Role of educational technologies in reemergence of India as a knowledge society

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Abstract— **India thrived as a knowledge society in the past. However, the colonial interlude extending over centuries systematically eroded her knowledge base. Though recently there has been a growing interest and awakening among the people and the government towards the goal to reemerge as a knowledge society, systematic solutions have been eluding us due mainly to our rigid structures of education, particularly the higher education. In this paper we discuss how knowledge centers, which can be developed within and outside our present structures of education, can harness education technologies, in synergy with the information and communication technologies, to facilitate the institutionalization of knowledge reforms in India and accelerate her march towards this ambitious goal. Recently we have taken a modest experimental initiative along this direction by starting a physics knowledge center in our institute. We also present here the encouraging results of this experiment.**

Keywords- knowledge society; educational technologies, information and communication technologies; knowledge reforms; knowledge centers; higher education

I. INTRODUCTION

The term "knowledge society" was introduced by the American sociologists Lane and Bell in the 1960s in order to distinguish service societies from industrial societies [1]. It generally refers to developed societies in which technological and scientific knowledge is a central factor in producing the social and economic system. India, by all accounts, thrived as a knowledge society in the past. However, the colonial interlude extending over centuries systematically eroded her knowledge base. The erosion was unabated even after independence due to uncritical copying of outside ideas, notions and structures and attendant intellectual slavery.

The emergence of new sciences and technologies, that include educational, information and communication technologies (ICTs), offers us renewed hopes for the first time after a long period of darkness to rediscover our glorious knowledge status. India, aspiring to reemerge as an ultimate knowledge destination, is fast waking to the fact that the most fundamental characteristic that differentiates a developed nation from the developing ones is knowledge. Here are a few recent encouraging initiatives that bring forth the country's aspiration.

- Setting up of a National Knowledge Commission to introduce knowledge reforms after three education commissions that spearheaded the cause of education through education reforms
- Initiatives such as INSPIRE (Innovation in Science Pursuit for Inspired Research), NMEICT (National Mission on Education Through Information and Communication Technology) and TIFR initiative on ancient Indian knowledge
- Participation in many prestigious international projects such as CERN, ITER, LHC, LIGO, and national projects such as the GMRT (Giant Metrewave Radio Telescope) near Pune, 21-meter cosmic-ray telescope under construction in the Himalayas; the lunar probe *Chandrayaan*, *Astrosat*, a petawatt laser planned for Hyderabad; and the India-based Neutrino Observatory

However, these initiatives are woefully short of the requirements of a large and diverse country like India. Several pioneering workers have expressed serious concerns about our current higher education scenario [2 - 4]. Recently, the Prime minister, Dr. Manmohan Singh also expressed the need to overhaul the science education in India to be in the race to become a global leader in science [5]. The aim is a tall order considering major challenges before us such as urban–rural divide, digital divide, teaching–research divide and low enrollments of eligible youth in higher education, particularly in basic sciences. Recently there has been a growing interest and awakening among the people who want to live by what they know [6, 7]. It is for the government to respect that wish and do all it can in service of the goal of reemergence of India as a knowledge society. Thought must be given to adapting initiatives in the field of education to promote development of knowledge with the people into life-enriching systems implemented by local initiatives. Alvin Toffler defines illiterates of 21st century as those who cannot learn, unlearn and relearn. Giarini and Malitza [8] proposed a vast modularization of curricula and an interlocking system of learning and work for active life up to the age of 76. Our present education structures are not equipped to handle these challenges.

Sam Pitroda, Chairman National Knowledge Commission, recommended creation of 1500 universities to attain a gross enrollment ratio of at least 15 % by 2015 and of 50 national universities to provide education of the highest standard [8]. However, with 'islands of excellence' and 'majority wallowing in mediocrity [9]' in our higher education structures, these recommendations may prove to be unproductive in achieving the envisaged expansion and upgradation, if we continue only with the present system. Education technologies can play a significant role and knowledge centers based on the synergy of education technologies with ICTSs can ameliorate the present situation and provide us systematic solutions as discussed below.

II. EDUCATION TECHNOLOGIES BASED KNOWLEDGE CENTERS

Association for Educational Communications and Technology in the United States defines educational technology as a complex integrated process involving people, procedures, ideas, devices and organizations for analyzing problems and devising, implementing, evaluating and managing solutions to those problems involved in all aspects of learning [11]. It evolved through the application of science of learning and communication to teaching and training with the aim of improving their quality and efficiency. On one hand it grew through the application of physical sciences and electronic engineering in the development of teaching tools and through the application of psychology of learning to practical teaching problems on the other hand.

