NURTURING NET GENERATION GRADUATES WITH GLOBAL SKILLS

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Abstract:

The total enrolments in more than 20,000 universities and tertiary education providers around the world are in the range of 200 million students. One in five students are enrolled in technology related disciplines. Various surveys reiterate that only a fraction of graduates are suitable for careers in the world of hyper-connected economies and competitive businesses with supply chains spanning the world. Universities irrespective of where they are functioning are facing new challenges, opportunities and expectations. They are being assessed, benchmarked and compared frequently by third parties with considerable impact on reputation, student enrolments, and resources. Tertiary institutions are on the cusp of enrolling a Net generation of students, who have diverse learning aspirations and needs compared the earlier generations. The emerging scenario requires the tertiary education to be reimagined in terms of the way a) the students are developed to possess global skills and values, b) faculty members are prepared to inspire students, c) curriculum and pedagogy are tailored to the needs of 21st Century workplaces and jobs, d) scientific research and innovation are carried out, and e) entrepreneurship is facilitated at the universities. This manuscript is based on authors' own experiences during the rise of world-class universities in Singapore, and close interactions with several tertiary institutions around the world. The reimagined higher education will enable future graduates to build liveable and resilient societies.

Keywords: global skills, values, education, engineer, research, innovation, entrepreneurship

Introduction

The 21st Century is on the cusp of enrolling a Net generation of students to the universities and tertiary institutions. They students have diverse learning aspirations and needs. They wish to learn at their own pace and interact with peers while leveraging the technology-enhanced learning tools. They are open to diverse views, flexible careers (example, nano-jobs), and innovation and entrepreneurial pursuits. They are aware that their workplace will be different from the earlier generations as the businesses leverage supply chains spanning the world and compete to differentiate in the local markets.

Businesses are now leveraging and integrating innovations from around the world. They source finances and diverse workforce worldwide. They customize products to the markets they serve, as opposed to the past practice of standardized products made in one place and sold worldwide. This has been possible due to the internationalization of trade and finance, and availability of modern transportation and information and communication technologies (ICT). The 21st Century workplaces seek employees with cross-cultures work abilities and global knowledge and experience as they need to interact and move internationally. Businesses require graduates with strong communication skills who are open to diverse approaches, and who can lead multicultural teams. They must be proficient in ICT skills as well as problem solving skills with real world experience. They need to be innovative, relevant, persistent, and ethical.

The Net generation will live longer than earlier generations, and need to be economically active for longer periods. Formal learning multiple times as they age (life-long learning) and regularly upgrading skills and knowledge is the new normal. They are comfortable with digital technology and prefer blended learning methods. The Net generation of students have a choice of diverse education providers such as public, private, not-for-profit, for-profit, online, part-time, international branch campuses, and their combinations. They have access to worldwide comparison

of universities at the programme level, internationally recognized and accredited programmes, and opportunities for the global experience at home and abroad.

This emerging scenario requires the tertiary education to be reimagined in terms of the way a) the students are developed to possess global skills and values, b) faculty members are prepared to inspire students, c) curriculum and pedagogy are tailored to the needs of 21st Century workplaces and jobs, d) scientific research and innovation are carried out, and e) entrepreneurship is facilitated at the universities. The following sections describe reimagined undergraduate education, graduate education, and scientific research, innovation and entrepreneurial culture at the universities so as to impart requisite skills, values, attitude, and knowledge to the graduates, which enable them to be suitable for diverse socio-economic opportunities.

