PHILOSOPHY OF TEACHING PHYSICS. **John Joseph M. Carrasco**

Main goal: TEACH ALL OF MY STUDENTS HOW TO IDENTIFY AND ASK THE RIGHT QUESTIONS. This is crucial for future physicists, obviously, but we also aspire to be teaching tomorrow's leaders in politics, in law, in medicine, in business, in engineering, in the arts, and the other sciences. It is an honor and a privilege, but even more so a true responsibility, to have the opportunity to inform the way my students question the world around them.

Why emphasize *questions* over answers? We physicists are famous for expecting to solve problems in domains vastly different than our own expertise. There is a reason for this: we learn to ask questions of a certain quality. At the end of the day we know plenty of people who are technically proficient and would find useful answers if only someone told them the useful questions. We want to teach people to be technically proficient and to know what questions to ask to get to the heart of the matter.

The *right* questions? Of course the appellation *right* is a loaded choice — any value judgement on the quality of a question must be — it presupposes a metric on interrogative space. I will assert it. We physicists have, at least in a certain heuristic sense, developed a knack for finding questions whose answers are *effective* for the relevant domain under investigation, but almost more importantly have the chance — the possibility — of being *universal* in some larger sense. As our trade is the real world, through the brilliance of careful experimentation we have the ability to probe idealized systems that can expose such *effective* truths. We have mathematics as our language, in all of its associated algorithmic consistency, without being slaves to mathematical pedantry[1]. Note the word *consistency* – this is huge, and we will shake the apparent firmament of our frameworks to extract consistency as seen in the revolutions of both Relativity and Quantum Mechanics.

Objectives:

- STUDENTS WILL UNDERSTAND THAT PHYSICS IS AN EMPIRICAL SUBJECT. Lab work is crucial to any undergraduate education in physics. As an undergraduate research fellow I worked with HEP experimentalist, Alan Weinstein, who taught me "every histogram has a story." These were no idle or trivial words. We could spend over an hour discussing a plot with uniformly flat bins, and every minute of it meaningful. Data is at the beginning and end of the questions we ask – it is the soul of physics.
- STUDENTS WILL LEARN TO CALCULATE. We physicists respect *calculation* and are rightfully suspicious of any line of questioning that can never ultimately affect the way in which we calculate. Applying the language of mathematics to physical problems is a critical part to learning how to identify fruitful questions. The most effective tool for encouraging the development of calculating muscles are well thought out and engaging assignments. These assignments executed on time, graded promptly, with pedagogic solutions, are crucial not only so I can know how my students are doing, but so we can all see what's working and what needs work.
- STUDENTS WILL LEARN HOW AND WHEN TO USE COMPUTERS. Students should be encouraged to develop familiarity with symbolic and numerical manipulation tools and realize the range of validity. Learning to ask the right questions so as to figure out how to break down a solution allowing a computer to find it, is an incredibly powerful way of

[1]Occasionally, I suppose, to our chagrin, but also, as Quantum Field Theory attests, to our incredible success.

exposing whether or not one has understood the key decision points involved in solving that problem.

- Students will develop the art of reflective play. Calculation is not the whole game. Building up intuition is critical to learning how to ask the right questions, and this requires the development of an important complementary skill-set: the engaged, considered, playful contemplation about systems. Kids learn to play good soccer by watching and playing with good soccer players. The same thing happens for all of us when it comes to playing with ideas. Physics lectures present an ideal opportunity for the type of guided *playful reflection* crucial to our field. Recitations and office hours are great opportunities for high-level interaction, but lectures are fantastic opportunities for engaged contemplation on the parts of students.
- Undergraduate students will be encouraged towards research projects. For undergraduates, even those who ultimately do not wish a career in academia, some of the best learning experiences will come about through undergraduate research. It conveys a sense of ownership of problems that can last a lifetime, and it provides real technical skills that tend to be useful in a variety of situations. My opportunities doing research as an undergraduate gave me the skills and perspective that made my career in industry incredibly fruitful, and my experiences in industry have left me in a remarkable position to be able to also mentor those who wish to pursue careers outside of academia.
- Everyone will have a place at the table. Many unfair environmental and cultural barriers have frequently blocked people of varying backgrounds / gender identifications / sexual-orientations / neuro-types from benefiting and celebrating fully the rich possibilities offered from being welcomed and nurtured by the field of physics, very much to the detriment of the field. I strongly believe in an inclusive discipline and that increased diversity can only benefit the depth and extent of our progress as a whole. It is not sufficient to merely be inclusive in the classroom, but part of my role in teaching is to ensure a safe engaged community amongst the student-body as well, and empower all of my students to expect such a space amongst their peers as well as figures of authority.

Teaching background: Having "grown up" as an undergraduate at Caltech, a very collaborative environment, I am fascinated by the possibilities of fostering peer-learning / "agile" cooperative scholarship (pair note-taking in class, peer-editing of assignments, virtual scrums to supplement recitations). I have lectured recitations for many undergraduate level courses while a Ph.D. student at UCLA. As preparation for this I took part in the training course the UCLA physics department offers all teachers and teaching assistants. I prepared and delivered an advanced course as invited lecturer to the 2012 Arnold Sommerfeld School at LMU Munich. Recently, this past summer, I offered a series of lectures for advanced graduate students and postdocs at Theoretical Advanced Study Institute in Elementary Particle Physics (TASI) 2014, in Boulder, CO.

Summary: I am a passionate believer in questions, and respect students ability to learn how identify and chase down fruitful ones. I am excited to join a department that supports and encourages engaged innovative teaching.