Artificial Intelligence Assisted Physics Pedagogy for Engineering Technology Students

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Abstract—The Artificial Intelligent Large Language Models of OpenAI.com have been used in physics courses in the ABET engineering technology and other curricula in our community college. The supremacy of using AI as a writing tool to improve lab report narration was verified readily, although the improvement of conceptual understanding through literacy was observed to be minimal in a cohort of students. An information pedagogy of converting assessment in multiple choice question format to an informational format with AI driven lab narration was examined in terms of the Force Concept Inventory (FCI) instrument, consistent with the acceptable practice of teaching to an assessment while not-teaching to an assessment tool. The assessment of the information pedagogy showed moderate improvement in the answering of the FCI questions. A numeracy pedagogy in the lecture component was implemented in problem solving using the AI calculation mistakes to emphasize the causation requirement in physics. The AI mistakes would generate an unreasonable graphical trend. Some of the AI mistakes bear resemblances to students' mistakes, suggesting that some students were using a language approach when failing to follow the math derivation steps. Our assessment echoed the recently reported mechanical reasoning and sensemaking results in the use of AI in physics pedagogy, with Computer Vision to emphasis spatial reasoning which plays an essential role in the problem solving of rotational motion in daily engineering and technology examples. Extending heat transfer coverage in Physics One to support diffusion models Generative AI is discussed.

Keywords—AI Large Language Models; physics pedagogy; diffusion models Generative AI

I. INTRODUCTION

The Artificial Intelligent Large Language Models of Openai.com have been used in physics courses in the ABET engineering technology and other curricula in our community college. On the one hand, the supremacy of using AI as a writing tool to improve lab report narration was verified readily, with minimal grammar mistakes and better sentence structure. On the other hand, the improvement of conceptual understanding through literacy was observed to be minimal in a cohort of students.

The AI assisted tools for pedagogy are endorsed by CUNY Graduate Center with the massive deployment planned for 2026. The CUNY AI pedagogy activities have been supported by a Google Grant at One million dollars. Currently our Biology Department in our community college is offering conferences to train interested faculty. We in the Physics Department will continue to conduct AI assisted pedagogy, consistent with CUNY Graduate Center.

II. FIRST LEVEL IMPLEMENTATION

A general issue of using generic information generated by AI in describing a lab could be corrected by asking students to include specific lab information with some numeracy. By adjusting the prompts, some specific numeracy can be incorporated as an easy method to improve the narration. The showing of improved grammar usage in sections such as discussion in a report has been encouraging to us as the graders. The pedagogy of adjusting prompts is consistent with the development of critical thinking.

The implementation echoed with the CUNY Graduate Center AI pedagogy directive: "Writing is not only about presenting your arguments, it's also about finding your way to your ideas and learning to express them clearly" [1]

III. SECOND LEVEL IMPLEMENTATION

To improve conceptual understanding, the following pedagogy was deployed. An information pedagogy of converting assessment in multiple choice question format to an informational format with AI driven narration was examined in terms of the Force Concept Inventory (FCI) instrument, consistent with the acceptable practice of teaching to an assessment while not-teaching to an assessment tool.

The FCI multiple choice question on 'baby pushed food off the highchair' can be described as 'drop and forward simultaneously' in terms of teaching the essence. A transformation as information in terms of pairs of words of (height, time) and (speed, range) would serve as keywords. An AI prompt: Write a few sentences using the key phrases of 'drop and forward simultaneously' and 'height controls time' and 'speed controls range' would generate examples mimicking human fluid intelligence, in our opinion. By the same token, the FCI question on "flying bird dropped fish" can be transformed using information pedagogy. The numeracy of "height controls time" being quadratic (height distance = 0.5*9.8*t*t) and "speed controls range" being linear (distance = v0*t) is straight forward when the "simultaneously" is captured as data columns side by side, namely, time column, height column, and range column. With a student's private subscription fee to AI, graphic output is included as well. Our College does not allow physics instructors to require students to use advanced AI tools, but we are allowed to teach diffusion models Generative AI mechanism using Google Colab.

The string-bow mechanism provides the force to control the speed of an arrow, a basic mechanism understood by the hunters before farming emerged. After the arrow leaves the bow, inertia keeps the forward speed constant, and that string force is no longer relevant. The reality of inertia can be mimicked as follows. Reality to a First Grader would consist of the 5 senses with 5 sensors, eyes, ears, nose, tongue and fingertips. Reality to an Eight Grader would consist of "something affecting behaviors" with that something called emotions like preference/indifference. Emotion is the cause and behavior is the effect. All open admissions students from astronomy to physics accepted that emotion as a mental construct is real, about 100 students in 5 classes in an assessment. Maybe every student would still remember "going through puberty" as real. By the same token, inertia is real as a mental construct for the effect of a constant forward speed after the arrow leaves the bow. That is what the forward motion tells us using language analysis. Note that the range is a local concept. When the range covers the distance of going around Earth, the forward speed is called tangential speed, an important nomenclature in polar coordinates, together with the radial counterpart.

