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Innovation and research: The future of education

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Abstract
A critical perusal of the modern higher education reveals that it has witnessed profound transformations inits200 year old history - from the religious colonial colleges of the early 19th century, to the public colleges and then research universities. Now we are again in the midst of a revolution that is moving towards establishment of virtual universities and the like. Increasingly, higher education is seen as being private rather than a public service. Due to this a number of forces are impacting the institutions of higher education. Important among these are the revenue generation models, marketing drives, status of the faculty, quality assurance, career options/entrepreneurial mentoring and the institutional policies.

Keywords: Innovation and research, future of education

Introduction
Education being essential for the growth and development of a society has to be comprehensive, sustainable and evolve continuously, to cater to the challenges of its multi-stakeholder eco-system. And this evolution is brought about by strong components of research and innovation. Research, the process of solving problems and finding facts in a systematic, if possible a creative manner; and innovation - generation of new ideas, thoughts, imagination leading to development of products and processes. Research is usually undertaken to review the current knowledge and is used to devise new applications, confirm or establish facts, reaffirm results of previous works, solve existing or perceived problems, support fundamental theories or develop new ones. On the other hand innovation may be evolutionary or revolutionary and sustaining or disruptive. While evolutionary innovation is closest to research, leading to a continuous incremental improvement, revolutionary innovation results in a complete overhaul, replacing one system with another in a short span of time. Sustaining innovations perpetuate the current dimension whereas the disruptive ones (policy changes/reforms) lead to radical changes. Research may stop at the point of a new invention, while innovation leads to the application of the new idea, ideation just being the first step.

The complex system of higher education offers abundant opportunities for research and innovation. To succeed in a highly competitive and market driven environment, educational institutions have to understand their respective ecosystems, partners/stakeholders and the intrinsic relationship between the two. Though seemingly vibrant and dynamic, educational System and institutions are averse to change and there are powerful barriers checking the optimal growth of research and innovation in an educational institution.

When we talk about research and innovation in higher education, what does it exactly mean? In its ambiguity it encompasses research and innovation in educational pedagogy as well as research and innovation driven higher education. In a nutshell it refers to both, innovating education and educating for innovation.

Innovating Education
In the last decade the digital revolution and integration of ICT into education has led to emergence of a number of technologies. Though directed towards majority of the stakeholders and spread across all aspects of education- curriculum, teaching and learning, administration and institutional culture, teachers' recruitment, education and its updation, parents, employers and collaborators, its main focus is on enhancement of curriculum delivery and enrichment of learning experience. The crux is to increase productivity of learning as well as learning efficiency.

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Technology-supported models based on gamification, online laboratory experiments and real-time formative assessment and collaborations are available in stand-alone or consortia mode. Gamification in education holds a lot of promise to enhance students' learning in STEM education. It is helpful in not just improving the content knowledge through increased engagement and immersion but also leads to development of critical thinking and analytical skills. Simulation in online laboratories, especially in a collaborative mode, is less expensive than the actual practical that needs individual infrastructure in each institution. Further, in a blended format, virtual manipulative may be used to enrich the learning process alongside the physical manipulatives. With the facility of anytime and flexible access to practical experiments students get more time to learn as well as experiment and later innovate. Integration of formative assessment (interactive assessment of academic progress) in a class room may also is facilitated through technology. Computers, tablets and clickers are some of the tools that assist instantaneous interaction and feedback in a class. Through various collaborations/consortia/platforms, technology also enables stakeholders from different geographies, cultures, socio-economic profiles to come together and acquire domain specific knowledge and skills. Collaboration through technology gives an opportunity to enhance academic interaction and conceptual understanding through global networks and exposure. Alignment of skill based curricula with technology can lead to more accurate and precise assessment of skills and more employable candidates.

It is worth mentioning here that the efficacy of the technology driven models does not depend only on technology itself but also on the pedagogy that it supports. These may not deliver the expected outcomes unless the skills in the use of technology to foster deeper learning are accompanied by good pedagogic resources. Thus, the catch here is that the teachers definitely need to acquire and upgrade skills to use these tools optimally and revisit pedagogy. And that is a challenging as well as expensive task. The adoption by teachers is most likely to be sustained and effective when there is adequate support from the policy makers. Therefore, to make education accessible, equitable, improve educational outcomes and develop a higher order of critical thinking skills, educators must consider adopting these innovative technology driven pedagogic models in higher education.

MOOCs, 'TED' talks and other free online educational resources are also changing the course of education. This has led to many teachers integrating web based resources into their teaching, resulting in class room interaction moving beyond content delivery and the size of the classes becoming smaller. The students on the other hand have a larger spread to choose from according to their interest and career pathways, degrees getting replaced by certifications and education gradually evolving into lifelong learning.

