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How to teach?

I was asked to share my experience and observations as a teacher. I chose to document these as an attempt to answer the question, "how to teach". The answer that I ended up with is, "*I don't know; one has to figure this out by oneself*".

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Based on my experience and observations as a teacher, answering the question "how to teach" is somewhat like answering the question, "how to make dosas": at a coarse-grain level, it is all the same. No, I don't mean to say that teaching is same as making dosas! At a fine-grained level, there are different ways to teach just as there are for making dosas. Let me set aside the dosa analogy for now.

Answering each of the four interrogative words what, who, whom, and why leads to a set of factors that determine how one may teach. The "who" (teacher) has to customize the teaching method depending upon "what" (subject+), "whom" (taught), and "why" (purpose). Obviously, the four aspects are interwoven with each other.

The "what"

- Subject viz., programming language, quantum physics, organic chemistry, analytical techniques, economics, design thinking, etc. Relative to each other, some are abstract. Some may be easily related to, based on day-to-day events and experience. Some are rather hands-on. Note that demarcation is not always clear.
- Emphasis – this is related to the subject and multi-faceted. I have chosen three subjects randomly to illustrate this point. One facet can be concepts and their manifestations as while teaching physical chemistry. Another can be 'information' which one ought to know, not necessarily learn by rote (e.g., as in organic chemistry). Emphasis ought to be on patterns and common themes that underlie such 'important-to-know-information', as well as on conveying how "knowing such information" helps. Yet another facet can be exposure

to nuances by considering a wide variety of case studies, experiments, data, problem formulations, etc. (e.g., as in analytical chemistry).

- Means and ends: a mathematics course may discuss proofs to theorems, which, by themselves may have limited utility... but discussion of how to prove will hone the skills required to approach problems of similar kind. How to approach is important; not the solution per se. Other examples include interpretation and limitations of data from techniques (analytical, preparative, diagnostic, etc.), output from software, etc.
- Core versus elective courses: The curriculum [1] of an academic program consists of core courses and elective courses. Core courses lay the foundation for learning advanced topics. It is essential to "cover the syllabus" of a core course; here, "cover" means discussing all the topics in the prescribed syllabus without compromising on understanding.

  One can have the luxury of "uncovering the syllabus" while teaching an elective; here, "uncovering" means discussing in depth, dwelling at length on some feature (say, for example, lengthy "aalaps" by classical musicians), "showing off" one's expertise, etc.

  Note that cover and uncover may translate differently depending upon the subject.

The "whom" [2]

- Class size (from <10 to >200)
- Level of the course viz., undergraduate, masters, or PhD
- Regular [3] students or working professionals
- Heterogeneity among the students. Some of the reasons for heterogeneity are as follows:

[1] This and a few other points are included as footnotes merely because they are not DIRECTLY related to answering the question "how to teach". The curriculum of an academic program consists of a set of courses. Each course will have a syllabus which is a listing of topics to be learnt to gain exposure to the course (or mastery over the subject as the case may be). Curricula have to be designed such that they make positive difference to the student who devotes to the program considerable resources (time, money, effort, etc.) often in the prime of one's life. Unfortunately, in reality, design of curricula and syllabi often are faculty-centric: availability of faculty members to teach certain courses, and their willingness to teach, (lack of) understanding, and familiarity with course contents. Framing of the syllabus for a core course is especially important, both in terms of the choice of topics and the number of topics so that these can be taught within the time frame of, say, a semester.

[2] Leaving out KG to 12th grade. This segment is also important and challenges are different and manifold. But this is out of scope of this write-up.

[3] By regular, I mean, students who seek admission to an academic program without a break and are full time students.

(i) The level of preparedness of students admitted to an academic program is not commensurate with the pre-requisites for the program.[4] A similar situation may arise for an elective because a core course was not taught (well).

(ii) Choice based credit system and open electives give students freedom to choose courses across academic units – academic background of students varies consequently.

(iii) Some students are unable to cope with the medium of instruction viz., English.

(iv) Vast differences in intrinsic learning abilities, varying levels of interest in a subject (or course) or the entire academic program,[5] lack of discipline and commitment to studies (arising from a variety of present / past and domestic / personal issues), etc.

Our failure to acknowledge heterogeneity may be inadvertent or imposed by logistics. This leads to adoption of uniform teaching methods viz., discussing topics at the same level of complexity and at the same pace, allocating the same amount of time to acquire a skill, etc. This may lead to some students losing interest in the course after a few lectures/weeks.

