Education with a purpose

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During interactions with faculty colleagues and scientists at HCU, IISER and NCL Pune as well as other institutions where I have given lectures and attended conferences, I often hear the record playing, 'it's very difficult to get students to attend seminars; they are not interested in research; we were far more motivated in our times, etc.' This chain of events which repeats sometimes once a week, and more often at other times has prompted me to think – is the lack of interest among students due to inherent poor quality or a disconnect with the research they are doing? While the former factor may be a topic in itself to write about, I will stick to the second point here. My perspective on the matter is that students will be enthusiastic about research or for that matter whatever they are doing, if they resonate and ring with the rest of the ecosystem around them. If not, they see this as a drag which could reflect in the way they respond and what advisors perceive. I feel that the reasons to study (Ph D or even at B Tech/M Tech level) have changed and the faster our education system responds to the changing reality, the more connectivity we will see among student, teacher and research. In the present system, the students see little meaning in 'what after Ph D (or M Tech)' and hence treat it like a rote set of steps even as the generous fellowship system supports their living costs. It's time to carry out a reality check on the course study in terms of challenges, problems and goals which are more interactive for the student.

In the traditional system in which many of us grew up, we read a lot of material and subjects in order to 'dig wide'. The assumption was that, given enough of a breadth, the depth or focus will come naturally at some point. And it did for most of us. The present smart phone generation is impatient. Information that was available to us in fat encyclopaedia and journal stacks by hours of poring over library books is now available to GenX at the speed of texting. Rightfully so (and I vouch for it) they have clearer ideas of what they wish to do at a stage, which the old guard professors believe is ahead of time. The sense I get is – they have a clear idea of what they want (to read and do) and they will put in 200% of their mind and soul into it. Outside of this, they are pretty much disinterested. They will learn the peripheral knowledge and auxiliary feeds if and when they need and want it. They know where to find it. They have the luxury of getting information freely and easily, which we did not at the same age.

So the model I propose is that the traditional courses and disciplines be retained for continuity so as to have an order in the system. But the important decision of what to do is taken from menu options which are closer to where the students will land up after finishing the course, be it B Tech, M Tech or Ph D. So instead of choosing chemical science or chemical engineering, a student will select an area which drives his/her interest. For example, a B Tech student may want to work in fuel cell or biomass transformation or continuous processes (these cases are closer to my own discipline and experience and are used merely to illustrate the point). A B Tech who wants to specialize in fuel cell and get into the energy sector will do a heavy load of electrochemistry (so much so that even the neighbouring chemistry department may not be able to suffice the necessary course requirements) – polymers, materials, composites, device fabrication, energy management, membranes, etc. In the present system, such a student will first do a B Tech in chemical engineering or polymer science and then realize that (s)he still needs to top up on electrochemistry and device fabrication before (s)he can do a Ph D in fuel cell. Similarly a specialty leading to biomass valorization will cover a lot more of biochemistry and biopolymers than for an average engineering student. And a student of continuous flow processes will study almost 50 : 50 courses in chemical/mechanical engineering and chemistry/biochemistry. The point is that the student should be enabled with course work to reach the end goal of what (s)he sees in the horizon, instead of after reaching the finishing line (degree granting stage). In other words, we need to recalibrate the depth versus breadth spread to reach a much greater focus toward a specific specialization in the same time. Another advantage of the purpose or goal guided education system is that it will minimize the hard distinctions between say B Tech, M Tech and M Sc students. A student may choose fuel cell and energy topic in any of these courses and except for minor variations such as more engineering focus for B Tech/M Tech versus more of chemistry and materials for M Sc student, the skill sets to work or pursue further in the given sector will be comparable. The Ph D research will then be driven by the specific gap to find a novel innovation in fuel cells based on the existing state of the subject. So the student will have a greater 'skin in the game' as (s)he pursues his/her research. Before I finish this point, I will add the last example from my own area of organic chemistry. Today an organic synthesis student learns all the principles of reaction mechanisms and chemical synthesis only to find that (s)he has not learnt enough of pharmacology and medicinal chemistry or process and flow chemistry to be ready for a professional job.

Having stated what to do, I will touch upon how to do it. Lest the inertia of the system gives this idea a burial before birth, I will answer the following FAQs in a line or two. (1) Should students commit so early in their life and select clear cut options so soon without sampling the whole space? Charity begins at home. Convince your own teenager/adult child on this and then I will be happy to share my reasons. (2) Would many courses and electives make teaching classes impossible? With MOOT/MOOCs and credit transfer options, with an equivalent university/institute, this is not an issue. (3) What about students who have not decided and want to study in the existing course options? The new system can ride on the present model and both can co-exist. Just like cell phone to smart phone transition, over a period of time there will be more students in the latter category than the present one.

The fourth question is a bit serious and I devote a longer explanation. How will students pick options that are in sync

with the reality of tomorrow and from where will they get this information and guidance? In the past this role was played by an uncle or a friendly neighbour who had studied in an IIT or was working abroad. Here are few suggestions I offer and these can be expanded over time. The NITI Aayog had published a vision document in April 2017 which lists several areas of relevance to the country. The National Policy on Biofuels was announced recently in May 2018. Such documents can be a repository for students interested in education guidance in graduate degree and emerging research areas. The second is connecting with industry. While a Ph D thesis topic may not be decided by the industry, the broad areas in which research will lead to applications and products for the country can complement the database. The third is to create a network of institutes and universities together with the national and strategic labs (CSIR, DRDO, ICAR, DAE, ISRO, etc.), so that problem statements which are part of the Invent, Innovate and Manufacture in India missions of these departments are shared with the next generation of students at IISc, IITs, IISERs, NIPERs, NITs, Central Universities, and others. In case of gaps on future ideas, I am confident that the coaching classes and web based tools will quickly fill in the vacuum once the model sets in.

To summarize, the navigation map needs to be adjusted with the goal post at the early/middle stage of the journey rather than towards the end of the road. Chemical sciences and chemical engineering are undergoing a transformation and paradigm shift to serve the human planet for the next 50 years. The sustainable development goals provide an arrowhead of focused research for students. The proposed changes in the subject and discipline based education system (from UG to Ph D) will transform our thinking to problem solving drivers which will enable skilled manpower that is ready to tackle the current and future challenges. A sketch of this higher education model was presented at the Research Scholars' Symposium in the Department of Chemical Engineering at IIT Bombay on 18 May 2018 in the talk entitled 'Sustainable chemistry and chemical engineering in a circular economy'. I surmise that many of us are aware of the fast changing reality in the university system globally and admire it from a distance. It's time we pivot our education system to prepare students who are empowered to light the bright future of a self-reliant India.

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