Secrets of Good Teaching

Edited by
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An Introduction

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Good Teaching as an Attitude

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Biotechnology

I never realised that the Best Teacher Award of our university for the year 2004 would predispose me to unexpected hazards like having to write this book chapter on science teaching. It is one thing to do well in one's job and be rewarded for it based on confidential student feedback forms, but it is a totally different thing to put in writing the principles of good teaching in a manner that others benefit from it. This is because, I have known some teachers who hardly teach anything in the strict sense of the term, but still manage to inspire learning in the larger sense. There are yet others who do a seemingly impressive job, and yet have little lasting impact on student learning, if one defines learning beyond what is measured in our examinations.

A teacher with the right attitude makes a lasting impact on student learning

In my own experience, there is no single technique of teaching that works well with all the people for all the subjects/topics at all times. If there is one thing that always works, it is the attitude of the teacher towards the students, the subject and most of all, the profession. A teacher with the right attitude puts students' learning as the ultimate goal and will mix and match all the available

tools and techniques to suit the teaching-learning process unique to a given subject or topic or class. Therefore, I decided to refer to some expert recommendations based on research in science education, and combined them with my own understanding and experience in teaching bachelors and masters level courses in modern biology and biotechnology since 1997.

Some good teachers may be born, but most of them are made, as products of a good teaching-learning process. This is because teaching is not a job but an inspired profession or passion. Even a single inspired teacher, whether at school, college or university leaves a lasting impression on the minds of students, not only in terms of the knowledge and training imparted, but also the values of teaching-learning and professional pride, and inspires a few students to emulate their teacher and take teaching as a profession. Therefore, good teaching is necessary not only to prepare students well for whatever career they choose, but also to inspire some of them to take up teaching profession. Somewhere down the line, when they also cultivate the right attitude towards teaching, they will not only combine the "dos" and the "don'ts" from the good and bad aspects of their teachers, but also add value with their own innovations and conscious efforts.

Some good teachers may be born, but most of them are made

It is critical to realise that the importance of good science teaching is not just limited to those students who eventually opt for science-related careers. A rational approach and scientific temper is essential for every citizen in today's modern world. In the words of Nobel Laureate Bruce Alberts:

> "All the rest will become the citizens who determine—by their understanding and appreciation of the nature and values of science—both the vitality of our nation and the future of our scientific enterprise. It would be fine if all Americans knew about plate tectonics or the way cells divide. But it is much more important that they understand what science is (and what it is not) and how its central values—honesty, generosity and respect for the ideas of others – have made possible the rationalisation of human experience that underlies all human progress".

This is the biggest challenge for good science teachers, as they have to balance the task of inculcating core values of science with the demanding routines of lectures, completing the syllabi and exams.

There is no doubt that the quality of science teaching as an inquiry-based learning process depends critically on the teacher's own experience with the processes of scientific inquiry. Unfortunately, Ph.D. is the only stage when Indian scholars truly experience this, but this does not mean that every Ph.D. makes a good science teacher. We often put up with Ph.D.s who can't even communicate their own research properly to their colleagues, let alone teach concepts developed by other scientists in a manner understandable to students. Deeper scientific knowledge and research experience are useful, at times even necessary (at higher levels of education), but not always sufficient for good teaching of science. The fact remains that teaching is a skilled profession, and a teacher with the right attitude can easily acquire these skills, with or without a Ph.D. or a degree in education. For example, an aspiring good teacher who does not have experience in scientific research can always get a feel of it by having a stint with some practising scientists.

Surveys among students often reveal that the characteristics of good teaching include the teacher's enthusiasm or passion for the subject as well as scholarship, rapport with students in and out of the class, ability to motivate and stimulate learning, clarity and organisation in presenting conceptual and analytical understanding of ideas, and the ability to provide intellectual challenges to students. Different teachers use different means to achieve them, but it is possible to identify some general teaching styles: *subject-centered teaching*, in which the course has a fixed structure, *teacher-centered teaching*, in which teacher adopts the most convenient mode of teaching that suits him/her, and *student-oriented teaching*, in which the learners' needs and the learning process define the whole style of teaching.

Good teaching is about passion for the subject, scholarship and rapport with students

All these styles may produce equally good results in terms of the students' performance in exams that test factual knowledge. However, *student-oriented teaching* in discussion mode often leads to better retention and application of knowledge

and its better application to other situations, apart from better motivation for further learning. Even if practical constraints force us to adopt different teaching styles at different times, it is useful to try student-oriented methods whenever possible. I have tried the discussion mode successfully in my classes on bioethics, bio-safety and intellectual property rights, especially since students tend to regard these subjects as peripheral to their learning needs in biotechnology. Discussions not only keep the students alert and engaged, but also improved their perception of these subjects and attendance in my classes.

