Interplay of Teaching and Research

Universities are the 'custodians of formalized knowledge' of societies. As custodians, they receive and maintain the knowledge that gets generated in other segments of the society, and, generate knowledge on their own. Thus societies expect them to track, receive, validate, maintain, generate and transmit knowledge. A university environment is thus geared to do all the above functions pertaining to knowledge. Different universities, in different geographies and epochs, have given different weightages to the above functions – based on the societies' demands of them.

Specifically talking of the Indian universities that got established in the colonial era, their primary goal had been to provide English-literate manpower with competencies to run the bureaucracy of British rule at different levels of hierarchy. To train independent thinkers, critical thinkers, scientific thinkers was not the main objective of setting up of these universities. Consequently, the universities were more geared towards administration and evaluation of remote students that actually studied in colleges affiliated to the university. This was quite in contrast to their contemporary 'western' universities – both in composition and purpose. Only non-British Indian universities like Aligarh Muslim University and Banaras Hindu University were conceived differently - both in composition and purpose. Without getting into historical details, suffice it to say that Indian universities started on a non-level playing field vis-à-vis their 'western' counterparts, against whom they were to be judged in times to come (in the post-independence era).

Post-independence, India had the aspiration to compete at the global level. However, its universities were not designed for that purpose. Repurposing them was not easy, given their established culture. So, a slew of new 'institutes' were created in the domains of science, technology and management, whose job was to create manpower with competencies in these domains in order to modernize to and run an industrial economy. Since this was largely a green-field project, the new institutions were geared towards quality undergraduate programs, with the expectation to start postgraduate and research programs in future. Independently, a range of research laboratories were simultaneously created to exclusively pursue research (mostly in applied areas and strategic areas) in a bid to quickly ramp up the research capabilities in the country, which was seen as an economically more efficient way to promote 'useful' research. It is only during the last 10-15 years that India started benchmarking its universities against their global peers and started calling into question their relative laggardness – particularly in the matter of knowledge generation and support for innovation. That is the juncture we are standing at today. (Continued...)

The New Education Policy 2019 envisages that higher education institutions will be restructured into three types: (i) research universities, focusing equally on research and teaching; (ii) teaching universities, focusing primarily on teaching; and (iii) colleges focusing only on teaching at undergraduate levels. This would bring Indian higher education institutions much more in line with their counterparts in the rest of the world.

Meanwhile, we need to recognize the changing nature of research itself. One always has had, and will continue to have, Ph.D. research: research conducted by students during their formal training as a researcher in a university. But beyond that, research has expanded into major research programs, based on networking of researchers, to enhance fundamental understanding of major issues of contemporary interest that call for interdisciplinary approach and large scale coordinated efforts. Similarly, large scale research programs to solve industrially and societally important problems have become a new norm. Both these kinds of research receive major funding from government agencies. To add to the above are industrially funded / end user funded research programs that look for the solution of narrowly defined specific problems of direct (and mostly immediate) industrial / end user interest, in a time bound manner. Thus universities and university faculty now have a range of choices for their research engagement - based on their readiness, preparation and orientation, beyond their Ph.D. research programs, often integrating Ph.D. research programs into these larger efforts of research.

Universities as custodians of formal (organized) knowledge and its disseminators have two ingredients going strongly for them in their role as knowledge generators: (i) faculty who are well versed in existing knowledge (ii) young students with fresh and inquisitive minds who can bring fresh ideas, approaches and immense dynamism to the research table. However, plugging these resources into viable research efforts requires strong awareness of important contemporary issues, efforts and approaches to solve them, and building strong connections to knowledge networks that are trying to solve them. It is here that the ingenuity, keenness, enthusiasm and persistent efforts of individual faculty and faculty groups begin to make a difference. Research oriented students naturally begin to gravitate towards wherever such environments are spotted, strengthening those environments further. Funding for large programs also starts gravitating towards them as they begin to get recognized as centers of excellence among students and peer groups. Existence of such groups gets the university better noticed by peers, students and the public at large. Thus efforts in this direction naturally get appreciated by the universities.