Gravity is a mental construct or a theory, and gravity pulls the baby food downward faster and faster (an effect or experiment). The non-linearity pulling is like credit card compound interests on the unpaid balance. Gravity pulls on the Moon as well, but the Moon has forward speed of about 1 km/sec, so the Moon was able to have high speed for a range equal to the orbital length. Since it is a circular path in the model, the keyword tangential emerges naturally. It is interesting to note that students in community college with open admissions understand reality in terms of cause and effect in social sciences, but it is in the physical sciences that the reality of cause and effect beyond the 5 senses was formulated. The need to use language in physics learning cannot be underestimated, and the AI Large Language Models are effective learning tools when students harness the power of language in the math modeling of physics.

The FCI question on "circular swinging of a heavy medallion" could use the keyword "tangential" as information, which is readily used in their math classes. A pair of internal forces must be inside a single object like that of a stretched rubber band, whereas a pair of forces must involve two objects like walking is toes and ground pushed onto each other. These are examples to show that key phrases are suitable for students to write AI prompts to generate various responses.

The assessment of the information pedagogy showed moderate improvement in the answering of the FCI questions. Basically, a second-level of implementation could be a training of generating AI prompts, using the well-respected FCI content as a standard calibration of content, away from a specific textbook such as free open stax physics, payment required textbook from publishers. The BEMA assessment tool content can be used as well (Brief Electricity and Magnetism Assessment).

The pedagogy is consistent with the following: We are not allowed to teach to an assessment tool, but we certainly teach to the contents in an assessment tool.

IV. THIRD LEVEL IMPLEMENTATION

A numeracy pedagogy was implemented in problem solving using the AI calculation mistakes to emphasize the causation requirement in physics. The AI mistakes would generate an unreasonable graphical trend.

A. Case A of Atwood Machine

The following prompt was submitted to the Openai.com webpage with a link to ChatGPT.com at the bottom of the webpage. Please solve the following physics problem. Part A: An Atwood Machine with negligible mass for the pulley had two vertical weights, 10 Newton on the right side and 70 Newton on the left side. Find the acceleration. Part B: The 70 Newton weight was put on a smooth horizontal. Find the acceleration in this new configuration.

The AI answers were wrong because the Large Language Model was using language to match the prompt, and there was little information on the transformation of an Atwood Machine geometry to block pulling. The wrong AI response is shown in Appendix for interested readers.

B. Case B of Newton's Second Law

An adjusted prompt was used. Please solve the following physics problem. A block of 75 Newton in weight was pulled along a smooth table by a string connected via negligible mass pulley to a vertically hanging weight of 5 Newton. Find the acceleration.

The answers were correct because the Large Language Model has many examples of solving two simultaneous equations on A-Newton block and B-Newton hanging weight, with A = 75 and B = 5 in this case.

Changing the weight values would generate a data table and a graphical representation could be used as another tool to judge the correctness of the AI Large Language Model.

C. Case C of Newton's Second Law With Friction

An adjusted prompt for the case with friction was used.

Prompt-1: Please solve the following physics problem. A block of 20 Newton in weight was pulled along a rough table by a string connected via negligible mass pulley to a vertically hanging weight of 60 Newton. The coefficient of kinetic friction = 0.35. Find the acceleration.

Prompt-2: Please solve the following physics problem. A block of 20 Newton in weight was pulled along a rough table by a string connected via negligible mass pulley to a vertically hanging weight of 60 Newton. The coefficient of kinetic friction = 0.01. Find the acceleration.

The AI answers were correct. Critical thinking needed to get the appropriate prompts is a supplement to the what-if thinking.

D. Case D of Rotation

Rotation geometry posed difficulty in Large Language Model. Here is an example.

Prompt-1: A pebble was glued onto a wheel which was resting on the ground. The pebble was initially at the ground level. Then the wheel rotated 30 degrees. Find the height of the pebble above ground when the radius of the wheel was 2 meters. (answer 1.732 meters).

Prompt-2: A pebble was glued onto a wheel which was resting on the ground. The pebble was initially at the ground level. Then the wheel rotated 20 degrees. Find the height of the pebble above ground when the radius of the wheel was 2 meters. (answer: 1.879 meters).