The "why" [6]

- Give students an in-depth understanding of the subject or mastery of a skill.
- How to integrate a set of concepts to find solutions to societal problems or answer a research question, apply class room learnings in a field trip or industry set-up, etc.
- How to "how to think" irrespective of whether students wish to pursue an academic career, join an industry, become an entrepreneur, liaise with the government to provide solutions to societal problems, contribute to policy formulations, etc.

[4] This is a serious problem and reasons are many: incompetent and/or unprofessional teachers, emphasis on rote learning, inadequate exposure to hands-on component, lack of infrastructure, failure to acknowledge heterogeneity among students, marks (grade) inflation, overt and covert compulsions to pass all students, etc.

[5] Possible reasons: (i) could not find any other course in this time slot, (ii) merely to earn credits required to graduate, (iii) just want a degree certificate from the Institute, (iv) this is the only program for which the student could get admission, (v) what the student thought about the program is not what it actually is because curriculum is not in sync with the name of the program (in turn, because faculty recruitment is not in sync with the requirements of the teaching program), (vi) student did not have the wherewithal to make an informed choice while taking admission, (viii) curriculum is "theory-heavy" and not enough hands-on required to get a job, (ix) not able to handle personal problems (domestic, ability-aspiration mismatch, romantic, etc.), (x) others.

[6] Reasons from the perspective of the teacher are not a part of this section: I have to teach because I get paid a salary / want promotion, my HoD asked me to teach, I love teaching, I want to learn this subject, etc. Another factor that I have set aside is preparing students to do well in competitive exams like JEE, NEET, IAS, NET, CAT, etc.

- Acquire mastery of a skill e.g., preparing samples for acquisition of high-quality data, perform experiments such that results are reproducible, etc.
- Help “weak students” to cope with...

  By weak, I mean, weak in all courses (generally a slow learner) or weak in certain types of courses. Approach varies in these two cases.

The “who” [7,8]

- Mastery of the subject being taught. This is obvious: one blind person cannot lead another!
  (i) It helps if the teacher has at least peripheral knowledge of how the topic links with other topics, if what is being taught is in the ambit of an inter-disciplinary area.
  (ii) One may have to teach a course with which one is not familiar because the ‘system’ requires one to do so for various genuinely unavoidable reasons. Obviously, one has to put in a lot of effort to prepare for the course.
- The syllabus of the course, assuming that it is well thought out, provides the framework for the “content” for the lectures. Occasionally, within the norms of the Institute, one may have to slightly modify the syllabus because of issues touched upon in the “whom” section (see above).
- Curating the contents at the beginning of the semester: what to discuss, in which sequence, leaving out archaic material, etc.

  It may help to provide a brief historical perspective.
- Lecture-wise points:
  (i) Clarity of thought vis-à-vis concept to be discussed, problems to be solved and their solution, etc.
  (ii) Recap of what was discussed in the previous lecture (or, lectures)

[7] During the course of a lecture, we ask, “is this clear”, “did you understand”, etc., or say (and in fact, mean) “if you haven’t understood, ask; I shall explain again”. The response may be a nod of the head or silence. This does not (in fact, often is not) mean that the concept is clear. They may be too confused, hesitant, etc. Another related point is that student may understand the concept but may not realize how it manifests or know how to apply it to solve a problem. We may find this out by ourselves by posing a question to test the understanding of a concept and/or its application.

[8] Quality and commitment of teaching assistants play an important role while teaching large classes.

- Speaking clearly and audibly, making eye contact, writing legibly, pausing at times so that they can go over the discussion in their mind and/or make notes, etc.

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Personal and behavioral attributes of a teacher

- Attributes that influence how students perceive a teacher but do not directly affect learning:

  (i) The dos and don'ts that we expect from a student when we are assessing them, as for example, in a seminar course or project presentation apply to us also.

  (ii) Students like an approachable and friendly teacher but might not understand the concepts; conversely, students may find a teacher intimidating but still get the concepts clearly.

  Being friendly ≠ Good teacher

  (iii) Humility to admit limitations e.g., not knowing the answer to a question (and devoting time to find the answer to be discussed in the following lecture).

  (iv) Acknowledging that there can be different perspectives in how a concept is conveyed, or solving a problem, etc.

  (v) Ability to create an atmosphere which allows students to express themselves.

  (vi) Discussing questions asked in quiz and mid-sem. examination, and handing over corrected quiz/mid-sem. papers within a reasonable period (say, a week or 10 days).

  (vii) Not repeating previous years questions, etc. Student volunteers maintain a controlled-access portal which has previous years questions of many courses. For some courses where questions tend to be repeated, previous years question papers are passed on selectively to juniors giving some an undue advantage.

