CONTINUING SCIENCE AND TECHNOLOGY COURSES FOR KNOWLEDGE SOCIETY NEED FOR NEW ANATOMY

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***Abstract*-Science and technology form the core basis for the present day knowledge era and continuing science and technology education is of prime importance for the universities of 21st century. UNESCO report (2002) states "Knowledge societies offer both signinficant opportunities and real risks. They require fundamental changes in teaching and learning habits, a new organization of content and structure of leaning provision and a new appreciation of learners' intellectual, emotional and social needs. The skill levels required in the labour market are high and all societies face the challenge of raising their educational performance." It is often argued that we need a new academy - more engaged in the environment they have been in and the need to do far more than expand and reach of the institution while maintaining their integrity as institutions of scholarship. Though there are various systems developed for university-society interaction, it is necessary to see them in a holistic way. The need for a new anatomy for developing successful continuing science and technology courses is discussed.**

Keywords **– Knowledge Society, Science and Technology Continuing Education, University Outreach and Engagement, Open Distance Learning**

I. INTRODUCTION

In many countries the advent of knowledge based economy and globalization have resulted in dramatic changes to the character and functions of the higher education. Many universities have under this pressure turned to become more enterpreneurial (Neave, 1995; Clark, 1998; Rosenberg, 2002; Blass, 2005). This new model of university is described under different terms like innovative university (Clark, 1996), entrepreneurial university (Clark, 1998),enterprise university (Marginson and Considine, 2000), post-modern university (Rip, 2004), responsive university (Tierney, 1998), service university (Buchbinder, 1993; Tjeldvoll, 1997), stakeholder university (Jongbloed and Goedegebuure, 2001). In all these developments one of the concerns is that this may lead to the disappearance of university of culture described by Readings. It is stated that there is crisis of purpose in the modern university. The hegemony of this multi-university has emerged as a result of powerful forces compelling it to conform "to the ideology of today, a global theory called corporatism". Its main role is the production of human resources appropriate for the market place rather than of a "national culture" (Readings, 1996). This concern about the market driven education is reflected in the UNESCO's draft resolution in 2003 which states that "unregulated growth of higher education markets could weaken the sustainability of national higher education systems, particularly in less developed countries". As Narasimharao (2010) points out the present day universities have the tough task of taking the social responsibility of protecting traditional university by moving away from narrow considerations of economics to a broader

multipurpose education. Wrestling (1997) points out that the traditional university has many problems and is beset from within and without. He adds that to preserve it and reform, it will take much hard work and all the good will, imagination and intelligence we can muster.

Since Science and technology form the core basis for the present day knowledge era, continuing science and technology education is of prime importance for the universities of 21st century. For National development buidling skilled and educated work force in science and technology is an important activity. For example biotechnology industry finds access to future employees and workforce development as one of the second or third major hurdle in further progress of industry (Dahms, 2003). Narasimharao (2010) while discussing biotechnology education and societal demands states : "The emergence of knowledge society warrants universities to ensure that overall work of the academy is more relevant to the nation's most pressing civic, social, economic and moral problems and there is an urgent need to have a fresh look at the approaches followed in biotechnology education and training, … … ….". Pisano (2006) argued the need for a 'new anatomy' for biotechnology which would help integrating different skills and knwoledge that reside in a range of disciplines and industry sectors. Similarly Puente-Rodríguez (2012) discussed local sustainable biotechnological developments and reconstruction of biotechnologies. He says that the rural third world are furthest from the techno-economic power centres. It is essential to develop new approaches that can be adopted to expand the boundaries of scholarship and for integrating the activities of various stakeholders of biotechnology (Narasimharao, 2012). This is true for other science and technology fields and there is a need for finding new approaches or restructuring existing approaches to facilitate more academy-soceity integration. This can happen when we are able to expand the boundaries of scholorship of the academics. It is in this context many leaders in higher education started advocating a new academy - more engaged in the environment they have been in and the need to do far more than expand and reach of the institution while maintaining their integrity as institutions of scholarship. We argue that we need to develop and evolve a new anatomy for higher education as a whole which suits the present day knowledge society.

II. Knowledge Society and Knowledge Economy

All development activities of human beings from ancient times can be attributed to the knowledge gained by them. However, the difference between now and the earlier time is the pace at which knowledge grows and the need to integrate this knowledge into region's social, economic and political development. World Bank report (2007) identifies knowledge economy as a process of generating relevant knowledge and putting that knowledge to work to generate further growth in terms of economic, political and social development. Obviously the higher education institutions play a central and crucial role. As Gunasekara (2004) states they have to be linked to place with enabling partnership role with industry, government and communities. There are many developments to make higher education institutions to connect to their place. Some of these developments are mode 2 thesis (Gibbons et al., 1994), university-industry linkage (Schiller & Brimble, 2009), Tiple Helix (Etzkowitz et al., 2007), Regional innovation Systems (Gunasekara, 2006), higher education for sustainable development (Barth et al, 2007), centres of excellence (Beerkens, 2009), National Innovation systems (Nelson, 1993) University engagement (Sandman, 2008), University outreach (Boyer, 1996). Narasimharao (2009a) argued the need for new approaches to biotechnology education and training giving the examples of using some of these concepts.