A term often used with reference to university research is "research of academic interest". Most professionals in industry take that term to mean a research of no industrial or practical value (and probably of not much value otherwise also). While this may be an uncharitable view, it is also true that often enough research problems get chosen that are on the margins of the value spread of the spectrum of investigations being carried out. This happens due to weaker connectivity with the knowledge frontiers and/or due to lack of research facilities or due to tendency to stay in one's comfort zone. All these challenges are common among developing societies that provide limited resources for research and expect inordinate results in quick time. So, what can individual researchers do to improve the quality of their research under these limitations? It is here that the virtuous cycle of research and teaching can help. Faculty can move swiftly to sharply identify the emerging knowledge trends and float advanced courses on them for post graduate students and researchers (also open to senior under graduate students). It does not matter that the faculty herself is not yet fully prepared to launch that course; it must be initiated and knowledge consolidated through, initially UG and PG research and then launching of Ph.D. projects. It is fundamentally important that university faculty choose areas of central importance to contemporary societies – not just push along the tracks of research they had themselves inherited and treaded. Building up of these new areas, usually multi or inter disciplinary may take the faculty out of their silos and into unchartered waters, but that is where the new knowledge treasures are likely to be found. Besides, this immensely helps the up-gradation of our courses and introduction of new courses in our PG / UG curricula, keeping them modernized for the times. (Continued..)

....Not un-often even intra-disciplinary approaches and collaborations can lead to new knowledge generation or to an application's solution.

Beyond its classification as fundamental or applied, research can also be looked at from the point of view of development of 'models' and 'methods' or application of 'models' and 'methods' to solve problems of societal interest. While the development of 'models' and 'methods' fall more into the regime of fundamental research (where the audience is one's professional peer group, and outlet is a research publication), their applications fall in the category of applied research (where the audience also includes industry, and the outlet is a prototype). A deep conceptual understanding of one's own domain together with a spirit of 'creative exploration' of its applications in other domains has been the moving force behind the development of new models and methods. 'Imaginative explorations' to harvest combinations of the existing models and methods for practical / industrial / societal applications has been at the core of applied research. These have often involved a cross fertilization of ideas across disciplines, whose culture we need to strengthen going forward. A synergistic choice of newer topics for UG / PG theses / projects initially, floating of new consolidated courses based on them soon after, and launching of Ph.D. program in these new areas constitute the step by step process of seeding them in our environment. We then need to consciously make efforts to link up with (or be the nucles to launch) the major national initiatives in these areas for solving problems of industrial or societal-national importance. Researchers are explorers. And, explorers recognize no bounds or boundaries. In today's world it means creating / joining and working with interdisciplinary teams with a mixed bag of knowledge, methods and tools to uncover new knowledge, develop new methods and tools in order to harness the conquest of these new frontiers for common human good. In terms of engineering research in particular, a prototype needs to be demonstrated. Universities have the right ambient (in terms of manpower and environment) to conceive, explore and come to the 'experimental proof of concept' stage. However, before an industry could be interested in the work, a 'prototype' needs to be developed. Very often a 'proof of concept experimental demonstration' gets confused with the 'prototype'. That is not correct. A prototype is the next level of development from the 'experimental proof of concept' stage. A 'prototype' is a highly / or sufficiently optimized and engineered 'design' drawing on the 'experimental proof of the concept' demonstrated. This stage of work is best done by a research institution which has stable manpower for the purpose and better standardization of processes and equipment used for prototyping. Lack of this stage only means the existence of an unfilled yawning gap between the stage of university output and the stage at which an industry can pick it up. Experience has also shown that a perceived great output from university research may not get picked up by a R&D laboratory, if the R&D laboratory was not in the know of the investigations and their rationale carried out in the university. Since prototyping takes so much time and effort to build, R&D labs may not like to bet blindly on university research. Thus associating a R&D lab scientist (as a co-supervisor) with the university research and exploration can make for a smoother passage of the 'experimental proof of concept' to the prototype stage.

In conclusion, universities can benefit from the synergy between teaching and research by carefully crafting the pathways to deeper knowledge acquisition and generation through UG / PG / Ph.D. investigations in areas of contemporary interests. The industrial value realization of this knowledge (beyond consultancy) involves building partnerships with R&D institutions. Intra-disciplinary and interdisciplinary collaborations are necessary for continually working at the knowledge frontiers as they emerge.

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TLC Activities from September 2018 till May 2019

The fourth "Teaching Learning Centre" committee for Pilani Campus was formed in September of 2018 with Dr. Kaushar Vaidya as the head (more on TLC: https://www.bits-pilani.ac.in/tlc/Pilani/index-.html). With 10 members from 10 various departments, three senior faculty members as mentors, a research consultant from IIT Kharagpur and a few student volunteers, the new committee started working towards strengthening the work of the previous committees as well introducing new ideas/concepts to facilitate a greater learning environment through stakeholders' participation in Pilani campus. The following report gives a brief overview of all the activities that the TLC had undertaken from September 2018 till May 2019.