Education technologies can be used in synergy with the ICTs to develop knowledge centers for education, on lines similar with the idea of village knowledge centers [12] introduced by M.S. Swaminathan Research Foundation (MSSRF) in 1998. The idea was introduced to provide adequate telecommunications infrastructure that would enable the dissemination of appropriate information regarding farming, education, health, weather, governmental news, job, loans and aid opportunities. Each village knowledge center would serve as the knowledge repository for the villages it served. Pertinent information was stored in databases in these sites, with appropriate technology for easy access and dissemination of this knowledge to persons seeking them.

The envisaged knowledge centers could be developed along these lines within and outside our present education structures in both virtual and real modes and will facilitate knowledge accumulation in a free and flexible manner by interested learners. They will serve as knowledge repositories consisting of knowledge spirals, modules and packages on how learners can enjoy and employ knowledge and how knowledge can empower and enlighten. They will blur the distinction between work and education and seek resonance of propensities and needs of learners with the knowledge activities they undertake. This would result in snug matching of aspirations with outcomes and boost the development of human resources, the most important "resource" for the knowledge society. The centers will thus open the floodgates of knowledge to our rich demography of youth and quicken our march towards the goal of knowledge society.

Two familiar components of our higher education system are teaching and research. Teaching pertains to dissemination of curricular knowledge and research to digging new knowledge. The two are often debated as independent because teaching is student centric and research is expert centric. However, the emergence of education technologies have paved way for lot of research in teaching itself and opened new directions for researching into how students learn, assimilate and apply ideas. Areas such as 'physics education research' and 'engineering education research' have now become established areas of research on equal footing with other research areas [13, 14]. The proposed knowledge centers will be natural places to undertake research in education.

Knowledge centers will also serve as natural places to research using such sources as nature, tradition and culture. For example, research into India's rich cultural heritage can lead us to rediscover her glorious knowledge status that sustained our civilization for millenniums. The amazing progress of developed world convinces us of the power of focused minds. But the large-scale violence and destruction in this world also points gravely that progress through powers of mind does not necessarily ensure progress of mind itself. India is a nation with a soul and her rich treasure of spiritual knowledge that focuses on the progress of mind / soul can make India a world leader in providing solutions for global peace and harmony by inculcating the spirit of education that is 'rooted to culture and committed to progress' as pleaded by the report, "Learning the treasure within" of UNESCO Commission on Education for 21st century [15]. Knowledge domains like yoga and vegetarianism are already attracting the stress ridden world population due to their natural, cost efficient benefits in diseases of psychosomatic origin.

OUR EXPERIMENTAL PHYSICS KNOWLEDGE CENTER

As a first step towards experimentation with these ideas, a physics knowledge center was developed in our institute (PIET, Nagpur). The underlying work was a comprehensive, systematic effort towards physics education research, motivated by the tools of educational technology developed by us earlier such as charts, models, tables of comparison of theory with experiment and application notes [15 - 20]. The center attempted to re-orient, re-explore and re-present the 'engineering physics' syllabus of first year B. E. course prescribed by the RTM Nagpur University to make it knowledge centric and knowledge intensive through a variety of 'learner centric' materials and activities.

The objectives of knowledge for enjoyment and enlightenment were addressed by developing learning material in the form of series, 'physics through interesting anecdotes/stories', 'physics through quotations', 'physics through convincing examples', and 'physics through illustrative sketches/figures/diagrams' and conducting activities such as 'Curiosity Corner' (for curiosity based learning) and 'Physics Clinic' (for diagnosis of ignorance and remedial learning). Comparative charts developed by us [18] by unifying topics that share the same conceptual foundation were used to enhance the ease of learning.

Going by the dictum, *the physics research of today is the engineering of tomorrow* and looking upon students as *young researchers*, the above objectives were addressed by promoting the spirit of scientific method of learning through interplay (seeking agreement) between theory and experiment. Tables developed by us for the experiments prescribed in the syllabus were used for this purpose. The thrill and excitement of research, usually experienced by Ph. D. students, could thus be made a part of UG education.

The objectives of knowledge for employment and empowerment were addressed by developing learning material in the form of the series, 'physics though innovative experiments' and 'physics though applications' and conducting the activity, 'Knowledge Kafé' that made the routes from classroom learning to industry applications visible to learners. Knowledge spirals were also developed that conveyed the scope of various topics in both the theory (depth of the spiral) and the applications (breadths of spiral at different depths). An example of such a spiral, the laser knowledge spiral, is presented in Fig. 1.

The course of 60 lectures was thus rebuilt as a repository of about 20 learning modules, each module dealing with a single conceptual unit of the syllabus. The components of modules included modular lecture unit, laboratory unit, programmed instruction unit, and individual study unit. The development of units such as film unit and multimedia audio-visual unit is underway. Table 1 displays the titles of some of the modules developed by us. Table 2 displays few encouraging examples of the response to our knowledge initiatives.

