

"Networking" Science & Technology Education - opportunities and challenges

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Over the past twenty years, the transformation of a relatively simple computer network used by a few researchers into a global Internet, involving hundreds of millions of people and generating a new economic order, took government, business and education, by surprise. Given the well-established tendency for people to underestimate the extent and rate of technological change, it seems reasonable to suggest that the extent to which the Internet created economic and social upheaval in the past ten years is likely to pale into insignificance by comparison with the changes occurring in the next decade. The next few years will encompass the significant impact of broadband, wireless, streaming media, voice recognition and the inevitable growth of new Internet applications in educational "networks". In the present context, change is the only constant! The electronic environment provides opportunities for presenters and proctors to be located virtually anywhere in the world and thus 'meet' regularly and in a cost effective way via email and virtual chat. This model offers considerable promise in addressing the resourcing issue. Further work on the nature and separation of tasks for team members together with an assessment of costs involved may provide a useful alternative for addressing the problem of resourcing online teaching and learning. A few "success factors" are suggested for this purpose in the paper. Development centered globalization addresses issues such as internationalised knowledge systems, the changing patterns of communication, and the penetration of technology into the social, educational and cultural fabric of communities, suggests the need for institutions to form strategic bonding in reviewing and managing the changing face of the global educational arena. Educational strategies vary from country to country depending on economy, culture, infrastructure and capabilities to identify the appropriate mix of wireless, telephone, satellite and computer-based communication techniques. Understanding of the distributed electronic communication technologies will help to demonstrate integrated networked education systems having features such as, delivery of simulated lessons, integrated student-teacher sessions, and learning activities in geographically dispersed schools and colleges. This paper discusses how theories of innovation have been incorporated in S&T education methodologies. The role of technological awareness in the educational system has been highlighted. In the recent management theory, the concept of "learning" and updating the skills of the teachers has become an important feature. Education, training and re-training has become a standing requirement for the speculative scenarios of the future educational institutions. The professional development of networks through learning and training has been emphasized in the paper. This needs to be followed by a comprehensive evaluation of the training programme. Based on the results of the study, a number of recommendations have been suggested relating to policy on professional development, training opportunities and methods to encourage student-teacher networks for constant interactions. In addition, the opportunity to share my thoughts with you today is also significant because I am eagerly looking forward serving the CASTME-Asia actively in the coming years. In view of the difficulties in keeping pace with development in knowledge explosion, telecommunications, distance and open learning, developing countries will benefit immensely by taking advantage of developments in technology to interact through a collaborative network. Additional to the issues raised earlier, there is also a number of specific reasons why tertiary institutions offering instruction by the distance mode should network in developing countries, especially of the Asian region should institute a collaborative network.

The transformation of a relatively simple computer network used by a few educational researchers into a global Internet, involving hundreds of millions of people has generated a new economic order, took government, business and education, by surprise. Given the well-established

tendency for people to underestimate the extent and rate of technological change, it seems reasonable to suggest that the extent to which the Internet created economic, educational and social upheaval in the past ten years is likely to be very significant by comparison with the changes occurring in the next decade. The next few years will encompass the significant impact of broadband, wireless, streaming media, voice recognition and the inevitable growth of new Internet applications in educational "networks".

Katz and Oblinger (2000) highlighted the potential impact of e-business on higher education, "The dominant issues facing the leaders of today's colleges and universities are what aspects to change and how fast can they be changed?". Further, as Schlender (2000) pointed out, the Internet has already "...reached a stage that isn't so much about vision and proprietary innovation as about execution and competition". This emphasis on execution and competition is a particular challenge to the typically slowly evolving institutions of higher education, which need to find the means to "e-volve" rather more rapidly in the Internet Age. Indeed, many universities are still struggling to come to terms with the imminent challenges posed by competition for online students through the emergence of the global lifelong learning economy. Universities with a significant role in distance education, however, are different: they have always been, and will always be, in the vanguard of innovation and institutional change.