Invited Speakers:

☐ The TLC had its first guest speaker in Mr. Scott Hartley, a Venture Capitalist and author of the book "The Fuzzy and The Techie". He delivered a lecture to BITS students on "Human Skills in our Technical World" on September 10, 2018.

☐ Prof. Usha Subramanian from the Myanmar Institute of Information Technology gave a guest lecture on Saturday, 23rd February 2019 from 3 pm for an hour followed by a discussion. Prof. Subramanian, a BITS alumnus, and a former faculty at the Department of Computer Science in Pilani Campus, in her talk titled "Teaching and Assessment - Experiences from BITS and MIIT", discussed how teaching and assessment should be learning- and learner- oriented.

Panel Discussion:

On 17/11/2018, the TLC, along with the Humanities and the Social Sciences Department, Pilani Campus, hosted Prof. Saikat Majumdar, a noted writer and a faculty member at Ashoka University. A panel discussion titled "Undergraduate Education in India" was organized based on Prof. Majumdar's book, "College: Pathways of Possibility", where Prof. Ashoke K. Sarkar, Prof. Chandra Shekhar and Prof. Sanjiv K. Choudhary participated along with Prof. Majumdar. Dr. Manoj Kannan moderated the panel discussion.

Delegation and Visits:

☐ Dr. Pankaj Kumar Sharma and Dr. Manoj Kannan attended a workshop conducted by Dr. Eric Miller, Director, World Storytelling Institute, in Chennai, during 22nd - 25th December, 2018. The theme was based on how storytelling can be used to teach science subjects, dwelling upon potential questions that can be asked to invite discussion in class through elements of storytelling and case studies.
☐ Dr. Tamali Bhattacharyya presented a paper titled "Improving the Quality of Technical Education using Pedagogical Instructional System Design" in the Future of Learning Conference, Learning 4.0: Connecting the Dots; Reaching the Unreached, during January 4 to January 5, 2019 in IIM Bangalore. Dr. Jayashree Mahesh had also attended the conference.
☐ Dr. Kaushar Vaidya and Dr. Manoj Kannan presented a paper titled "Intensive Teaching Workshop – An Institutionalized Program for Educator Training at BITS Pilani" in the National Teachers' Congress at MIT World Peace University in Pune during January 4 to January 6, 2019.
☐ Dr. Kaushar Vaidya attended the launching of Asian Society of Engineering Education (AsiaSEE) ceremony on 8th May 2019 at the University of Hong Kong. As a founding member of AsiaSEE, Dr. Vaidya along with delegates of over twenty institutes/universities from Asia signed a vision document of the society. By joining this society, BITS Pilani, joins other reputed engineering institutes, and commits itself to contribute towards the advancement and enhancement in engineering education via research and practice for the future generation.   (Continued...)

Photos of Workshop on Team Based Learning

Intensive Teaching Workshop

The TLC conducted an Intensive Teaching Workshop (ITW) for 16 newly recruited faculty members. The entire exercise was divided into two major segments: ITW 1 and ITW 2. The ITW 1 saw ten modules presented by various domain experts. The inducted faculty members enjoyed the background information provided in these sessions and enthusiastically interacted with the resource faculty. The ITW 2 saw two presentations by the participating faculty members, one only based on blackboard, and, the second a mixed presentation involving board work and slides. The 16 members were divided into three groups with 6 resource faculty on each group, for interacting and giving feedback. The in ducted faculty members were also given options of sitting in "open" classes to have hands-on experience on pedagogical practices that they could emulate from their colleagues. Few faculty members from various departments "opened" up their classes for the same. The participating faculty members liked this experiment very much.

SEER

TLC BITS Pilani introduced a new talk series to enhance the teaching-learning discussions among the faculty members across the disciplines on campus. The SEER (Sharing Experience and Educational Research) series is envisioned to be a once in a month TLC forum activity to discuss research articles in teaching-learning and to share unique pedagogical practices by the BITS faculty members. It was planned that a SEER session would typically have two sessions of thirty minutes each where a faculty member would present his/her research on pedagogy and its best practices in the first half, while another faculty member would share his/her teaching experience with the BITS community. The aim is to generate discussion and debate and to learn from each other.