Teaching through discussion leads to better retention and application of knowledge

The choice of teaching style depends critically on the intended learning goals. The current practice in the West, especially the US, is to clearly spell out the learning goals in the syllabi, in the text books as well as in the evaluation of students. While it may take time for these practices to enter the Indian educational routine, individual teachers would benefit immensely by asking themselves in advance: What do we want our students to learn in a particular course/ subject/topic/class? Are they concepts, factual knowledge, memory, practical skills, analysis, inductive or deductive logic, interpretation, problem solving, articulation, rational approach, team spirit, life skills or better citizenship.

As teachers we should ask ourselves what it is that we want our students to learn in our course?

All these goals are important for learning in the larger sense of the term, but most often the course requirements are such that some goals may be more critical or more achievable than others, or they may be needed in different combinations. A little advance thought on learning goals immediately puts the entire teaching plan and choice of teaching methods in context. For example, the learning requirements are best met when equations are solved on the blackboard, and when three-dimensional structures of biomolecules are shown as toy models or projected on a screen, preferably with animation. Similarly, a demonstration or simulation may help in understanding the underlying principles or methods, but hands-on experimentation is the only way to acquire the practical skills needed

to be able to carry it out independently at a later stage. In addition to learning goals and student needs, other factors that should be borne in mind while choosing teaching methods include student backgrounds, their prior knowledge, preconceptions and misconceptions, their learning styles, class size, infrastructure and logistics.

Teaching methods should suit students' backgrounds, knowledge, and learning styles

As regards good teaching practices, a typical class room lecture with the help of a blackboard is often the most convenient, time-tested and most practical method, but it can be converted into a good teaching-learning exercise with a few simple practices: Always plan your lecture in advance, make yourself aware of the students' prior knowledge and identify the major and minor concepts or learning goals and the connections between them to help you with the planning. Always begin the class with something familiar or important to the students.

Face the students and maintain eye contact, move around a little bit, speak loudly and clearly and vary the tone of the speech intermittently. Pause frequently and assess whether the students are in tune by asking questions or prompting them to ask, or involving them in discussions, using paradoxes, puzzles and apparent contradictions to engage students, especially the dull, distracted or naughty students. Focus on interactive learning, and never hesitate to say "I don't know", or "I wish I knew" or "We need to look that up—why don't you do that and tell us all in the next class?"

Teachers must maintain eye contact with their students

Also do not hesitate to carry the text book or your teaching plan to the class or to refer to them during the class. Never dictate notes or encourage students to note down your lecture verbatim, but tell them if you want them to note down something specific, and teach them how to make notes from books.

Plan the content and pace of the lecture keeping in mind the weakest student of the class without boring the brighter ones and vary the content and pace during the class if necessary. Use charts, models, transparencies, slides, powerpoint projections or videos wherever necessary and possible but don't become dependent

on them entirely (what if power fails?). Use the blackboard frequently, but only to write important terms, structures, equations, diagrams or concepts that you want to emphasise, but not sentences or paragraphs, and make sure that you wipe the board clean before and after the class. Always try and relate the lecture contents or examples from foreign books with examples from your own country or city, including linking them to daily life situations or reports from news media. Stick to the medium of instruction to the maximum extent possible and always encourage students to communicate with you in the medium of instruction (for example, English), but make sure you do not put off students who have language-related difficulties in learning or communication.

Plan the content and pace of the lecture keeping in mind the weakest student of the class

The main purpose of text books and audio-visual tools is to enhance learning. To that extent, use them as students' learning aids rather than as teaching aids for your convenience. If you are more specifically interested in instructional resources other than books, there are instructor's manuals, CDs and transparencies available for certain subjects, including biochemistry and molecular biology. A simple search on www.amazon.com will help you locate them, if your library doesn't have them. Avoid repeating everything in the textbook and leave something for the students to figure out, add your own insights from other books or your experience and make sure you are above the textbook in your students' perception. Always provide references or handouts in addition to the prescribed textbooks to encourage additional reading.

Add your own insights from other books or your experience to textual material

The use of audiovisual tools doesn't automatically improve learning, even if it makes teaching more convenient. Moreover, well-crafted presentations may run the risk of emphasizing the teacher's delivery rather than student learning. I have always preferred using the blackboard for its sheer simplicity and convenience, but have often felt guilty for not taking the trouble of making slides or transparencies. Once I offered to use transparencies or slides to enhance the pace of my teaching in a microbiology course to complete the syllabus in time, but

my students opposed the idea vehemently, saying that they are bored of some of their teachers copying entire sentences and paragraphs from text books onto transparencies and reading them out in the class. The students could not keep pace with the projections or take notes, nor did they have a feeling of communication with their teacher. I would have never used transparencies that way, but decided to go with the students' sentiments, as they agreed to attend extra classes to allow me to complete the syllabus at my own pace using the blackboard. This experience confirmed my long held suspicion and exploded the myth that teaching aids automatically enhance learning. After all, aids are only as good as the teachers who use them. Good teachers master their aids to enhance learning, and bad teachers become the slaves of their aids to cover up their deficiencies.