Universities with a significant commitment to distance and open education institutions have been at the forefront of adopting new technologies to increase access to education and training opportunities. Distance education operations have evolved through the following four generations: first, the Correspondence Model based on print technology; second, the Multi-media Model based on print, audio and video technologies; third, the Tele-learning Model, based on applications of telecommunications technologies to provide opportunities for synchronous communication; and fourth, the Flexible Learning Model based on online delivery via the Internet. Although many universities are just beginning to implement fourth generation distance education initiatives, the fifth generation is already emerging based on the further exploitation of new technologies. The fifth generation of distance education is essentially a derivation of the fourth generation, which aims to capitalize on the features of the Internet and the Web. To place the fifth generation Intelligent Flexible Learning Model into a meaningful conceptual framework, it is worth reviewing briefly certain features of the previous four generations of distance education. Some of the characteristics of the various models of distance education that are relevant to the quality of teaching and learning (Taylor, 1995) are summarized below:

Models of Distance Education - A Conceptual Framework include

- Models of Distance Education and Associated Delivery Technologies
- Characteristics of Delivery Technologies
- Flexibility Highly Refined Materials Advanced Interactive
- Delivery Institutional Variable Costs Approaching Zero

With a detailed cost analysis of various technology interfaces it is noticed that prior to the advent of online delivery, variable costs tended to increase or decrease directly (often linearly) with fluctuations in the volume of activity. For example, in second generation distance education delivery, the distribution of packages of self-instructional materials (printed study guides, audio-tapes, videotapes, etc) is a variable cost, which varies in direct proportion to the number of students enrolled. In contrast, fifth generation distance education has the potential to decrease significantly the costs associated with providing access to institutional processes and online tuition. Through the development and implementation of: automated courseware production systems, automated advice systems, and automated business systems, the fifth generation of distance education has the potential to deliver a quantum leap in economics of scale and associated cost-effectiveness. Further, effective implementation of fifth generation distance education technology is likely not only to transform distance education, but also to transform the experience of on campus students.

Consistent with Schendler's (2000) proposed emphasis on execution and competition, the fifth generation model will not be presented solely as a set of abstract principles, but will be mentioned as an overview of the e-University Project, which has been planned thoroughly and is

now in the early phases of implementation at the University of Southern Queensland (USQ), Australia. It is focussed on the preparation of graduates of both undergraduate and postgraduate courses and the university as a whole for the emerging 'e-world', with the following specific areas considered:

1. Opportunities for students to access information and communications technologies.
2. Routine use of information and communications technology in administrative dealings with students.
3. Using information and communications technologies in core educational processes.
4. Opportunities for students to learn about information and communications technologies and their implications in the student's area(s) of specialisation.
5. The introduction of courses/specialisations in aspects of the e-world, and
6. Thinking through the use and implications of information and communications technologies in strategic planning and resource allocation.

The electronic environment provides opportunities for presenters and proctors to be located virtually anywhere in the world and thus 'meet' regularly and in a cost effective way via email and virtual chat. This model offers considerable promise in addressing the resourcing issue. Further work on the nature and separation of tasks for team members together with an assessment of costs involved provide a useful alternative for addressing the problem of resourcing online teaching and learning. A few "success factors" are suggested in the following paragraphs. The first is access: to allow students who would otherwise be denied educational opportunities to gain access to courses. The second is equivalence and integrity: students taught at a distance should receive an equivalent education and an equivalent qualification with the same integrity as those earned through the conventional mode. The third is excellence: quest for excellence in quality of learning materials, teaching, support services, academic and administrative systems or professional development of staff. As the resolution of these issues continue to dominate the theory and practice of distance and open learning, many countries in the world, especially those developing, became increasingly attracted to this form of education.

In Asia, like in other regions of the world, the countries are as diverse in many respects just as they are similar in others. Some of the common features include huge and rapidly expanding populations which are still mainly rural, an exceptionally large demand for education which has not been met, the lack of adequate capacity of conventional educational systems to provide access for all, and the inequitable representation of those who have been marginalised through resources, location, economic and other reasons. Two-thirds of the world population are in Asia (about 4 billion). In most of the Asian countries, therefore, governments have recognised the need to use education as a potent force for national and regional development and hence embarked on the establishment of dedicated learning institutions.