Research and Innovation Driven Higher Education
Professional and research universities offer greater opportunities for research and innovation as compared to local/regional universities where the mandate is to provide degrees to the candidate's enrolled. Though there is a little scope for domain specific innovations in regional universities, innovations if any in this sector mainly are transformational in nature, emphasising sustainability. Innovations in professional and research universities orient more towards product and process changes. Here the (doctoral) research degree process has production and dissemination as its core elements. This has allowed such universities to become hubs of research. With the proliferation of private players in the higher education and the explosion of knowledge products on the web, it is becoming increasingly important for the universities to rediscover themselves and move towards innovation. Presently, most of the public funded universities are a part of one or another national or international research and innovation system. Accordingly, their research is geared towards addressing societal problems – current as well as future. Majority of such research ends at seeking answers, peer reviewing and publications. Depending on the mandate of the university, some of it gets disseminated among its stakeholders. Being the key players in discovering new knowledge universities can be pivotal to translate research into innovation. While research may end at the point of finding a solution to the problem, innovation, the application of a new idea that becomes an intellectual property, calls for moving beyond the laboratory to prototype development, testing, refinement and implementation at the perceived scale. Are the universities prepared for it and should all the universities go for it are the points to be deliberated upon. The mandate and primary focus of a university can be the determining factors for this.

Does a strong research base of an institution alone can be enough to promote innovation? The answer would be no because the key players in the two scenarios differ. Research calls for academics who indulge in the creation and nurturance of knowledge while innovation needs more diverse human resource. It needs a multi-disciplinary team where academics create the new knowledge but its management in terms of traction and marketing may be left to other professionals, specifically trained in that sphere. Though important for present day research as well, Multi-disciplinary teams and collaborations are more important for innovation. Growth cannot take place in a vacuum but requires openness and interaction between systems and their environment. Same is the case with educational institutions that may not be able to take on the onus of transformation by themselves alone but the need support of various stakeholders and policies. No one stakeholder can exist in isolation and have to accept the fact that they are part of a broader innovation driven system that has multiple stakeholders and processes. Precisely for this reason more and more collaborations are coming up between industry and academia. Such situations are win-win for both the partners as innovations can be directed towards answering very specific problems arising out of a related practice. At the same time, the solutions are ready for testing/adoption as soon as these come into being. The other positive fall out of such collaborations is the refinement of skills and narrowing down of the skill gaps for employability. The young professionals engaged in these projects are better prepared for working in complex and multi-faceted work environments and are industry ready.

Researches have shown that successfully innovating enterprises involve universities in their research and innovation process. With the largest percentage of innovative jobs being created in the manufacturing sector (64%) followed by business services and agriculture in

Europe, such an eco-system also promotes employability as well as employment generation. It is expected that universities may have to close down a number of courses by 2025 unless come industrial partners on board for teaching. With this in view, a number of 'collaboratories' are coming up to provide an open space and technologies to the concerned stakeholders on any given issue. Focussing on issue based learning, research and innovation, collaboratories provide open access to the academia and practice and can prove to be a strong alternative to public debate. However, with the collaborations as well as collaboratories, IP related issues need to be taken care of otherwise the multi and trans-disciplinary nature and the number of stakeholders involved can lead to a chaotic situation.

Artificial Intelligence ((AI), machine learning and big data analytics are some other elements that are/going to be important components of research and innovation in the coming years. Our research still mainly focuses on generation of more data despite the fact that huge data are already available in a number of institutions, organizations and on the web itself. These need to be brought together on one platform and made accessible, to be contextualised and collated. Digital search engines and AI driven support systems can read through, make computations, synthesise and communicate outcomes much faster than any human being. The most popular use of AI is in voice and image recognition but when integrated with other tools such as sensors, image analysis or drone based technologies, a number of innovative solutions can be generated in healthcare, agriculture and service sectors through algorithms and APIs. Now these technologies are being used to find new ways to study social sciences - linguistics, psychology and culture. Currently a research is underway to map poverty in Africa by embedding satellite imagery into AI to create a paradigm shift in public policy.

It is becoming increasingly evident that integration of current research and innovation into teaching is going to be the determining factor for the sustenance of a university. Its curriculum and curricular delivery will have to constantly evolve to factor in all the current and emerging scenarios. And this change has to start at the top. The academic leadership will have to be more open to change, responsive and flexible. Rather than being mere administrators or a managers the universities need 'thought leaders' at the top that are more of mentors and enablers who recognise and nurture talent, simultaneously gearing the institution to produce multi-faceted human resource capable of addressing present and emerging challenges through research and innovation. On the part of the academicians and the faculty, they will have to make efforts for personal development to take forward their research base through participation in project based platforms and consortia that address specific issues that need innovative solutions. And it is this change in the underlying mental models of what an institution does that will lead to the ultimate - paradigm innovation the *mantra* for the future of education.

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