☐ The first session of SEER was held on 31/01/2019 where Dr. Pankaj Kumar Sharma from the Department of Biological Sciences discussed a paper titled "Can Undergraduate (Biology) Students Learn to Ask Higher Level Questions?" by G. Marback-Ad and P.G. Sokolove. Prof. Ashoke Sarkar, our Director for Pilani campus, shared his valuable experience regarding teaching in BITS Pilani in the second half of the session.
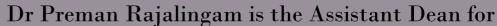
☐ The second session of SEER took place on 28/02/2019 where Dr. Kaushar Vaidya from the Department of Physics discussed a paper titled "Peer Instruction: Ten years of experience and results" by Catherine Crouch and Eric Mazur. Prof. P. Srinivasan from the Department of Mechanical Engineering shared his insightful experience of classroom teaching in BITS Pilani.

The third session of SEER took place on 26/08/2019 where Prof. Tapomoy Guha Sarkar from the Department of Physics discussed the original work by Benjamin Bloom on the taxonomy of educational objectives. He also talked about some of his efforts towards using the taxonomy to set balanced question papers and devise a metric for teaching-learning outcomes.

 The fourth session of SEER took place on 24/09/2019 where Prof. Navneet Goyal from the Department of Computer Science and Information Systems discussed about - relating Machine Learning concepts to academic/pedagogical practices. He share his experience on simplifying ML concepts by drawing analogies with pedagogical practices and academic models. He enumerated all such analogies to explain concepts like model complexity/flexibility, overfitting/underfitting, supervised learning, unsupervised learning, ensemble learning, active learning, etc.

Workshop for Research Scholars

Workshop for Research Scholars

The Teaching Learning Centre of Pilani Campus organized a half-day workshop titled "Teaching-Learning Workshop for the Next Generation Academicians" on Saturday, September 07, 2019. Focusing on three modules of "Communication", "Laboratory Instruction with an Emphasis on Assessment" and "Ethical Practices in Teaching Learning", the workshop roped in more than 15 resource persons including faculty and senior research scholars to address myriad questions/doubts from over 78 participating PhD scholars. The five hours' workshop saw lively discussions, group activities and informative interventions by both the scholars and faculty members. Certificates were awarded to the attendees at the end of the workshop.

Dr Preman Rajalingam is the Assistant Dean for Educational Development and Senior Lecturer in Medical Education at LKCMedicine, NTU. Dr. Rajalingam started his career as an engineer but eventualy switched to the role of an educator. A strong advocate of the learner centric paradigm, he is an expert in the pedagogy of higher education; in particular Problem-Based Learning (PBL) and Team-Based Learning (TBL). During his visit to BITS Pilani, Pilani Campus for the Team Based Learning Workshop, we took his interview.

(Continued..)

Team Based Education: An interview of Dr. Preman Rajalingam (NTU, Singapore)

Q. What was your personal journey into team-based learning like? How did you get inspired into a teaching pedagogy which we haven't seen traditionally in our times?

A. I was not a very attentive student; I would skip class and study only for the exams. I only discovered my love for education after completing engineering and joining a polytechnic to start a new diploma programme where we used problem-based learning. In the process of creating a curriculum, drawing upon my own background led me towards a formal understanding of pedagogy. When it comes to team-based learning, it is not the one prescription for all scenarios. It has been effective in some American schools and professional programmes. I am an active supporter of active and collaborative teaching.

Q. Could you highlight the striking differences between active collaborative and team-based learning?

A. In problem based learning, students start by defining a problem and proceed to solve it as a team. It is therefore an example of active and collaborative learning but not of team-based learning. Problem-based learning is more student-centred than team-based learning in that the students decide what they wish to research and read about. In team-based learning, on the other hand, the teacher decides what work to assign; the students learn the material and apply it to the questions at hand. Both approaches are collaborative in nature, and can't really be compared; the choice of approach depends on what one is trying to achieve.

Q. How difficult was it to transform pedagogy in a university setting from traditional practices? What are the responses of different stakeholders like students, teachers and administrators?

A. My current situation is unique because it is a new school. From the very beginning, the senior leadership was highly supportive, and the incoming students were mentally prepared for something new. The transition is generally most difficult for the faculty. New faculty or faculty joining a new school have the mentality that they have to start afresh, but converting existing courses at universities is always challenging. Individual faculty members who are passionate and do a great job may suffer for a lack of management support and resource support. Some initial resistance from students is expected because they are averse to doing more work.

