# How ChatGPT Can Help Understand What Teachers and Scientists Don’t Understand: Physical Meaning in Modern Physics

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# Abstract

Modern physics often reveals a gap between mathematical formalism and physical meaning (intuitive picture). Students, teachers, and even researchers frequently manipulate equations as abstract symbols without fully connecting them to the real phenomena they describe. This paper investigates the potential of artificial intelligence (AI) systems, particularly ChatGPT, to serve as a mediator between abstract formulas and intuitive understanding. We present AI-driven methods for generating explanations at multiple levels—ranging from analogies and metaphors to formal reasoning—and demonstrate support for novel problem formats such as inverse problems and wordless problems. For researchers, AI facilitates the exploration of concepts with unclear or contested interpretations, including quantum states, dark matter, and the cosmological constant. For students, AI systems encourage movement beyond symbolic manipulation, fostering deeper conceptual understanding. Our experiments suggest that conversational AI can become a valuable partner in both teaching and research by revealing implicit meaning within physical theories and connecting mathematical abstraction with human comprehension.

# Keywords

Artificial Intelligence, ChatGPT, Physics Education, Conceptual Mediation, Mathematical Formalism, Inverse Problems, Wordless Problems, Educational Technology, Intuitive Picture

# 1. Introduction

Physics is simultaneously the most mathematical and the most conceptually challenging of the natural sciences. While mathematics provides the language of physics, the physical meaning (intuitive picture) of equations often remains hidden. This 'formalist gap' is particularly acute in modern physics, where quantum mechanics, relativity, and cosmology rely on constructs that lack intuitive grounding.

# 2. Background and Related Work

AI in education has typically been studied in areas such as adaptive learning, automated assessment, and intelligent tutoring systems. However, the interpretive role of AI in connecting mathematics with conceptual meaning has received little attention.

# 3. Methodology

ChatGPT was tested for its ability to explain formulas such as Newton’s second law, Schrödinger’s equation, and Einstein’s field equations across three layers: analogical/metaphorical, visual/descriptive, and formal/derivational reasoning. We also explored alternative problem formats such as inverse problems and wordless problems.

# 4. Results

Students reported greater confidence in connecting formulas to meaning, higher engagement with inverse and wordless problems, and appreciation for AI-generated analogies. Faculty noted that ChatGPT’s alternative framings sometimes revealed overlooked interpretive pathways.

# 5. Discussion

The role of AI as a mediator between symbols and meaning has implications for natural language generation, cognitive modeling, and educational technology. Limitations include occasional inaccuracies in AI output and the risk of overreliance by students.

# 6. Conclusion and Future Work

This study demonstrates that ChatGPT can help address a long-standing problem in physics: the disconnection between mathematical formalism and physical meaning. Future work will design structured pedagogical frameworks, test scalability across larger student groups, and explore cross-disciplinary applications.

# 7. References

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