

Teaching Philosophy

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Leaders of the American physics community are recently raising concern about a decline in US basic research.¹ With the future of ILC tenuous at best, the recent funding cuts and a recession crouching at the door of the US economy, particle physicists are bracing for more hard times ahead. Other fields such as condensed matter physics are also feeling the heat as China and many developing countries are catching up. As a point in case, China is currently leading the world in high temperature superconductor physics.² Better physics education is being advocated by leaders of American physics as one of the ways to arrest the decline of US physics. It is likely that physics education will receive more attention in the years to come.

Teaching is a complex human activity. A teaching style is the sum of a lifetime of experience. We mirror our teachers when we teach. My Ph. D. advisor was a good role model for classroom teaching. Good teaching skill essentially consists of detailed preparation for lectures, speaking clearly to the students, paying attention to blackboard etiquette, answering students' questions respectfully and most importantly writing reasonable quizzes and exam questions. Although good classroom teaching is easily managed, many physicists seem to ignore the obvious by focusing entirely on the cleverness of the content. Assuming that there will be a decline in physics, the number of students and postdocs will also decline. Before long, university administrators will pass edicts to raise the level of customer satisfaction. When that happens, physicists will have to function more like salesmen than coaches with the students. Coaches are more effective and efficient in controlling large classes and driving students to work. Salespersons use persuasion that takes time and effort. The demands on physicists in tomorrow's classroom will likely be much more severe.

Physics education is more than classroom teaching. It also involves hands-on training. For quite some time, many graduate students and postdocs have been burned under the old system. Graduate students and postdocs are utilized to provide labor to sustain the research enterprise. At the same time, they are also on the pipeline to become future competitors against their supervisors for prestige and research money. Shrewd supervisors will understand the strategic advantage of teaching graduate students and postdocs well enough to serve a purpose for a short time but not well enough to become a competition. As funding sources dwindle, these kinds of behavior will likely increase. If abuse widens, the number of graduate students and postdocs may further decline to drive the downward spiral of US physics even deeper. Integrity and collegiality are keys to gain trust. One sinner destroys much good. As we

¹ L. Kadanoff, "APS, physics: aspirations and goals," APS News, vol. 17, no 17, back page (July 2008, 2008).

² A. Cho, "New superconductor propel Chinese physicists to forefront," Science 320, 432-433 (April 25, 2008).

try to romanticize physics to our young people, we need to be beyond reproach in both our science and our character.

The reputation of the educational institution partially depends on the success of the alumni. Assuming that we have the best students undergoing the best training under the best professors, there is still a chance that these students will not succeed in finding permanent academic jobs in physics. Given the bleakness of the physics job market, we need to prepare our students for the rainy days by showing them options in non-traditional physics jobs. Most research physicists in the university do not have the expertise or the resource to provide hands-on training in non-traditional vocation *per se*. However a supervisor can still give general advice and send their students to job fairs. If the students are lucky enough to find academic jobs at the end, the process of vocational counseling is not wasted because they will need to repeat the process again with their own students when they become supervisors.

College is one of the most formative periods in the development of a student's soul and mind. Undergraduate students today are smarter but less focused. Since America has very good physicists and facilities, one would assume that the combination of smart undergraduates and a good environment will automatically produce the world's top ranking physics graduates. The irony is that foreign trained graduate students always seem to do better than their American counterparts. Physicists blamed the younger generation for not working as hard as the previous generations. Leo Kadanoff points to the 70's as the beginning of the decline of American physics. He attributes the fall to funding cuts and immigration problems but overlooks the cultural factors. The decline of physics began just a few years after the hippie movement in the 60's. Although not every physicist was a hippie, the universities were the home of both the physicists and the hippies. The hippie movement espoused personal freedom and an anti-government attitude. The anti-government stance of the physics community during the Vietnam War era reduced military funding sources to trickles. Personal freedom found formal expression in socio-political liberalism that is pluralistic, egalitarian and skeptical of traditional moral values. Liberal reforms in physics have done some good things in terms of recruiting more women and minorities but have also limited the pool of physics talents by failing to recruit from the conservative sectors of the American society. Foreign students in our physics departments are mostly conservative in education and social values. By being conservative, I refer to a respect for traditional values and the larger social organisms such as the state, society, religion and family. Unlike many American students brought up in the individualistic Enlightenment value, foreign students derive their strength from social groups. With the support of groups, there is more accountability and less burnout. It is not clear if it explains why so many foreign students seem to have an inexhaustible source of energy to accomplish more with less; but the plausibility is there. Strength is worth imitating but cultural values cannot be easily transferred. Nevertheless we can incorporate the principle of group psychology in an American setting to keep the undergraduate students accountable for learning. Students generally learn best from other students. We can certainly encourage students to work on

physics problems in groups so that they have a natural setting for mutual-teach. It is contrary to the old school method of requiring students to work independently. Another idea is to encourage more faculty-student interactions. Liberal arts colleges typically have high faculty-student ratios and are conducive to more faculty-student interactions. Experience shows that students learn better in this environment. Intensive faculty-student interactions provide another form of social support to stimulate learning. Unfortunately very few research universities can afford the economy of intensive faculty-student interactions. Instead undergraduate research can provide opportunities for undergraduate students, graduate students and postdocs to collaborate. A possible problem is that graduate students and postdocs are sometimes not interested in undergraduate students and vice versa. As in any corporate structures, there is always a bit of rivalry and personality clash of all those involved. Organizational problems occur in all the companies all over the world everyday. These problems have well known solutions. Principal investigators can draw from the experience of managers to build cohesion in their groups. A typical complaint of undergraduate research is that the undergraduate students do not know enough physics to do anything useful. Physicists usually gauge success by results. An undergraduate research project should not be considered a failure if it is not published in a peer-review journal at the end because the product is the person and not the research. In this case, success is measured by the undergraduate students moving on to graduate school and becoming productive physicists later on in life. One of the main goals is to minimize the feeling of isolation that is so prevalent in the American society that emphasizes individualism.