III. Teaching Philosophy of Dr. Mikhail Kagan

"It is impossible to teach, it is possible to learn…"
(unknown author)

I see my aim, as a teacher, to excite my students' enthusiasm for scientific discovery, to make them eager to learn and explore, and to be there for them when they need friendly guidance from someone as curious as they are.

In fact my task is somewhat simplified, since many freshmen are attracted to science in general and physics in particular by popular books (such as the ones by Stephen Hawking) and especially science fiction movies and series. They are very curious about the Big Bang, Black Holes, and Worm Holes; they are intrigued by Quantum Mechanics and the Theory of Relativity and by the remarkable successes of modern technology. What "remains" for me to do is to sustain their interest and not let them get bored on their way from the introductory physics courses to the pillars of modern science. Towards that end I demonstrate, whenever appropriate, how ideas they are learning can be applied to higher level courses. For example, I motivate them to learn the basics of relative motion and the concept of inertial frames by discussing the twin paradox and Einstein's elevator. For a number of years, I have also talked about black holes when studying Newton's law of gravitation and the concept of escape velocity. There are surprisingly quite a few facts from "fancy" science which can be explained without too much complicated mathematics.

At the same time, my ideal (freshman-) student is not necessarily a well prepared, highly motivated one. He or she is the one who is not afraid to say "*I do not know*" and is willing to learn and understand. Needless to say, it is my responsibility to create a friendly atmosphere, encouraging critical thinking and granting everyone the liberty of expressing their opinion whether or not it is shared by the majority and/or by me.

The most important thing that I convey to my students is that scientific knowledge is not a mere collection of facts. The integral and the most important part of science are methods, ways of thinking. Moreover, the structure of physical knowledge is *not* quite tree-like, where theorems branch out from lemmas which, in turn, stem out of axioms. It rather resembles a highly interconnected network, a *web of knowledge*, whose nodes are facts and ideas from a scientific field joined by links of methods, which are, in turn, connected to facts and ideas from other fields by yet more generic methods and ways of thinking. Enrico Fermi once said: "Never underestimate the joy people derive from hearing something they already know." I have made it my recipe. I meet my students at a familiar corner of this web and we wander together around to the nearest sites probing the ground of methods applicable at that place and then take on an exciting journey to an uncharted site.

Students are actually quite equipped for the journey. They are 18-19 years old, so they ought to be already experts in something, perhaps not in physics yet. The first week of classes, I conduct the "Expertise building activity". Students are asked to form groups based on their area of expertise and discuss what it took them to develop mastery. After that each team should explain it to the other teams, non-experts in their field, how to achieve success and how to handle failure. At the end of the activity we summarize what is common in becoming an expert cook, dancer, athlete or video gamer, and discuss how those strategies could help them to succeed in college and particularly in a physics class.

This *transfer* of expertise, the very ability to use their skills in a new context, to apply their classroom knowledge to real life is most valuable. This is exactly what scientists do on an every day basis. So in order to help my students to be successful in physics, I teach them how to think like physicists.

In fact, student centered education is not about teaching. It is about learning. Early on in my teaching career, I used to ask myself: "How do I excite and motivate my students?", "How do I help them master good learning strategies and be successful in the class?", "How do I assess if they really know what I think they do?".

Nowadays, I would paraphrase the questions: "How do I make students enthusiastic about the class so that they can motivate themselves?", "How do I help them use the (learning) strategies they already know to be successful in something else they do?", "How do I teach them to self-evaluate, to tell if *they* know what they think they do?". In essence, "How do I teach them how to learn and how to teach themselves?".

Finally, students whom we teach today and who will graduate tomorrow will become the most active part of our society, a society of those who will have some understanding about the importance of the existing educational and/or research disciplines, and will favor some of them over others. And, after all, it is society who decides which areas are their main priorities and whether science deserves further support. With that in mind, I strive to make sure that my students realize that physics is an inalienable part of the interests of modern society.