Prompt-3: A pebble was glued onto a wheel which was resting on the ground. The pebble was initially at the ground level. Then the wheel rotated 90 degrees. Find the height of the pebble above ground when the radius of the wheel was 2 meters. (answer = 2 meters).

The AI answer of Prompt-2 was inconsistent even without geometry knowledge. A small rotation degree should generate a small height.

V. SUSTAINABILITY

Sustainability is maintained by the requirement of assessment. Specifically, our sustainability plan echoed the learning outcomes of Calculus Physics One in our College [2].

Using AI ethically to enhance reading and understanding text in physics, engineering, and forensic science majors. The design is aligned with the following outcomes. The Course Specific Outcome-3 says that "Describe and analyze physical situations using graphical representations". The Course Specific Outcome-6 says that "State Newton's laws of motion and use them to analyze and solve conceptual and quantitative problems involving inertia, mass, weight, friction, and circular motion".

Using AI ethically to discern career pathways for students majoring in physics, engineering, and forensic science. The design is aligned with the following outcomes. The Course Specific Outcome-12 says that "Set up and solve problems using the following concepts and their application. Heat capacity, latent heat, thermal expansion, heat transfer". The Course Specific Outcome-13 says that "Use the kinetic theory of gases to analyze gas properties such as pressure, temperature, RMS speed, kinetic energy, and mean free path". The Program Specific Outcome-1 says that "An ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology".

The Assessment instruments have two perspectives, namely, expect what students can do and how to deliver as an instructor.

The "student to demonstrate perspective" is described below. (1) To demonstrate an ability in a test to write prompt submission to AI for a variation of input values with the corresponding output changes and to display the resulting trend in a graph. (2) To demonstrate an ability in a test to write prompts to AI to generate simulation codes and to display two random walk models with numeracy to support the understanding of diffusion theory of heat transfer. (3) To demonstrate an ability in a test to write prompts to AI to show career pathways requiring the use of AI analysis in STEM jobs.

The "how to deliver from faculty perspective" is described below. Assignment-1: how to write prompts to ask AI to solve some physics problems. Assignment-2: how to visualize random walk model with numeracy using AI-assisted coding to be part of the CUNY policy on "Writing Intensive plain English". Assignment-3: how to write prompts to ask AI to survey STEM jobs requiring AI-assisted coding.

VI. DISCUSSION

Some of the AI mistakes bear resemblances to students' mistakes, suggesting that some students were using a language approach when failing to follow the math derivation steps. Our assessment echoed the recently reported mechanistic reasoning and sensemaking results in the use of AI in physics pedagogy [3], with an emphasis in spatial reasoning which plays an essential role in the problem solving of rotational motion in daily engineering and technology examples. Our mechanistic reasoning is built on cause and effect, an alternative perspective to match our work to the reported sensemaking results [3].

There are at least two remaining questions: Can AI Large Language Models do spatial reasoning? There are diffusion models Generative AI for text to image technology. Can Computer Vision do spatial reasoning? The two answers of 'depend on the consumer markets'' seem appropriate in our opinion. The transformation of consumer products to become educational tools is what keeps sustainability.

The mimicking of human intelligence is artificial intelligence. Asking AI to transform a C++ program to a Python program in drone flight control is a shortcut when paying an AI subscription fee, from a student's perspective. The Python codes are more English-like when compared to C++ codes. For engineering and technology applications, MATLAB AI tools such as simulating sensors with neural networks are within ABET guidelines. Using neural networks for data fitting can certainly be included in physics labs as well. The MATLAB AI tools are natural extensions in lab automation environments, while AI Large Language Models can serve as a natural extension for learning conceptual physics that set the distinct equations. For instance, heat diffusion is first order partial derivative in time with random walk while wave equation is second order partial derivative in time with interference, both heat and wave equations share the same spatial dependence, a second order partial derivative in spatial variables.

VII. CONCLUSIONS

The paper summarized the AI Large Language Models as educational tools in physics pedagogy for STEM students. The first level of implementation improvs writing lab report narration. The second level of implementation builds up prompt writing skill using the Force Concept Inventory contents. The third level of implementation builds up AI Large Language Models with numeracy for trend prediction. The diffusion models Generative AI encourage physics pedagogy to include the discussion of heat transfer and diffusion. An understanding of AI technology will improve the AI-assisted pedagogy efficacy (That AI is not magic). Perhaps we could reduce the 14 labs in Physics One to 10 labs (minimum number of labs required by New York State Law), in support of the lecture materials; and transform the remaining 4 lab contact time for more detailed diffusion discussion.