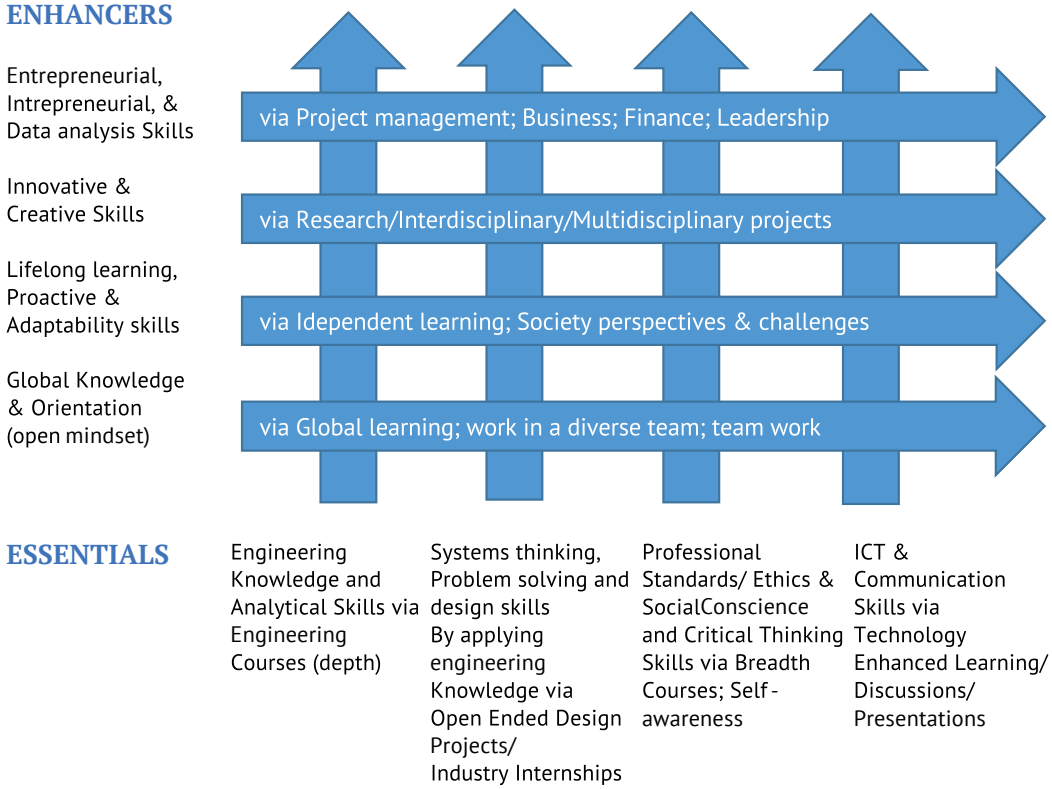
Reimagined Undergraduate Education

Various aspects of reimagined undergraduate engineering education are captured in the Schematic 1. Most engineering education providers have focused on technical depth courses involving engineering science fundamentals and engineering. Some institutions recognize the need for imparting ICT and communications skills and students' exposure to the professional ethics and standards. They are embracing technology-enhanced teaching and learning. The assortment of terms used to describe the application of ICT to teaching and learning include e-learning, online learning, cyber learning, virtual learning, computer-based instruction (CBI), computer-based training (CBT), computer-aided instruction (CAI), internet-based training (IBT), web-based training (WBT), fully online distance learning, digital educational collaboration, multimedia learning, m-learning (mobile technologies). Essentially all these are forms of technology-enhanced learning and teaching methods to facilitate various pedagogies asynchronous learning, blended or hybrid learning, flipped or inverted learning, personalized learning, collaborative, peer learning, problem-based learning, outcome based education, active learning, etc. In other words they capture the imagination and needs of the Net-generation students. International branch campuses and private tertiary education providers are early adopters of technology-enhanced teaching and reach out to the students. Obstacles for fully adopting technology-enhanced learning include a) reluctance on the part of faculty members to change, b) lack of necessary support for faculty adopting new technology and pedagogy, c) curriculum and pedagogy lagging behind, d) not yet fool proof against cheating, e) issues associated with quality assurance and assessment, f) lack of trained staff to support, g) financial viability, h) technology divide among the students, i) limitations on extent of social interactions among students and between teacher and students, and j) asynchronic feedback. Judging from the rapid progress of ICT technologies in recent years, it is conceivable that many of the above mentioned bottlenecks will be overcome in the coming years.

