Virgil Pavlu

Teaching Statement

-read closely, as this is not the typical "I use the board" statement-

PHILOSOPHY

Knowledge is freedom. I find that people are often naturally insecure and seek reassurance from each other; this makes us vulnerable to propaganda, in a broad sense: if the average Joe has no stable inner belief, he eagerly fills up the emptiness with whatever ideas happen to gain popularity first; but once he has a belief, it is one intrinsically hard to change. This "blindly follow the leader" attitude is so deep built into our nature, that we see instantiations of it ranging from great achievements to individual contradictions and history-wide disasters – and the disasters all have the same principal cause: *ignorance*.

Uneducated *Joe* cannot let go of his ossified ecosystem of values; sometimes contradictions are too strong and the ecosystem collapses out of frustration, leading to depression, broken families, misery. Hence the parental intuition that *education* is perhaps the sole defense against our insecure nature.

"I have a dream". The first purpose in being educated is the development of ability to reason and thus to adapt to change - too many teachers and parents, too often, forget this. Knowledge cannot make Joe smarter in the sense of multiplying numbers faster; it can, however, teach him to use a computer to multiply numbers *much* faster. Passing this stage, Joe is not insecure anymore; people know his name, *Johann*; he found a path of prosperity for himself, family and community - he is *happy*. The teacher must ensure that every Joe leaves the class a Johann, if at all possible. The students with difficulties at learning are easy to spot; they need extra attention, more examples and less expectation on theory. I think these students are the main part of the teaching job, because the other students might end up getting the material anyway, while the plain Joe will fully depend on the help from the instructor.

Next step is being able to learn alone, which is the critical turning point of not being average anymore; instead the student is to become *Johann Friedrich*, a hard working citizen, *noticed* at his work place and in his town. For him, very-smart-and-uneducated means less than educated-and-not-very-smart, because the world has become very competitive: it is no longer enough to know, but he has to know well enough to be better than others. This is the type for whom I design my undergraduate class. I prefer top-down expositions so that students can always see the goal but sometimes I build up both from top and from bottom if I expect them to figure out the middle. Occasionally, I do a puzzle for fun. Weekly assignments are a given. It should be challenging and satisfying for Johann Friedrich to be my student: typically he complains for the first half of the course –"it is too hard"– and thanks me at the end –"I've learn more than in all other courses combined this year".

Johann Carl Friedrich Gauss dreams of finishing graduate school, the next level of education, and to become a professional scientist who will teach others and solve scientific problems for engineers, businessmen, lawyers and doctors; he will be *appreciated* for his service. Graduate classes should be designed for this type, with emphasis on how to approach problems. I find a good idea to show graduate students a hard problem, and then gradually introduce them to the material which allow them to tackle it. For undergraduate class, I take some of the assignments from the graduate class and make them into extra credit assignments; few students attempt them, but they usually need help.

At the very top, it is perhaps the creativity – more than knowledge or intelligence – that can make a world-class difference, but that is only because the expectation that, at world-class stage, knowledge and intelligence are a given. A rare combination of education, native ability, creativity and passion, makes sometime the scientist *excel* beyond his lifetime, with contributions to mankind for which history remembers

him simply as *Gauss*. Creativity needs to be educated too, and that is a near impossibility; as an educator, I can not be sure that there is a Gauss in my class, but I am going to do my best to help him spot himself. I occasionally discuss an open problem and the current state of related research, or a notorious difficult problem and/or a scheme for solution. I am proud to have been the teacher of one such student (also friend) at Dartmouth College, while being TA for the Algorithms class; most of the discussions we had were about other topics than the course: he was interested on research in Machine Learning. (A previous silver medalist at International Math Olympiad, he is currently at UC Berkeley for his PhD in Mathematics.)

Mathematics and abstractization are fundamental to science in general, and Computer Science in particular: they often make the difference between a good and poor student. While triangle geometry might never be used by Joe as mean to compute an angle, it will surely be useful sooner or later as a representation tool; as such, Joe needs to understand the logic of it more than he needs to remember the formulas. It follows that the teacher *must* know the logic and, equally important, build the course on it. This is the model I follow; here is such an example from the discrete math class I was TA-ing at Dartmouth:

show that:

$$\binom{n}{b+f} \cdot \binom{b+f}{f} = \binom{n}{b} \cdot \binom{n-b}{f}$$

There is an easy brute-force solution here (thats is, trivially manipulate the factorials to get the result), but this teaches students only that they should master algebra manipulations, without any insight of the mathematical fact. I explicitly state in the assignment that this solution is worth only 60% of the total points.

The solution I discuss is the following: Say I have n students and I want to pick f of them for the football team and b for the basketball team; how many ways are there to pick the two teams? Well, there are two ways to think about it : (1) I can first pick $b+f$ out of n as a big sports team, and then pick f out of the $b+f$ for for football and have the remaining b for basketball - this gives the number of possibilities in the left side of the equation; (2) I can first directly pick b out of n for basketball, and then pick f out of the remaining $n-b$ for football - this gives the right side. (1) and (2) are describing the same quantity and therefore are equal.

This solution is infinitely better for educational purposes than the brute-force one: it teaches students how to reason, it shows *the use* of combinatorics and it is *simple*. Moreover, it opens the possibility of discussing the concept of symmetry of variables: as a variation of (2), I may just as well pick f out of n students for football first and then b out the remaining $n-f$ for basketball, thus obtaining a third formulation of the same quantity, symmetrical of the right side in b,f.

