

Mario I. Caicedo, PhD

Physics Teaching Philosophy

I am Mario Iván Caicedo Sandgren, a retired Professor of Physics from Universidad Simón Bolívar, an institution with a high reputation in Latin America. Over a 30-year career, I have taught and researched in four interconnected areas: theoretical and mathematical physics, mathematics, geosciences, and complexity science. For me, teaching has never been about the simple transmission of knowledge, but about acting as a catalyst for curiosity, critical thinking, and a genuine love for discovery.

My teaching experience spans all levels, from introductory calculus-based physics for engineers and scientists to advanced undergraduate and graduate courses in classical mechanics, electrodynamics, quantum mechanics, quantum field theory, relativity, and geometrical methods. I have also collaborated with geoscience colleagues, teaching elasticity, seismic data analysis, and wave propagation. Beyond formal instruction, I have mentored 38 undergraduate research projects, four Master's theses, and co-supervised two PhD students. I consistently guided them to present their work at conferences, often encouraging the students themselves to take the lead in explaining their results. This hands-on approach fosters independence, confidence, and a deep sense of ownership over their learning.

I strive to humanize science by sharing brief stories of the lives and times of the scientists behind the discoveries. Understanding that Newton worked in a very different world than Feynman, or that Curie faced enormous obstacles as a woman in science, adds a crucial layer of cultural and historical context. These narratives make physics more relatable and help students see themselves as part of an ongoing human endeavor.

A central focus of my teaching is addressing the preconceptions and misconceptions that often hinder learning in physics. Many students, like Aristotle, instinctively believe that heavier objects fall faster. Others are convinced that a vertically launched object has zero acceleration at its apex. To dismantle these ideas, I employ simple, playful in-class demonstrations—simultaneously dropping a backpack and a wallet, tossing a small rock upward, or timing a pendulum's swing. These activities spark laughter, surprise, and deep reflection, creating memorable “aha!” moments. I habitually complement these demonstrations with sketches and diagrams on the board, using geometric intuition to visualize vector fields, wave superpositions, or spacetime curvature, helping students build a robust mental model of physical phenomena. I also use carefully selected YouTube videos that showcase experiments difficult to replicate in a classroom, further solidifying conceptual understanding.

I endeavor to make learning a dialogue, not a monologue. Students are encouraged to ask questions at any time, because the only “silly” question is the one left unasked. I maintain an approachable and humble demeanor, ensuring that curiosity is always valued over mere correctness. While mathematical rigor and conceptual clarity are essential, I constantly connect abstract principles to physical intuition and concrete examples.

A pivotal moment in my teaching occurs in the second-year electromagnetism course. I deliberately elevate my students, introducing them to the profound depth of Landau and Lifshitz’s *Electrodynamics of Continuous Media*. I want them to feel the pride of working with graduate-level material, to stand on the summit of what theoretical physics can describe with its most powerful tools. They master the properties of ideal conductors and feel, rightly, at the top of their intellectual game. It is from this very peak of confidence that I then lead them to the cliff’s edge. I present a seemingly trivial problem: “Calculate the surface charge density on a perfect conducting sphere of radius 30 cm, charged with $q = -1.609 \times 10^{-19}$ C.” They apply the formula $\sigma = q/(4\pi R^2)$ with the assurance of experts. Only then do I ask the innocent, devastating question: “So, the electron has now become a ‘fat’ layer stretched over the entire sphere? Is that the image we accept?” The silence is profound. You can see the collapse in their eyes—the glorious summit crumbling beneath them. They have been thrown from the top of the world into the dirt and muck of a fundamental contradiction. “So... how is it *really* done?” they ask, their foundation shattered. My reply is a disarming laugh and a humble confession: “The truth is, I do not know. We have just brilliantly broken our own model.” This is where real science begins—not on the summits we conquer, but in the humble mud where we get stuck, pushing us to question, test, and unravel the truths of the physical universe.

Technology is a key ally in my pedagogical approach. In recent years, I have developed comprehensive GitHub repositories for course materials, exercises, and demonstrations, enabling students to engage with content asynchronously and interactively. I have also begun integrating AI tools to assist with complex calculations in advanced topics such as general relativity, demonstrating how modern technology can augment our capabilities while reinforcing, not replacing, critical thinking and deep conceptual understanding.

At its core, my teaching philosophy is deeply humanistic. I believe in cultivating empathy, patience, and joy in learning. A student’s frustration, anxiety, or mistake is not a failure but a vital part of the process. I work to create an environment where they feel respected, safe, and empowered to explore. I encourage them to connect physics with the wider world: history, art, philosophy, and the grand narrative of human understanding. All of this is done with humility, without pretension, with the sole aim of nurturing confident, curious, and

lifelong learners.

Finally, to summarize my approach, I maintain what I call a *flying checklist*:

1. Treat students with kindness and respect at all times.
2. Encourage questions and curiosity; the only silly question is the one left unasked.
3. Help students manage frustration and anxiety, guiding them to find joy in discovery.
4. Be accessible and approachable.
5. Combine rigor with intuition: in proofs and examples, connect abstract ideas with visual or concrete illustrations.
6. Provide notes before lectures and emphasize key ideas during class.
7. Go into technical details while maintaining perspective on the larger conceptual picture.
8. Lead by example, maintaining high standards without arrogance.
9. Utilize technology and open-source tools to enhance understanding and verification.
10. Design assessments based on understanding and practice, not extreme time pressure.
11. Make learning an engaging and joyful experience.

In summary, I view teaching physics as a privileged conversation across time and culture—a chance to engage with the elegance of nature, the ingenuity of the human mind, and the pure joy of discovery. It is a profound honor to guide students on this journey, and I hope to continue doing so in a manner that is both intellectually rigorous and deeply humane.



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