In the linear model, knowledge transformation from universities and other research institutes to the society occurs either through 'market pull' or 'technology push'. In this model publication and patenting assumes two different systems of reference. Theorisation of the role of universities and other educational institutions to their place started highlighting the importance of knowledge spillovers from these institutions to the surrounding society for regional economic and social development (Etzkowitz, 2002; Van de Ven, 2007; Weerts & Sandmann, 2010; Holland, 2001; Braskamp & Wergin, 1997). It was argued that there is a need for inventing an interface strategy through new organizational mechanisms (OECD, 1980). Two dominant approaches to this concptulaization were identified (Gunasekara, 2006). Both bodies of thought (one focusing more on developmental and another on generative highlights that universities are increasingly linked to place but they offer different analyses of the driving forces shaping that relationship. Knowledge is no longer considered as the domain of one organisation or one institution. It is stated that the sharp distinctions between academic and lay players in knowledge production have weakened because the latter play a key role as brokers (or even as creators) of science (Gibbons, 1998).

It is argued that in the knowledge era what the committee on rejuvenation and rennovation of Indian higher education system observed with regard to disciplinary boundaries should be extended to the various systems and concepts of tertiary education. The systems boundary walls should not be rigid but be porous so as to use different features that are available in different systems. One of the best examples can be open distance learning. Though this has gained popularity in many countries including India, it is always treated in isolation. For instance in dual mode universities in India the distance education concept is not used in upskilling the regular students of conventional universities. For exploiting the advantages of knowledge society it is necessary that the higher education takes a new approach to integrate various concepts and models as per target group's limitations and requirements. It is in this context we discuss professionalising of science education.

III. Professionalising Science Education and Continuing S & T courses

UNESCO report (2002) states "Knowledge societies offer both signinficant opportunities and real risks. They require fundamental changes in teaching and learning habits, a new organization of content and structure of leaning provision and a new appreciation of learners' intellectual, emotional and social needs. The skill levels required in the labour market are high and all societies face the challenge of raising their educational performance." Knowledge based economy raises the educational bar of a person in order to be employable. Most of the time we prepare our science graduates for careers in research by introducing various developments in science and technology. We may thus turning out bright, eager graduates with updated scientific knowledge to further advance that particular subject. However, if we have to take into consideration the needs and demands of the society and its stakeholders, we need to review our approach.

Narasimharao et al., (2011) discussing how natural sceicnes need to be oriented for professionalizing universitiy education argued that preparing science graduates towards a professional orientation will enable them to apply their knowledge in real world situation. Tobias et al., (1995) defines this professionalism as th ablity to provide the same level of expertise and leadership as professional do in other fields. In other words these science graduates should have the ability to use the products of scholarship in their work and by being familiar with the practical aspects of emerging problem areas. Schuster (2012) discusses on how science graduates (Ph.Ds) should be prepared to be able to do many things in academia, industry,

governments, not-for profit organizations, and every realm of our society.

Narasimharao (2013) identified issues in professionalizing natural science education. He identified these under the heads - preparing the graduates for the work place, challenge of integrating knowledge from different disciplines, involving all stakeholders of higher education in the development of program, preparing the students for professional appraoch, courses for diferent professions and orienting tertiary education. We can plan both at macro and micro levels. For instance if we take biotechnology, we can identify the job function and task of each category working in a specific area (see Dahms & Leff, 2002). Also we can list the general work skills, industry related skills, industry related knwoeldge and attributes for a bioscience technical specialist. Besides subject specific and technical skils the graduates should also acquire some generic skills (Johonson et al., 2002). Sandesh and Gireesh (2013) discussed various challenges one may face when one wants to start one's own enterprise immediately after completion of Ph.D. studies.

In this era of knowledge economy, there is a need to develop educational systems parallelly in tune with other developments. This warrants for moving away from rigid boundaries of disciplines to provide opportunities for fulfilling the needs of students seeking science based careers outside the acadmic world and also the needs of local, regional and national employers who hire them. It may be necessary to develop new courses and curricula specific to professional practice. This does not mean that we need to dispense away the traditional discipline based programs. What is required is to fulfill the needs of students who may need a different graduate experience for the workplace: banks, insurance&financial companies, small and medium scale enterprises, military, intelligence, security (that have an increasing need for science and technology savy staff), civic service organiszations needing people having knowledge in science as well as in sociology, economics and other fields, non-governmental organizations in different fileds needing people having science based knowledge and government organizations. For instance, we can identify three broad routes for preparing students in algal biotechnology - Careers in algal biotechnology for developing specialist educationists and researchers in various branches related to algal biotechnology, careers in algal biotechnology to cater to the needs of the industry and careers in algal biotechnology to cater to the needs of society. We can identify a detailed job prospects and careers for each of this category (Narasimharao et al., 2012). It is rather important that we develop suitable continuing science and technology education programmes using different approaches.