I enjoyed great success as a teacher, especially in theory classes, I think because of my style of explaining the "inside mechanism" in a intuitive manner. At Dartmouth, students from the math class, specifically requested me next term as an unofficial teaching assistant [TA] for the Algorithms class, which basically ended up with me doing voluntary work for a term.

Mathematics is for computer science what shopping is for cooking dinner: no shopping translates immediately into no dinner. The idea that Joe can graduate as major in computer science without encountering elementary math concepts like greatest common divisor is complete nonsense. Since we are at it, why is it harder to compute angles for Joe in North American schools than it is for Sergey, Anca, Yitzhak or Li in other parts of the world, despite the western region being considerably wealthier and technologically more advanced? -Hence the U.S. massive imports of scientists and engineers from the East (myself included)-. Unless we really expect globalization to completely take over very soon, basic math education in the United States is in dire need for improvement. I am doing my part in class by going through all math required, even if it is a prerequisite for the course; however some students are too far behind - the real problem is at the high school level and earlier.

EXPERIENCE

Instructor of record. I frequently teach the *Information Retrieval* course at Northeastern University, for both graduate and undergraduate students. It is a somehow challenging class for students because it has a bit of everything: theory, programming, math, assignments, projects, and a final exam. Among other things, students build a retrieval engine, and come in contact with new technologies: foundations of World Wide Web, Google, spamming, tracking, text processing etc, which makes the class a popular pick. It is also a challenging class for the teacher, because of the vast amount of material covered and also because of the infrastructure needed for the students projects.

I am also the Instructor of record for the *Machine Learning* course since 2008. The course is about learning techniques (Decision Trees, Neural Networks, Support Vector Machines, Boosting, EM, Clustering, K-Nearest Neighbor, dimensionality reduction), focused on understanding what happens at each step of the algorithms. Students are required to implement themselves most of the techniques, to solve pen and paper exercises, and to work on a term project. Text: Duda, Hart and Stork "Pattern recognition" 2nd edition.

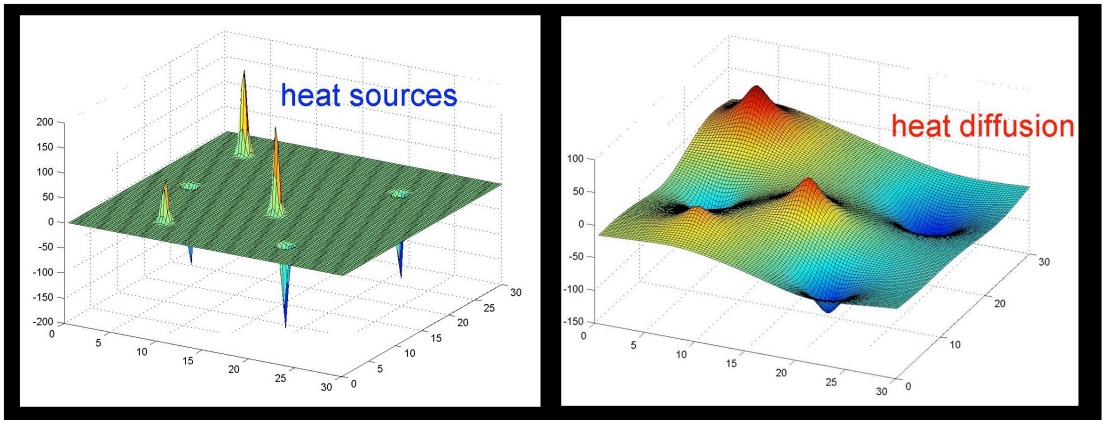
I thought several times the *Algorithms* Course (master level). Text: Cormen et all "Introduction to Algorithms", 3rd edition.

I have a overall rating of 4.1/5, which is higher than the college average.

Teacher Assistant. At Dartmouth College, I was a popular TA for theory classes (Discrete Math, Theory of Computation, Algorithms and Information Theory); my job was invariably the recitation, where sometimes I had more students than those who attended classes. I also TA-ed Computer Architecture. At Northeastern University, I was TA for all theory classes and Information Retrieval. In college, I was TA for introduction to CS and Lab Assistant.

Lecturing and presentation tools. Besides the my own lectures in the Information Retrieval course, I held several guest lectures in Discrete Structures, Algorithms, Machine Learning and Theory of Computation for other instructors. I had numerous lectures in the Algorithms and AI seminars and several conference talks.

I like using the board and chalk when *explaining*; I write in such a way that the current topic or problem is always visible. I prefer to use the projector when *showing;* I have to say that I enjoy preparing slides so much that I end up working on every single talk that comes out of our lab, and sometimes out of other labs; I even saw my slides in talks I was not involved!



Slide (Machine Learning) describing how heat and cold sources drive an equilibrium (view in color).

Math tutoring. I have been involved with teaching since high school doing private lessons for math exams (which are considerably harder in my native country than they are in U.S.). I continued in college, and also expanded to basic computer classes, as that was my main source of income. At some point in college I spent for several months working for an NGO in helping secondary school students with math.

Patience. I am a very calm person, and I think it's a good thing - I enjoy teaching and teaching requires a lot of patience. I live with four kids at home, ages 5 to 16, and so I have a lot of personal experience with youth development. In particular, I like to build a friendship type of relation with my students, so that we can talk about anything; I found that they become more comfortable this way, for a better interaction.

I am born in Romania, studied for the last ten years in United States, my best friend is from India and my wife is from Colombia. Among many differences (cultural or not), I learned that different people understand different things in different ways. Especially on face-to-face private conversations, I found that it is worth adapting to each student.

December 1st, 2010