The use of audiovisual tools doesn't automatically improve learning

Good teachers use aids to enhance learning, not to cover up their deficiencies

If you want to use audiovisual aids as a good teacher, never produce entire paragraphs on your slides—only brief points and visuals like tables, graphs, photos, diagrams etc; don't darken the room as students can't take notes, never read from the slides or transparencies and never lose eye contact with the students—which means you should memorise what is on your slides/transparencies. If you are not sure about organising your presentations, do a google search on the internet to locate the faculty websites of the best known American or European universities in your subject, and browse your way to the presentation materials that many of their teachers make freely available on the web, but use them only as guidelines to design your own presentations in accordance with your students' unique learning needs.

The learning attitudes of students towards science depend not only on the preparation of their teachers, but also on the students own beliefs and superstitions. They can often be the biggest barriers to learning scientific concepts and even more importantly, scientific temper. The main difference between science and (religious or other) faith is that science accepts only what can be proven, but

faith demands you to accept everything that cannot be proven, without a question. But we often fail to convey this effectively to our students, which is one of the reasons why even some of our best science students do not necessarily rank well in terms of scientific temper. The general tendency to teach scientific concepts as a set of established truths makes them no different from socio-religious teachings of faith, unless teaching scientific truths includes giving a flavour of how these truths were established and others were rejected.

Students' attitudes towards a subject also depends on their own beliefs

The best way to teach scientific concepts is to focus on knowledge as an outcome of a process of inquiry, rather than just as a product. Even when we do this, we must remember that the learning of students may be impeded by their prior conceptions and misconceptions. Identifying them can help us in removing the barriers to their learning. They include *preconceived notions*, such as underground water must flow in streams because it does so on the surface; *nonscientific beliefs* such as creation as the basis for life and "dashavataras" (the ten avatars in Hindu mythology) as a proof of evolution; *conceptual misunderstanding* that arise out of a confusing mix of scientific concepts and prior notions, *vernacular misconceptions* that arises from the use of terms that mean one thing in science (for example work as in physics) and another thing in daily life; and *factual misconceptions* that are based on falsities learnt during childhood but retained unchallenged into adulthood.

The best way to teach scientific concepts is to focus on knowledge as an outcome of a process of inquiry

Knowing our students and their attitudes to science can tremendously enhance the quality of our teaching. Remembering the names of all the students, as well as having an idea of their socio-cultural and other backgrounds is of immense help in building the right level of rapport needed for an effective teaching-learning process. I haven't been very good at remembering names, but I try to ensure that it doesn't come in the way of building a good rapport with my students, at least till I improve on this count. If you are teaching in a metro city, it is also important to remember that the students in your class tend to be from diverse cultural,

religious, linguistic and socio-economic backgrounds and that there can be different barriers to teaching and learning among different students. For example, it is a common misconception (among teachers and students alike) that assertiveness, outspokenness and competitiveness are indicators of a students' interest or mastery of the subject, and *vice versa*. These are often conditioned by upbringing, but can be changed by a perceptive teacher.

Make efforts to build a rapport with students

In our intense preoccupation to teach our own subject well, we often also overlook the students' overall understanding and attitude towards science and scientific activity. It may be very useful to occasionally seek answers from students to questions such as: What is science? How do the scientists do it? What is meant by scientific thinking? How do scientists test the validity of their work? How do scientific discoveries or scientific thinking help (or harm) society? How do scientists help protect society from the abuse of science or technology? Some of their answers might surprise you and prompt you to rethink the way you approach your teaching of science.

Also take frequent informal feedback from the students regarding the subjects you teach and your teaching style and use them to introduce changes in your teaching methods. At the end of each course, ask yourself simple questions like: How satisfied am I with this course? What are the strong points and weak points of this course? What did I find most interesting and most frustrating about this course? What would I do differently if have to teach this course again? Also take a formal feedback from students based on a suitably designed and confidentially administered questionnaire in the middle or end of the course. The questionnaire that I have designed and used in the last few years is provided for reference.

Take formal and informal student feedback frequently

Finally, it is extremely important to recognise that good teaching by an individual teacher is just one of the many links in the overall system of education, lest we blame teachers for everything that is wrong with our education. It also

depends on a whole gamut of systemic issues including educational policies, recruitment and faculty development programmes, good administration, infrastructure, curriculum, teaching aids, fee structure, examination learner-friendly environment and the attractiveness of teaching as a profession.