Universities are also making efforts to develop systems thinking, problem solving, creative and innovative skills of the students by introducing design projects, research projects, multidisciplinary projects, and industry sponsored projects, and flexibility in the curriculum for self-directed learning and peer to peer learning. Breadth courses offer the opportunity to develop abilities such as entrepreneurial skills, creativity, lifelong learning, and global knowledge. The application of engineering principles to new types of problems can develop critical thinking by requiring new elements of thought, e.g., new questions, new points of view, new interpretation and inference, and different implications and consequences. In both depth and breadth courses, students' motivation and interest in engineering could be enhanced by relating classroom teaching to the real life experiences and societal challenges, by updating courses with new knowledge, by providing hands-on and experiential learning (experi-learning) involving problem solving, applying knowledge and skills, hands experiments, industry internships and internships abroad, by providing interdisciplinary and global learning experiences, and by providing opportunities for entrepreneurship, intrapreneurship, team work, and test bedding solutions. Curriculum may

be re-casted to accommodate bit sized (shorter duration) modules so as to involve industry professionals as well as international academics. Students' exposure to the international academics and industry professionals will expand their horizons and open up their minds for new possibilities. In other words, the T-engineers (with depth and breadth skills and knowledge) should be developed with greater emphasis on experi-learning.

Figure 1 - Key features of training T-Engineers via experi-learning



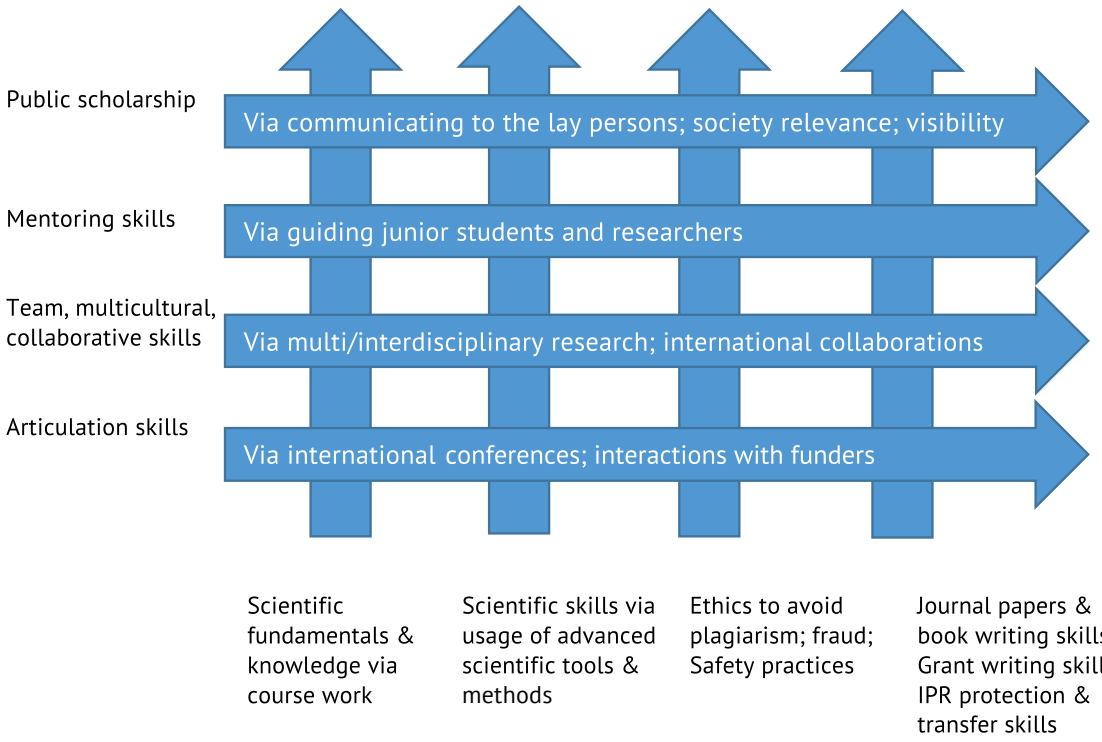
Reimagined Graduate Education

For long the graduate (post graduate) education is not high on the agenda of academic leaders. Graduate class work typically comprises a selection of courses on core engineering subjects, emphasizing mastery of fundamental engineering principles and thus preparing students for the PhD qualifying exams in a particular discipline. The skills and knowledge acquired through the graduate research work depend largely on the particular research project that the student works on. The quality of graduate training should be given greater attention as some graduates will go on to become academics and influence and inspire future generations. Many of them will also become chief scientists, chief technology officers, and chief information officers. They contribute to the organizations and support their chief executive officers in foresight, strategies, vision, and new innovative products. Along the way some of them will become entrepreneurs by setting up start-up companies based on their own experience and research led innovations. Hence from these diverse considerations, there is a need for training quality graduates in a more holistic way and future ready, and what should that be?

