

The mode of education in Pakistan – which is transactional with teachers and faculty leading the way and the students having little choice but to fall in line and go through it to get class promotions, certificates and degrees and jobs – has to be redesigned.

The purpose must be aimed at arousing curiosity, questioning, critical thinking, and analytical ability at a very young age. The present system: with parents discouraging young children from asking questions, the one-way monologue from uninspiring teachers to a bunch of passive students sitting in an unexciting classroom, rote learning, memorizing material taken from notes from teachers' lectures and digesting selective pieces of that to reproduce them during examinations, and the obsession with grades, rather than absorbing, retaining and assimilating knowledge has to be completely dismantled.

The academic stagnation resulting from the present system has landed us into economic stagnation. The new system to meet the challenges of the future has to encourage nurturing adaptability, curiosity, creativity, and comfort with uncertainty, and problem solving skills. This would require interactive learning technology tools that inspire and motivate the young minds and prepare them for the jobs of the future. Technical skills should be in harmony with liberal arts and social sciences as interdisciplinary teams and horizontal collaboration can help solve complex social and economic problems.

Schools have to be equipped with local area networks, high speed fixed lines, wireless and wire based broadband internet connections, cloud computing, learning management system and all the supporting infrastructure including devices that can be easily accessed by the students in their homes, classrooms and laboratories. A World Bank survey of 33,500 schools in Pakistan to assess available options for internet connectivity revealed that only 9,800 had an optical fibre node in the area; 2200 were located in areas that do not get a cellphone signal for voice calls what to speak of data transmission.

Universal Service funds should be used to extend 4G/LTE connectivity to secondary cities and rural areas, expand service coverage, and set up new cell towers connected to the service providers. Satellite internet connectivity through 12000 low earth orbit satellites at altitudes of 550 km may also be explored. The public expenditure incurred on connectivity, laboratories, paying market-based and performance-linked compensation to highly qualified but adaptable and motivated teachers and faculty selected purely on merit and evaluated on achievements would have a high payoff to the economy in the medium and long term. We should consider this as an investment in human capital formation rather than as a recurrent expense.

Large-scale recruitment of teachers in STEAM subjects in lower and higher secondary schools across the country will be required, followed by their training and continuous upskilling. Unlike the current method, the selection of these teachers should be on the basis of academic rigour, intellectual grounding and pedagogical adaptability to excite the imagination of the students. I have seen school boys and girls at the Science Museum in Karachi set up by the Dawood Foundation participating and enjoying hands-on interactive learning experiments. Science and math became fun for them rather than dull and boring chores. Learning by doing helped them grasp basic concepts and develop foundational understanding that will stay in their minds until new knowledge displaces the old.

Young minds should not be frowned upon for making mistakes but encouraged to learn from their mistakes. Innovation occurs through trial and error and fear of failure inhibits innovation and learning. Some of them can approach the resource persons/ teachers who don't have to provide them ready-made answers but walk through the whole thinking process and encourage a 'let us do together' way of arriving at the answer. These practices can stimulate and prepare students for lifelong learning, upskilling and reskilling – the name of the game for the future.

The other area which needs a complete overhaul is the incentive structure for researchers and research faculty. Professors in many universities in the world have become rich – some of them millionaires – not by agitating for higher salaries and perks to be granted by the government but by dint of sheer hard work and cashing out their intellectual capital. A 2012 study showed that companies founded by Stanford faculty and alumni generate annual revenue of about \$3 trillion and have created more than 5.4 million jobs. Between 1970 and 2016, Stanford's Office of Technology Licensing saw the creation of over 11,000 inventions and issued more than 3600 company licences that have generated \$1.7 billion in royalties. MIT faculty, alumni, graduates and postgraduates have founded 2784 companies including 42 unicorns and big name firms such as Dropbox, LinkedIn, FireEye. Route 128 in Boston is strewn with thousands of these companies.

How many such companies have been set up by the entire faculty of all the 220 universities across Pakistan together? The record so far is pathetic due to structural rigidities and perverse incentive structure. Faculty members should be allowed to retain financial returns on their intellectual capital, inventions and patents. Due to paucity of financial resources, research laboratories at the universities and the expensive equipment they possess should be pooled and shared by other outside researchers.

Promotion criteria should move away from sole reliance on impact factor journal publications to a combination of publications, patents and inventions and contribution towards solving problems facing the economy. For example, a research scientist who is able to develop a pest-resistant high yielding variety that increases the average national yield of cotton on a sustained basis by a significant multiple should be rewarded generously in form of awards and honours, promotion, perks and privileges compared to her colleague who may have produced an impressive number of impact factor publications.

The present resistance to inducting highly qualified expatriate scholars because of the insecurity of the incumbents in our universities and research institutes will also eventually evaporate as these newcomers would be seen as useful allies and partners, bringing in new insights and knowledge to the ongoing research and collaborating with the local faculty members in applying them to the real world problems. Collaborative rather than individual interests would also bring about unpredictable spillovers and unexpected technological benefits to the country.

Defence production, strategic planning divisions and the Pakistan Atomic Energy Commission have done a commendable job in research and development in their related fields. It is now time that the dual use of these technologies for civilian purposes were institutionalized through close collaboration between defence research establishments, government scientific research institutions, the private sector and academia.

To recapitulate, Pakistan has to pull itself out of its low ranking on Global Innovation and Readiness indices by a multipronged disruptive strategy that dismantles the present mode of education.

The main ingredients should be to, one, expose the students right from the beginning at the school level to STEAM subjects, making them fun and exciting and recruiting and training teachers on a large scale for that purpose. Second, to invest in R&D in the public and private sectors, defence and academia and develop close collaboration between them. Third, to encourage expatriate scholars and researchers to enter into joint projects with the local researchers. Fourth, to revamp the incentive structure of university faculty so that they can set up their own startups and reap the dividends on their intellectual capital. Fifth, to send as many Pakistanis as possible on overseas scholarships if they are able to secure admission in the STEAM fields at the top universities, And, finally, to invest heavily in labs, ICT infrastructure and connectivity in the schools, colleges and the universities.

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