and not up-to-date information (Kalyan, 2024). As a consequence, in this study, other applications such as Gemini or Perplexity are also recommended.

The main objectives of this study are to monitor the use of AI in academic work performed by first-year undergraduate engineering students, to increase their critical view of AI-generated material, and to survey students' perceptions of AI potential risks.

2. Methodology

The methodology used is as follows:
(a) Perception survey on possible positive or negative aspects of artificial intelligence. Statistical treatment of the data.
(b) b) Design teamwork activity related to the subject in which AI is used to generate text, images, questions, and problems.
(c) c) Activity management: Intermediate interactions with the professor to detect errors or mistakes in the generated material.
(d) d) Delivery of the work at the end of the activity. Including some reflective paragraphs on the use of IA. It is necessary to verify the evolution of the students' perceptions.

Finally, the analysis of the set of results will facilitate the introduction of improvements in the learning activity in its methodology and application in subsequent years.

In the intermediate interaction with the students, the professor should consider that the learning environment and the learner's previous experiences influence the learning environment (Segaran et al., 2021). AI learning is often performed online, without interactions. It can be a problem for some students generating anger or anxiety (Hoferichter et al., 2022). In this study, the selected option is a teamwork activity to facilitate the interaction between peers.

3. Results and discussion

3.1. Perception study

A survey (Likert scale) was conducted at the beginning of the academic semester to ascertain the students' perceptions. A statistical study was carried out with the collected responses. Positive issues are reduction of task time (RT), easy accessibility (AC), Increased degree of autonomy (DA), complementary source of contrast in learning (CS), increased self-learning (SL), improvement assessment (IA), and general perception (GP). The best scores are those of the reduction of task time and easy accessibility. A similar result has been found in a previous study (Suñol et al., 2024).

Figure 1. Perception survey: Positive issues evaluation of the positive issues of AI in learning tasks-activities.
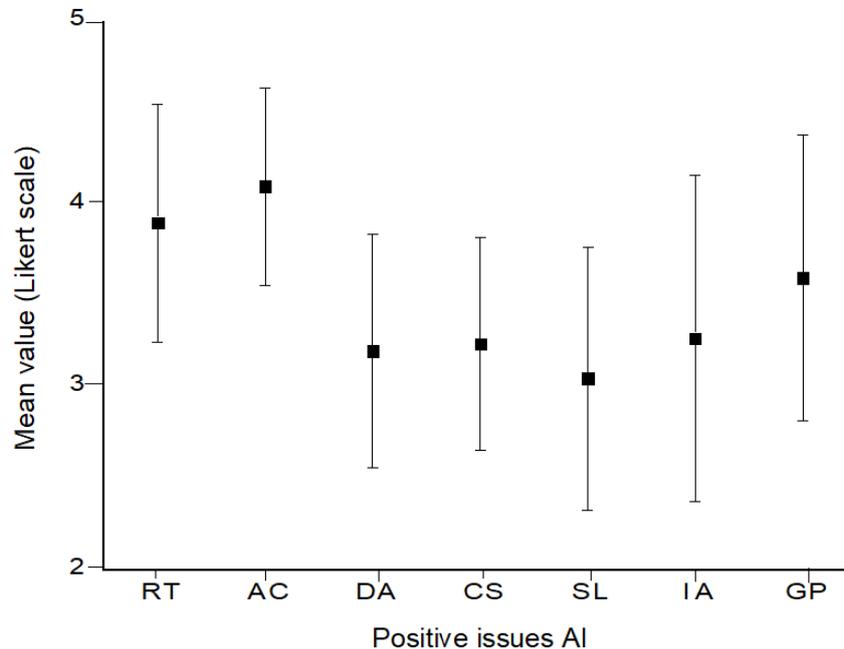
With respect to the general perception of AI, it is positive (mean score 3.6).

The risks taken into account in the survey are wrong information (WI), biased information (BI), socio-economic discrimination (SD), loss of privacy (LP), decreased critical capacity (CC), false learning (FL), and human work replacement (WR). Other issues not considered in this study are the lack of personalization, the potential for echo chambers, and the non-deep understanding and learning. The last question is not linked to learning, but it has been included because students often remark in the open comments at the end of the survey. These open comments help the professor to understand the learner's feelings about AI and influence further modifications in the activity and/or the survey.