World class universities have been paying attention to the postgraduate students' abilities to use modern scientific tools and methods, and advanced scientific knowledge and skills imparted in specialized domains. However solving many challenging problems such as clean water, energy, environment, transportation, food and nutrition, health and wellness, and security and liveable societies require integrative minds. Most interesting and useful innovations in recent years are a result of multidisciplinary and interdisciplinary efforts. Hence the students should be given opportunities to collaborate and interact with other disciplines. For sustaining a research-led innovation career which typically spans over four decades an individual needs to raise funds

regularly in a competitive and resources limited world. This requires effective communication and marketing skills to convince diverse investors and stakeholders while maintaining ethics and research integrity and respecting intellectual property rights of others. In order to develop and implement innovative solutions to the societal challenges often researchers must be able to work with others from different cultures, languages, norms and safety standards. Hence the graduate researchers need exposure to overseas research cultures and practices, and familiarity with intellectual property protection and transfer processes. The graduates should be mentored to aim the right questions with the right approach and attitude and to convey effectively the importance, relevance and impact of their work. Curricula should be flexible enough for those who desire to pursue entrepreneurship and translation of research outcomes into practice. Various aspects of a reimagined quality graduate education are captured in the Schematic 2. University's internal structures should have porous boundaries to facilitate interdisciplinary research and learning. Academic environment should be conducive for collaborative research and creating new frontiers. Perhaps global graduates be developed via enhanced interactions with overseas peers via a) visiting faculty, b) graduate student exchanges, c) collaborative research, d) joint publications, e) joint conferences, f) joint graduate courses, etc.