The students evinced keen interest and enthusiasm in these initiatives that also led to notable improvement in their curricular performance. Learners who were interested in setting up personal learning itineraries based on these modules were guided by the faculty. The introduction of scientific method of learning evoked a very good response. We experienced that seeking resonance between thought and practice through "doing what you say", or "practicing what you think" at the young age of UG can develop roots of intellectual honesty and when done with such involvement experiments can turn out to be very strong techniques of learning physics. As one starts explaining what one observes and starts observing what one expects the process of learning becomes most natural!

CONCLUSION

The purpose of educational technology is to facilitate and improve the quality of human learning. Thus knowledge centers harnessing the synergy of educational and ICTs can play a very significant role in facilitating and accelerating knowledge reforms through quantitative expansion and qualitative improvement of education in India and quicken her march towards the goal of a knowledge society. Our first experiment in this direction has produced encouraging results and opened a lot of further scope for future work.

TABLE I. EXAMPLES OF KNOWLEDGE MODULES

Syllabus	Knowledge centric reorientation
Crystal Structure	**Atoms in Order**: crystals in nature, basic concepts, Bravais, Miller and Bragg
Laser	**Solution Looking for a Problem**: Story of discovery, Laser in everyday terms, Interesting facts, lasers everywhere (applications), lasers in research
Optical Fibers	**The Wonder Light Pipes:** the story of piping light, interesting milestones, fiber-optic communication, practical issues, fibers all around (applications)
Quantum Theory	**Big Theory of Small Things:** Pioneers of quantum revolution, wave or particle? de Broglie makes a bold suggestion, complex unity of matter and radiation, why quantum in engineering?
Semiconductor Physics	**Useless Turns Useful:** why useless, why useful, growth of semiconductor devices, miniaturization of technology, the chip revolution
Cathode Ray Oscilloscope	**Eye of an Electronic Engineer:** How CRO enables us to see voltages or currents, Learning CRO for enjoyment and enlightenment, Learning CRO for employment and empowerment

TABLE II. ENCOURAGING RESPONSE OF STUDENTS TO OUR KNOWLEDGE BASED INITIATIVES

Initiative	Response
Curiosity Corner	It triggered curiosity among students and brought out many interesting queries, many of them being beyond syllabus. Some enquired into the colours of butterfly wings and pointillisum paitings and some others wanted to know how something as abstract as Einstein's special theory of relativity can be involved in something as practical as navigation. Some wondered about the feasibility of time machines whereas some others were curious about sun's mass and age. Interactive sessions with faculty and experts were conducted to satisfy curiosity among students.
Physics Clinic	The activity pertained to removing misconceptions and clarifying doubts in what has been taught as a part of the syllabus. Tools developed by us such as models, charts and other learning material were used for this purpose. For example, doubts like how atoms pack in different solids, how fibers guide light and how standing waves resonate to amplify light in lasers were clarified using models developed for this purpose. Charts were used to make easy the study of such topics as behaviour of diodes under different biases and interference in various cases of thin films.

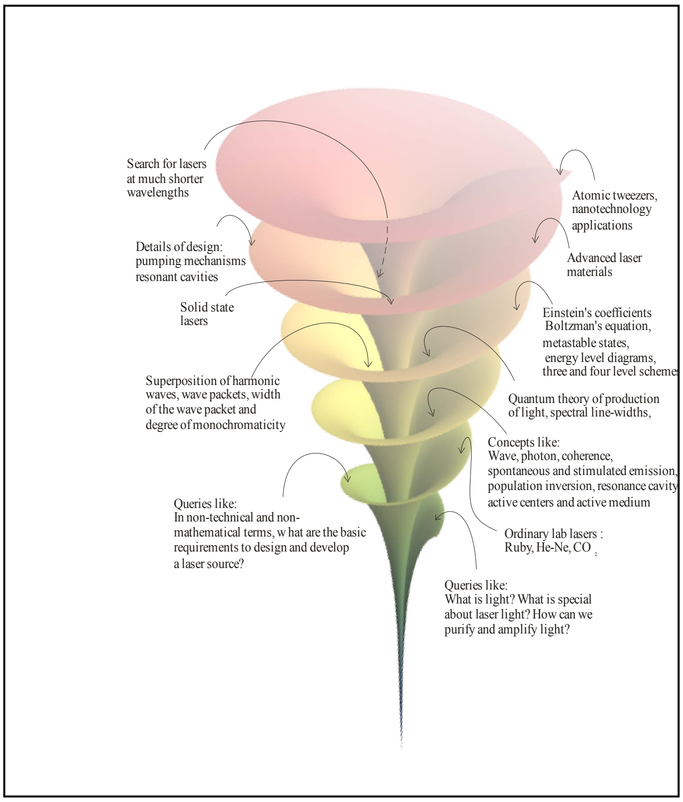

Figure 1. Laser Knowledge Spiral

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