Figure 2. Perception survey: Negative issues evaluation of the positive issues of AI in learning tasks-activities.
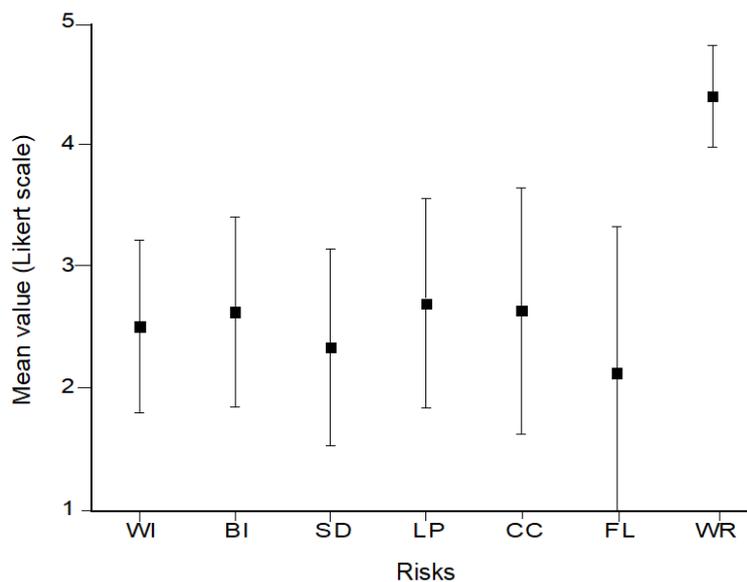
Regarding the other risks of AI use, students do not perceive them significantly before performing the activity. Generally, professors and students have similar views on the potential benefits and risks of the academic use of AI (Marshik, 2024). Nevertheless, the professors are more sensitive to these risks. However, just as the students refer to future work problems, the professors point out other aspects such as the difficulty of applying AI in evaluation processes. AI was not well-accepted as a complete substitute for teacher grading (Alsalem, 2024). Other issues remarked by the academic staff are the increase in academic disparities and the decrease in professor authority (Jang, 2024).

3.2. AI material critical revision

In the intermediate interactions with each teamwork, the professor should check the questions problems, images, and references. Based on personal experience, a quick review can detect the most common errors. A random check can also be done. Errors are usually found when generating complex problems. This is the time to provoke a critical view of the material they have generated in the students. Most students tend to consider that everything the AI provides them is correct. One of the techniques suggested to students is providing an example problem to the AI. In this way, errors are minimized although they do not disappear.

Some examples of Perplexity AI correct application.

"Which of the following statements is a direct consequence of the second law of thermodynamics?
a) It is impossible to built a perpetual motion machine of the first kind.
b) It is impossible to build a perpetual motion machine of the second kind.
c) Energy is conserved in all thermodynamic processes.
d) Absolute temperature is always positive.
Correct answer: b) It is impossible to build a perpetual motion machine of the second kind."

"Generate one problem similar to this one and provide the solution.
A radiator with an exterior surface of 1.5 m^2 is painted with aluminum paint (emissivitat=0.55). (a) What is the heat flux through the radiator derived from radiation when the temperature of the radiator is 50ºC? (b) What is the heat flux absorbed if the room walls are below 22ºC? (c) What is the net heat flux from the radiator?
Problem 1: Solar Heating of a Black Roof
Problem: A flat black roof with an area of 100 square meters absorbs 80% of the Sun's radiation. If the solar intensity is 1000 W/m², calculate:
(a) The rate at which the roof absorbs solar energy. (b) The temperature increase of 1000 kg of water stored in a tank under the roof if all the absorbed energy is transferred to the water over 6 hours. Assume the specific heat capacity of water is 4186 J/kg°C.
Solution: (a) Rate of energy absorption = Solar intensity Area Absorption factor = 1000 W/m² 100 m² 0.8 = 80,000 W

(b) Energy absorbed in 6 hours = 80,000 W 6 3600 s = 1.728 x 10^{11} J Temperature increase = Energy absorbed / (Mass Specific heat capacity) = 1.728 x 10^{11} J / (1000 kg 4186 J/kg°C) ≈ 41.3°C."