Figure 2 - Key features of quality graduate education

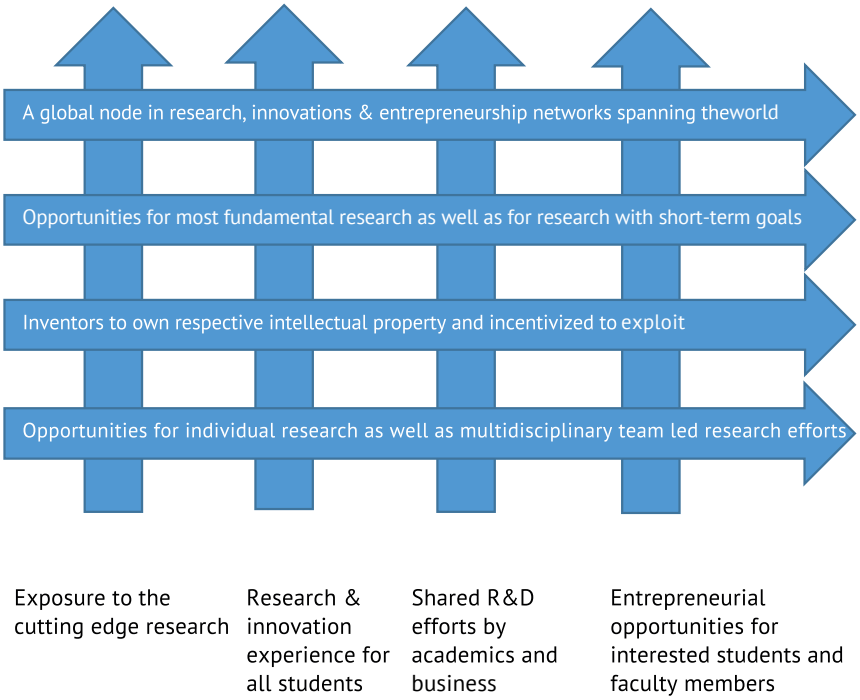


Fostering Vibrant Scientific Research, Innovation & Entrepreneurship Culture about fifteen percent of 20,000 universities around the world are ubiquitously active in scientific research. Majority of them are in high income countries. They perform both scientific research and education. However, bulk of the universities around the world are primarily involved in educating students, and not involved in scientific research and new knowledge generation. This is due to the national policies which expected the universities to focus on educating large number of students, whereas the respective national laboratories and dedicated organizations to focus on mission oriented scientific research and development. This situation has led to a) academic faculty members using outdated knowledge teaching students, b) poor infrastructure so that teaching is heavy on theory and less on hands on experience, and c) less confident and under prepared students for the fast paced innovations and competitive world. Evidence in recent decades suggest that education and scientific research efforts should be intertwined at the universities especially to facilitate

technology-entrepreneurship, novel innovations with fresh minds, and solutions to the societal challenges. In order to foster vibrant scientific research, innovation and entrepreneurial culture, universities are to implement several aspects captured in the Schematic 3. Most faculty members at the majority of 20,000 universities around the world are not exposed to the cutting edge research in respective fields of interest. Sending faculty members on short term exchanges to the world's leading research centres will enable them to appreciate the latest trends and approaches to the scientific research and innovation. Upon return they can apply similar or fine-tuned approaches which better suit the respective local needs and conditions, and to address the locally relevant grand challenges. University policies should encourage ubiquitous research and innovation culture involving all students and faculty members. For undergraduate students it could take the forms of undergraduate research opportunities programme and final year research project. Scientific research and development is becoming expensive. Neither universities nor businesses have all the resources they need to generate new knowledge and translate into innovative products. Shared efforts by the universities and businesses in terms of research facilities, infrastructure, research human capital, prior knowledge, and translation into products are desired.

New knowledge generation and translation it into viable products and services often require different, complimentary skills. Only a fraction of researchers have the appetite for entrepreneurial pursuit. Even the research-intensive universities are yet to master the ubiquitous entrepreneurial culture. Universities must proactively implement policies that encourage students as well as faculty members interested in entrepreneurial pursuits. A fraction of proactive universities go to the extent of allowing inventors to own respective intellectual property rights and further incentivise them to exploit inventions. Universities are to make efforts to become an active node in the global networks of scientific research, innovation and entrepreneurship. While universities and research funding agencies emphasize addressing of grand challenges of the societies via multidisciplinary team efforts, there must be room for individual research motivated by the most fundamental questions in chosen domains. For this purpose, the research funds and individual researcher's time may be managed by one third and two thirds principle i.e. two thirds focused on research with specific short term goals, and one third focused on the most fundamental and interesting research.

Figure 3 - Fostering Vibrant Scientific Research, Innovation & Entrepreneurship Culture at the universities