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The rise and fall of MS-PowerPoint

- I began using MS-PowerPoint about two decades ago. It made teaching 'easy' – slides, once prepared, could be used year after year. Updating the slides was not mandatory. Less time for preparation and more time for non-teaching activities. Learning Management Systems (e.g., Moodle) made sharing slides easy.

- Even students found ‘it’ easy – they go through the slides just a day before the quiz or exam. They largely stopped referring to other reading material... questions outside of slides were deemed ‘out of syllabus’. Those who attend lectures could afford to be less attentive.
- I did not use slides for a couple of courses that I taught recently. I noticed that students are more attentive... During lecture, I paused now-and-then so they can take notes.

  I am not sure how this works if

  (i) there is no text book that one can follow page-to-page and

  (ii) the class size is very large.

  Students genuinely need some reference material for revision. There are no text books that I can follow page-to-page for the courses that I teach.  Biology is a happening field and we witness paradigm changes every now and then. So, it is essential to refer to original research articles and review articles.

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Teaching in the era of the internet

- From the perspective of teaching, my professional journey recently mimicked a snake and ladder game: I landed up at a square with a long snake and slid all the way down to the starting point. All these years of experience and observations of teaching seems to be of little use. Why so? Answer: internet!!

  (i) Internet is accessible, affordable, and laissez-faire! Students have access to ‘information’ (= knowledge, content, practice problems, etc.) pretty much free of cost. This was hard to get in the pre-internet era... books were expensive, some books were not easy to understand, no visuals, etc. We had to attend lectures to get ‘information’.

  (ii) I revered my teachers and blindly trusted them. I believed if the teacher said that a topic discussed in a lecture is important and did not ask why, where, or how it is (or will be) important. Nowadays, students are dismissive if they are not convinced of why or how what I discuss is important. They *think* they can get this information from the internet whenever they want (they may or may not).

  (iii) Large language models (LLMs; e.g., ChatGPT) have added a new dimension. It is possible to configure Perplexity (an LLM), even the free version, to search only ‘academic’ sources to answer a question – this ensures that the information it retrieves (or, uses to synthesize its answer) is based on peer-reviewed content.

- Is there solace? Yes...

  (i) I am not alone... the entire teaching fraternity across the world is grappling with these issues.

  (ii) The strength of a system (or, of an individual) itself turns out to be its weakness also. It may seem paradoxical but this is true based on what I have experienced so far.

  Most of the 'information' accessible on the internet is of short duration and addresses a very specific question or (a part of a) concept. While this is favored by students, it is not often easy to connect several pieces of 'information' to bring out the 'big picture'.

  Short duration of the video is its strength – because a typical student has very short attention span but the short duration is also its weakness – there is no scope to discuss the manifestation of a concept, how to link it with others to solve a problem, etc.

  (iii) The Teaching-Learning-Assessment (TLA) initiative launched a few months ago by our Institute has brought in some positive changes:

  (a) Infrastructure e.g., making class rooms amenable for group discussion.

  (b) Providing access to digital tools that are handy for collaborative learning.

  (c) Creating a platform where one can bounce off ideas + share experience.

  (d) The Parimal and Pramod Chaudhari Center for Learning and Teaching has launched few initiatives along a few verticals. Looking forward to re-calibrate myself.

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To teach or not to teach

- I devoted considerable resources (time, effort, money – quite handsome at that time considering our financial situation) to learn to play violin. It took me 2 years to realize that playing violin is not in me. I stopped. Fortunately, there is no compulsion for me to play violin. So, I need not and I do not.
- Back to the dosa analogy: I have seen, end-to-end, the process of making dosas. Many variants. Many times. Yet, I have never been able to make yummy dosas. I have accepted that it is not in me to make dosas, just as it is to play violin. However, there have been occasions when there is a compulsion to make dosas "for others". Then, I keep it simple, set the expectation bar low, and unabashedly admit that, "*I know this is not my forte, I am doing out of compulsion, I have prepared with all sincerity, this is the best I can do*."

It is necessary to acknowledge that not everyone is cut out for teaching. Some of us know our limitation. If there is no compulsion to teach, then all well (*no need to play the violin*). However, we have a compulsion to teach in our system (*make dosas for others*). We need to accept our limitation and try to do as good a job as we can.

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So, how do I go about teaching the course I have to teach in the next semester? Well, I don't know. I have to figure it out! Let me begin by answering "what", "why", and "whom"! And, try to design activities that are amenable for collaborative learning of concepts in this era of LLMs.

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