Q. What are the essential ingredients of team based learning?

A. Team-based learning requires the creation of really strong teams of students that are purposefully built and kept together for as long as possible. Permanence is essential if you want them to evolve from being mere groups of students to an actual team whose members support each other. You need very strong curriculum development; faculty must take energy away from delivering lectures and devote it to developing questions, problems, and new curricula for team-based learning. They must be open to not being in control and let students take some measure of control.

Q. So the faculty must relinquish the role of the instructor?

A. The faculty need to partner more with the students. The instructor is always central to the teaching process. They need to be more receptive to what students are bringing out and want to learn.

Q. What are the major hurdles in implementing a team-based learning approach?

A. A major challenge is convincing faculty members to adopt this approach at a large scale. Individual faculty members may be convinced about team-based learning being a robust evidence-based pedagogy. But when it comes to the whole school, faculty members feel they lose control over the curriculum. Hence, change is easier in smaller courses. As some cultures say "If you want to go fast, you go alone, if you want to go far, go together". Once the system is implemented across the whole school, it provides a stable context in which to make changes and improvements. There are benefits to the whole school moving together.

Q. What would be a strong philosophical motivation for a new faculty facing a large class to think of this as a better approach?

A. I would ask them what makes them passionate about teaching; I would be surprised if it is the opportunity to deliver lectures. Most faculty are motivated to engage with students, answer questions and solve problems with students.

Few Aspects of Effective Teaching

As a teacher I face this constant conundrum of figuring out what are my exact goals in a class room. The problem on its face may seem to have a trivial solution – impart your knowledge to the students, but it is not so. And this realization comes with time and experience and a few years of teaching. I am still seeking the holy grail of perfect teaching, which I don't know if exists at all, but in this article I try to highlight a few of its imperative aspects. I define "good" teaching as one which attempts to maximize the positive impact on the lives of a collection of students which we call a class. Before teaching a class, teacher must understand and accept that the students come with different interests, goals and capabilities. Also a student is attending another 5 – 6 courses along with yours. And by the end of their 4-5 years of under graduation, they will finish up to 40 – 45 courses. Outlining it all, I can sum up the thoughts inside the mind of a concerned, anxious and pensive teacher at the starting of a course in form of the following three questions.

1. What is it that you want to achieve in your 40 hours of interaction with the students?
2. What is it that students will take away from your class at the end of the course?
3. And most importantly how to ensure that students will retain what you impart to them in your class.

Let us confront them one at a time.

Answer 1. It is important to keep in mind that just completing the syllabus is never an achievement. Number of students coming to your cabin with a lot of questions can be counted as an achievement. The class room interaction is not just supposed to impart knowledge but to tickle the curious bone in every student. Make them wonder, introduce them to the joy of asking questions and understanding ideas. If the 40 hours of classroom interaction can lead to 100 hours of self-study, then it is really an achievement. So plan the class room interactions in such a way that you tell them something not only new to them but something unbelievable and counter-intuitive every 2 – 3 class. Dazzle them! This will definitely keep them coming back to you and your class.

Answer 2. List out the key concepts or the definite takeaway from your course. At the end of graduation, students do not remember everything that they were taught over 4-5 years. There are always certain ideas which I feel sit at the crux of a subject. It is prudent to spend a little more time explaining these key ideas. I will in fact advise to use modern teaching techniques like flipped classroom or other active learning methods while teaching these key ideas for better absorption and longer retention by the students. This is definitely the outcome we seek at the end of a course.

Answer 3. There are two ways to improve the retention of knowledge by the students and they have been already mentioned above.

- One is by stimulating the curiosity of the students such that they engage in a lot more self-study. This is the most important ingredient of good class room teaching. This ability comes with time to most of us. But if we can pass on the excitement and thrill of learning to the students, they will certainly remember it forever.

- Students learn better when they have more participation in the classroom. And the contemporary teaching and learning techniques are very useful when it comes to that. With active learning, which has more involvement and better engagement with the students, they essentially absorb the knowledge in their long term memory. These new techniques are strongly recommended to be gradually introduced in classrooms. They also reduce the disparity among with students with different capabilities as students get to work and learn together.

It goes without saying that teaching is an art and everyone has her/his own way of stroking the canvass. But keeping these points in mind and working towards them will help streamlining our classroom teaching and the outcomes.

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