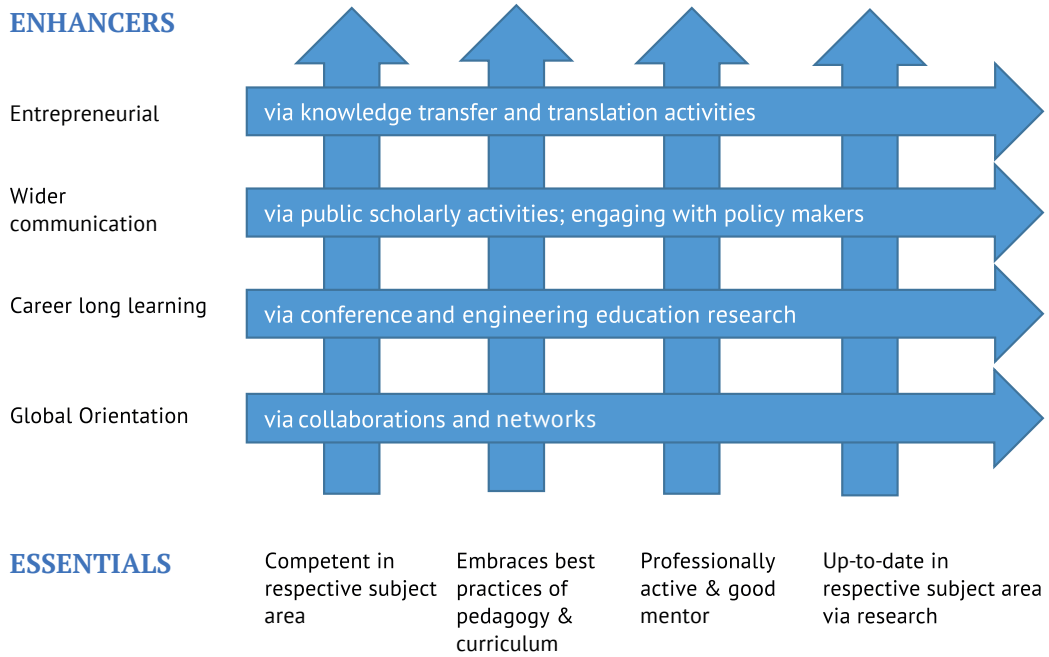


According to a 2010 survey by Morell and SPEED (Student Platform for Engineering Education Development), the key attributes a well prepared engineering faculty member include a) competent in his/her own discipline, engineering fundamentals and problem solving; b) current in his/her research, publishes, networks, communicates effectively and keeps up with trends in his/her discipline; and does all of the above with an entrepreneurial spirit; c) an effective teacher, knows about learning and outcomes assessment, facilitates learning using learner-centred strategies, keeps up with developments in engineering education, studies and uses the effectively, cares about the students and their learning, enjoys being as a mentor; d) understands the role that the profession has in society both locally and globally, practices it as part of his/her career development as well as leads, serves and participate in forums to promote policy making and excellence in engineering education and research/innovation; e) aims at developing the skills and competencies engineers should possess through practice and experience in order to better serve society and be a role model for students.

The faculty members of engineering schools are to follow essentials and enhancers mentioned in Schematic 4 to possess necessary attributes to nurture future engineers. While they are competent in respective subject areas they must also keep up via research and development. They must be professionally active and embrace best practices of pedagogy and curriculum so as to inspire the Net generation. Their own global understanding and connections will enable them to serve as good mentors. Participation in public scholarly activities in addition to the respective professional activities will enhance their image in the eyes of students. They could sharpen their entrepreneurial abilities by actively pursuing knowledge transfer and translation via industry projects and start-up company activities.

In other words well prepared faculty members are essential to foster vibrant education, scientific research, innovation and entrepreneurship culture at the universities.

Figure 4 - Enabling Engineering Professor to Inspire the Net Generation



Conclusions

The total enrolments in more than 20,000 universities and tertiary education institutions around the world are in the range of 200 million students. The majority of them have come into existence over the last fifty years in response to the growing demand for higher education. They are diverse in terms of nature of institution (public, semi-public, private; religious, teaching, research, and

research-intensive), size (boutique, medium and large enrolments), governance (autonomous and semi-autonomous), funding mechanisms, range of programmes, location, mission, vision, mode of delivery (full time, part time, online, mixed mode), level of resources, quality of students, gender of students, quality of faculty members, flexibility of programmes, national and international partnerships, accreditation and quality assurance, etc. Recent decades have also seen widening of tertiary education covering many new disciplines which have flourished at the interfaces with other disciplines. While the mass higher education goals of nations are fulfilled, an unintended consequence is emerging. A good proportion of the graduates are either underemployed or unemployed. They lack the requisite global skills, attitudes and values. Reasons include a) static nature of curriculum and pedagogical methods, b) inadequate infrastructure and resources at the universities, c) underprepared faculty members, d) varying motivations of Net generation of students, d) separation of education and scientific research at the universities, and e) mismatch between the needs of dynamic jobs market and global skills and knowledge of graduates.

It is opportune time to reimagine tertiary education by a) embracing technology-enhanced learning and teaching, b) training educators, c) fine tuning curricula to suit the needs and expectations of the Net generation students, d) facilitating cutting edge research culture to spur the next wave of innovations, and e) providing opportunities for entrepreneurship. Continual improvement in all aspects of tertiary education, scientific research and entrepreneurship is to be pursued vigorously and passionately.

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