In Figure 3, two wrong generative IA images are shown. Obviously, the left images do not correspond to nanoparticles and the right image is not a calorimetry scan.

Figure 3. Generated nanoparticles image (left) and generated calorimetry scan of a crystallization process (right). Gemini.
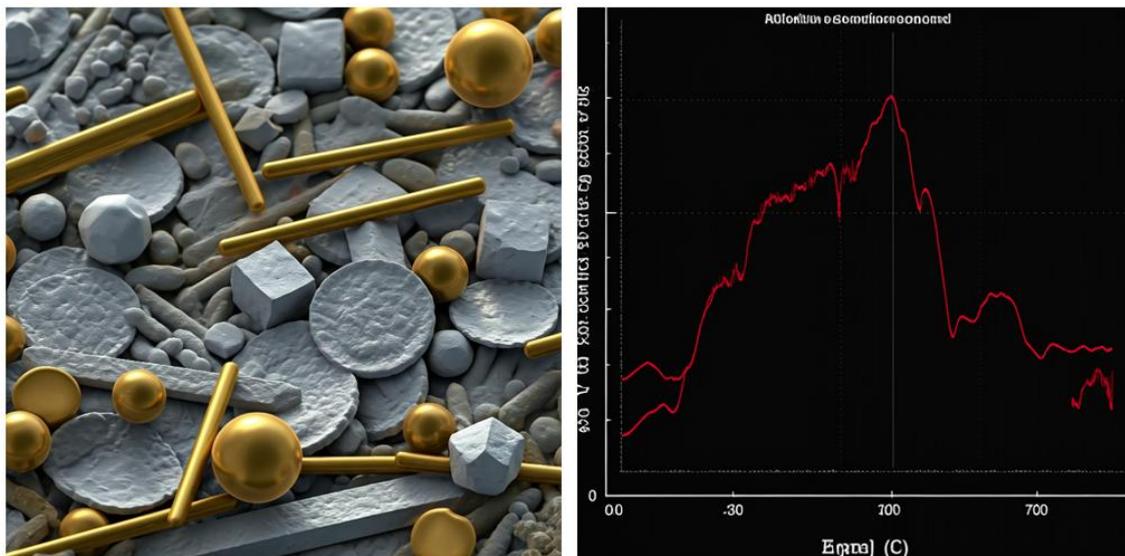
Regarding the generation of text, this is usually of a general and informative nature. In addition, if the request is complex, for example, searching for articles that discuss several topics, the probability of an incorrect response increases.

"Write two paragraphs about magnetic refrigeration of data centers from scientific articles

Magnetic refrigeration is emerging as a promising technology for cooling data centers, offering a more energy-efficient and environmentally friendly alternative to traditional cooling methods. This innovative approach leverages the magnetocaloric effect, where certain materials undergo temperature changes when exposed to varying magnetic fields. In magnetic refrigeration systems, materials like gadolinium are subjected to alternating magnetic fields, causing them to heat up when magnetized and cool down when demagnetized. This cyclical process can be harnessed to create a continuous cooling effect without the need for harmful chemical refrigerants, significantly reducing the environmental impact of data center cooling operations." Perplexity.

AI provides two references, only one is a scientific article (linked to magnetic refrigeration, not to data centers). Thus, also correct references should be checked.

3.3. Final remark

The final perception of the students is included as a section of the final deliverable. It is noted that the visualization of AI as a danger to their professional future has been reduced. In the other risks, increased interest is detected in the generation of erroneous, incomplete, or unverified information. Concerning the general assessment, it remains positive (as all the AI potentialities remarked in this study).

4. Conclusions

In this work, the use of AI platforms by first-year university students to generate text, questions, problems, and images and to find references (in a teamwork activity) has been promoted. Their initial perception has been collected in a survey which shows that students initially do not give excessive importance to the risks of AI in learning processes. They focus on its accessibility and the reduction of work time.

The interaction with the professor allows students to be aware of errors in the material generated by AI and increases their critical vision regarding this. However, the overall assessment of the use of AI in learning processes continues to be positive after the teamwork activity. Likewise, the need to train AI is evident. If the query is provided with a model, the probability of the problem, question, or image being wrong decreases.

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