IV. Identifying Approaches for Continuing Science and Technology Education

We need to develop new innovative approaches to meet the various challenges we may face in professionalising the science and technology graduates. Knowledge development at regional level is basic to strengthening of knowledge society and knowledge economy. The role of universities in regional development goes beyond study of technology transfer and direct employment effect of spin-off companies and the establishment of science parks. It embraces wider ethos of developing human and social capital within the region. There is need that science and technology programmes of universities focus on professional development of local managers, integrating implicit knowledge available locally, development of skills and knowledge relevant to the region, research and information on embedding local business in global economy etc. It may be necessary to analyse the knowledge and technology available and what challenges one may face in applying them at local level.

Discussing on the new approaches for algal technologies to be more successfully used, Narasimharao et al., (2012) identified four major challenges for universities (Bio-business and knowledge transfer, Knowledge and Technology integration, Human resources development and Capacity building, and Expanding boundaries of scholarship). They argue that for facing these challenges it is necessary to evolve some innovative and new approaches. Guruprasad (2013) discussing multifaceted industry-academia collaboration touched upon several issues involved. They include need for initial learning programme (ILP), continual learning program (CLP), training and carrer development and role of universities, higher education for associates, industry specific certification programmes for working professionals, knowledge management and development of "sharing and learning " culture, reuse of intellectual assets, intellectual property creation, internal networking, self-sustaining centres of excellence (CoEs), finishing school and communities of practice (CoP). Anand (2013) discussing corporate education in universities in India states "Separation of the professional courses like engineering, medicine, law, pharmaceuticals, agriculture and management studies was a step towards job oriented education. The need to introuduce job oriented courses in humanities and sciences became iminent as the number of job seekers increased several folds as years passed by". Whether the existing structure will hold good for these kind of demands is to be carefully analysed. One has to take into account the various developments that are taking place in tertiary education field and see how these development can help in preparing professional oriented courses in humanities and sciences.

V. Need for New Anatomy

The research of Pisano suggests that in order to bring more success for science and technology for societal demands one need to develop a suitable and different structure. Pisano (2006) attributes the failure of several biotech ventures to the flawed 'anatomy' adopted from Silicon Valley success. By "anatomy" he means the sector's direct participants (start-ups, established companies, not-for profit laboratories, universities, investors, customers; the institutional arrangements that connect these players (markets for capital, intellectual property, and products); and the rules that govern and influence how these institutional arrangements work (regulations, corporate governance, intellectual property rights). He suggests that for biotechnology to succeed, its anatomy must help in three ways: managing risk and rewarding risk taking, integrating the skills and disciplines that reside in a range of disciplines and functions, and advancing critical knowledge at the organizational and industry levels. This may be related to several challenges identified by Narasimharao and Nair (2010) while discussing universities and corporate education.

We can identify various systems of education and training developed in response to the knowledge society demands. These may be classified as

- Open University and Open distance learning, Virtual universities
- Corporate universities, Franchise universities, Academic brokering
- Collaborations of conventional universities, Consortiums
- University outreach programs, Community colleges, Knowledge media

Narasimharao (2009b) reviewed biotechnology education and training through these various educational systems with some examples. Some of the Institutes/universities of higher learning are modifying their system by introducing certain innovations and avoiding compartmentalization of different systems of education and following more flexible approach to focus on the objective to be achieved. In order to make education nearer to societal needs, universities/higher education institutes are evolving certain

concepts/models like university-corporate education models, mode 2 model of education, triple helix, National/regional innovation systems, higher education for sustainable development, public-private-panchayat partnership, university-industry cooperation models, skill development mission, finishing schools, centres of excellence and relevance, community colleges, scholarship of engagement etc. We need to integrate various systems/concepts to bring out a new 'anatomy' which is suitable for the knowledge society.

VI. CONCLUSIONS

Developments in knowledge society should be treated in a wholistic manner and not merely on economic considerations. It should lead to 'knowledge culture' (including economy) at all levels (including rural and remote areas). Universities and tertiary education institutions are central to this whole concept as they are the key players in knowledge production, knowledge integration and knowledge dessimination. They need to come out of rigid boundaries they created for themselves. They have to act freely without confining themselves to a system or to a concept. Their aim should be to fulfill the objective of suiting themselves for the needs and demands of knowledge culture. There are many concepts and systems developed and practiced in recent past by several tertiary education institutions. Reviewing and integrating these concepts and systems for evolving a new structure for developing science and technology courses for regional development is necessary for getting real benefit particularly for rural and developing areas.

Regional development cannot happen when universities/tertiary education institutions work in isolation merely functioning as degree award institutions. They need to integrate in their teaching and research the real world nature to enable the students relate their science knowledge to problems and issues faced in civic society including industries and corproates. This is akin to the difference between 'corporate education' and 'coroporate training' as given by Ryan (2010). Corporate education goes above and beyond mere training. It inovles the generation of new knowledge to help companies and orgaisations grow and develop, rather than the limited focus of corporate training that only aims to develop an individual's operational competency. Universities and colleges need to develop strategies for preparing their science students as professional who can apply their knowledge to real world issues. Efforts like add on courses for vocational training, soft skill training, employability skills and the like cannot be treated in isolation. The continuing science and technology programmes should be designed in such a way that science amalgamates with management, economics, sociology, and also needs of different professions.

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