ACKNOWLEDGMENT

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ChatGPT 4o mini ~ Let's go step by step to solve both parts of the problem 0 Part A: Atwood Machine with vertical weights Given Weight on the right side: W_{right} = 10 N Weight on the left side: W_{left} = 70 N · The pulley is massless, and friction is negligible. We know that the net force on the system causes the acceleration. The equation of motion can be written as: $F_{\text{net}} = (m_{\text{left}} - m_{\text{right}})g$ Where must and must are the masses on the left and right sides, and g is the acceleration due to gravity. To find the masses, we can use the relation: For both sides ≈ 7.14 kg $\frac{W_i}{g} \frac{\Phi}{2} = \frac{10}{9.8} \approx 1.02 \text{ kg}$ Message ChatGP1

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Appendix

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	$W_{\rm hell} = \frac{W_{\rm hell}}{10} = \frac{70}{10} = \frac{7}{10} \frac{1}{10} \frac$	
	$m_{\rm bh} = \frac{g}{g} = \frac{9.8}{9.8} = 7.14 \rm kg$	
	$m_{\mathrm{right}} = rac{W_{\mathrm{right}}}{g} = rac{10}{9.8} pprox 1.02 \mathrm{kg}$	
	Now, the net force on the system will be	
	$F_{ m net} = (m_{ m ieb} - m_{ m right})g$	
	Substituting the values:	
	$F_{\rm int} = (7.14 - 1.02) \times 9.8 \approx 59.88 {\rm N}$	
	This is the net force, and the total mass of the system is:	
	$m_{\rm intel} = m_{\rm inte} + m_{\rm intel} = 7.14 \pm 1.02 \approx 8.16 {\rm kg}$	
	Einsilv, we can calculate the acceleration of the votem value $\vec{F} = mc$	
	First 59.88	
	$a = \frac{m_{max}}{m_{max}} = \frac{1}{8.16} \approx 7.34 \mathrm{m/s^2}$	
	So, the acceleration of the system in Part A is approximately:	
	$7.34 {\rm m/s}^2$	
	Part B: 70 Newton weight on a smr. h hosizontal surface	
	In this case, the 70 N weight is now on a smooth horizontal surface, and the 10 N weight is hanging	
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62. ChatGPT 4o mini -		Con Line and
C character to think	Part 8: 70 Newton weight on a smooth borizontal surface	
	In this case, the 70 N weight is now on a smooth horizontal surface, and the 10 N weight is hanging	
	vertically. The key here is that the horizontal surface exerts no vertical force on the 70 N weight, so	
	the only force involved in the horizontal direction is the tension in the string.	
	We will follow similar reasoning:	
	 For the 70 N weight on the horizontal surface: 	
	$m_{\rm bit} = \frac{70}{9.8} \approx 7.14 {\rm kg}$	
	2. For the 10 N weight hanging vertically:	
	10	
	$m_{elght} = \frac{1}{9.8} \approx 1.02 \mathrm{kg}$	
	The force acting on the right side (the hanging weight) is just its weight, which is 10 N. For the left	
	side, since the surface is smooth and horizontal, there is no friction, and the tension in the rope provides the only force on the 70 N weight.	
	Let's analyze the forces:	
	+ For the hanging weight, the net force is $F_{\rm right} = W_{\rm right} = 10{\rm N}.$	
	- For the 70 N weight, the tension T in the rope provides a force pulling it to the right.	
	The tension in the rope is equal to the force a 👃 3 on the right side (the 10 N weight), so:	
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	Let's analyze the forces:	~~	2. 10.	
	• For the handing weight, the net force is $F_{\text{total}} = W_{\text{total}} = 10 \text{ N}$.			
	- For the 70 N weight, the tension ${\cal T}$ in the rope provides a force pulling it to the right.			
	The tansion in the rope is equal to the force acting on the right side (the 10 N weight), so:			
	T = 10 N			
	Now, using Newton's second law for the 70 N weight on the horizontal surface:			
	$T \sim m_{\rm intr} a$			
	Substitute the values for T and $\mathfrak{m}_{\rm lash}$			
	10 = 7.14 a			
	Solving for acceleration a:			
	$u = \frac{10}{7.14} \approx 1.4 { m m/s}^2$			
	So, the acceleration in Part B is approximately:			
	[1.4 m/s ²]			
	Summary of Results:			
	 Part A: The acceleration is approximately 7.34 m/s². 			
	 Part B. The acceleration is approximately 1.4 m/s². 			
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