I took to teaching profession by choice, leaving more glamorous and better-paid jobs in the industry and media. I have no regrets for my career choice, but I am pained at the declining popularity of teaching as a profession, not only among the students that we produce, but also among parents, scientists, society, and the government. The teaching profession today attracts only those who have missed all other "better" opportunities in life, and is increasingly mired in bureaucratic controls and anti-education concepts such as "hours" of teaching "load", "paid-by-the-hour", "self-financing" courses, "contractual" teachers etc.

With privatisation reducing education to a commodity, teachers have been reduced to tutors and teaching has been reduced to coaching. The consumerist boom and the growing salary differentials between teachers and other professionals, and the value systems of the emerging free market economy have made teaching one of the least attractive professions that demands more work for less pay. Yet, society expects teachers not only to be inspired but also to do an inspiring job! Therefore, aspiring good teachers have the added responsibility of asserting the value of their profession and the importance of other inputs that make good teaching possible. It is also equally true that if our teachers don't react to politicians playing with our courses or projecting astrology as a science (just to cite an example), it doesn't matter any more whether they are good teachers. Therefore, good teaching is not just a recipe of do's and don'ts, but an attitude and once you acquire it, it reflects itself in many ways, both inside and outside the class.

Good teachers have the added responsibility of asserting the value of their profession

STUDENT RESPONSE SHEET FOR N RAGHURAM
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Instructions: This response is meant to be confidential. Please answer all the queries honestly and objectively, and mark 'NA' if not applicable. Thanks for your cooperation.

Course Particulars:

Course code & Title	Theory / Practical	B.Tech / M.Tech Semester	Academic Year

Student Response

1. Approximate % syllabus covered in the class:
   a. ~100% b. Above 75% c. Above 50% d. Above 25%
2. Compliance with the no. of teaching hours allotted and actual hours taught:
   a. ~100% b. Above 75% c. Above 50% d. Above 25%
3. Were the lectures usually relevant to the actual syllabus:
   a. Yes, quite b. Adequate c. Sometimes d. No
4. How did you find the pace of teaching?
   a. Just right b. Too fast c. Too slow d. Uneven
5. Clarity of speech:
   a. Quite clear b. Somewhat unclearc. Variable d. Not clear
6. Logical flow and continuity of thought and expression
   a. Good b. Adequate c. Variable d. Poor
7. Organisation of lectures in terms of content, preparation and depth
   a. Good b. Adequate c. Variable d. Poor
8. Use of blackboard and/or teaching aids:
   a. Adequate b. Too much c. Variable d. Too less
9. Did the lectures generate enough interest and help in developing new concepts?
   a. Always b. Often c. Sometimes d. Never
10. Balance between basics and latest advances in knowledge
    a. Adequate b. Often too basic c. Often too advanced d.Uneven
11. Balance between concepts and the methodologies behind them
    a. Adequate b. Often too basic c. Often too advanced d. Uneven

12. Were questions encouraged in the class?
    a. Always b. Often c. Sometimes d. Never
13. Readiness, honesty and accuracy in handling questions in the class
    a. Very high b. Adequate c. Variable d. Poor
14. Was the teacher readily available for interaction/guidance outside the class?
    a. Always b. Often c. Sometimes d. Never
15. Were reading lists / references provided in the class?
    a. Always b. Often c. Upon request d. Never
16. Were the suggested reading materials accessible/available and useful?
    a. Yes, always b. Often c. Sometimes d. Never
17. Do you think attending these lectures will help you to tackle your exams and fulfil your career goals?
    a. Yes b. Often c. Sometimes d. No
18. How do you rate your own attendance in this part of the course?
    a. ~100% b. Above 75% c. Above 50% d. Above 25%
19. What proportion of the allotted practicals was actually (and effectively) conducted?
    a. All b. Most c. Some d. None
20. Was the teacher available, helpful and useful in enhancing your practical skills?
    a. Yes, always b. Often c. Sometimes d. Never
21. Overall, how do you grade the relative teaching performance?
    a. Excellent b. Good c. Fair d. Average e. Poor

Course Design Feedback

22. Was this part of the course relevant to your concept development and career needs?
    a. Yes, quite b. Adequate c. Sometimes d. No
23. Were this set of practicals relevant to your skill development and career needs?
    a. Yes, quite b. Adequate c. Sometimes d. No
24. How do you rate the overall content and structure of this part of the curriculum?
    a. Excellent b. Good c. Fair d. Average e. Poor

(*Nandula Raghuram is currently a Reader in Biotechnology in GGS Indraprastha University, Delhi He had a stint in industrial R&D and science journalism before joining as a lecturer in the University of Mumbai. He received the Best Teacher Award in 2004. He can be contacted at raghuram@ipu.edu*)