Learning and teaching, has become associated with the tremendous growth of the interactive computer and communications technology. Beginning with print intended purposely for education, the delivery of education to remote students has gone through the Multi-media model, the Tele-learning model and now the emerging fifth/sixth generation of education, the Flexible Learning Model. Thus, associated with the exponential population growth in the world, is the need to educate and train the mass of people in the 21st century. Contemporary developments and advancement in telecommunication, and computer technology especially, have added the facet of "virtuality" to imply the ability to time-shift as well as overcome geographical distances.

Challenges are imminent and would need to be effectively managed for a smooth and positive transition into the next millennium. What must occupy our minds right now is how best to face the challenges and effect the necessary changes. In view of the difficulties in keeping pace with development in knowledge explosion, telecommunications, distance and open learning, developing countries will benefit immensely by taking advantage of developments in technology to interact through a collaborative network. Additional to the issues raised earlier, there is also a number of specific reasons why tertiary institutions offering instruction by the distance mode should network in developing countries, especially of the Asian region should institute a collaborative network. Some of these reasons include the following:

1. **Common purpose:** All open and distance education institutions have a common purpose of providing quality lifelong education and training appropriate to the rapid economic development taking place in the region and tailored towards the needed flexibility for catering for the huge demand in education and the labour market for constant training for upgrading or converting qualifications.
2. **United front:** Although the Asian countries have distinguishing cultural, geographic, political and linguistic characteristics which at times could constitute barriers in developing relationships at times, it could equally be argued that the common interests of the institutions which have developed from geographical, political or linguistic alliances should be pursued through a united front.
3. **Globalisation and strategic bonding:** Development centered globalization (Dhanarajan, 1997), which addresses issues such as internationalised knowledge systems, the changing patterns of communication, and the penetration of technology into the social, educational and cultural fabric of communities, suggests the need for institutions to form strategic bonding in reviewing and managing the changing face of the global market and educational arena.
4. **Complementing similar networks:** Open and distance learning institutions in other regions of the world have established and continue to maintain constant professional inter-relationships through national, regional or academic and professional organisations. These electronic networks have been found to be a useful way of taking the distance out of learning and teaching. A collaborative network will also serve a complementary role to the ones already available, and also serve a specific regional function.

The *collaborative network* will provide the open and distance learning institutions in the Asian region to do a lot of things which distance or the lack of face to face meeting prevent. For example, the collaborative network could be used to promote (i) intra and inter-institutional co-operation, (ii) the rapid sharing of information on changes in educational paradigm, (iii) management of distance learning, innovation in pedagogy and technology, etc. as and when available or needed, (iv) the maximisation of the use of scarce resources by sharing across geographical and other borders develop a collegiate environment towards common professional and educational matters within the region, and (v) effectively manage learning in an environment which indicates that the borders between traditional and open universities might soon become blurred with emerging developments in technology and education. However, the concern that the use of collaborative networking through technology might further marginalise the 'haves' and the 'have nots' within the developing world is real and will need to be tackled. Developments should not further widen the already existing gulf between the emerging economies and the yet to emerge ones within the developing world. Similarly it should not marginalise the developing world in what should be a concerted effort toward a common global development in distance and open education.

Thinking through the use and implications of information and communications technologies in strategic planning and resource allocation the essential features of a fourth generation e-Learning environment support a learning process that is interactive, non-linear and collaborative. These features include the use of an interactive study chart as a basic navigational tool, which sets the broad parameters of the subject matter content to be investigated, and lists a number of exemplary references. References are electronic and hot linked via specific URLs. Additionally, the students are free to surf the Net for supplementary teaching-learning resources that meet their specific needs. They are also able to upload and download assignments, with those of sufficient quality being added to the teaching-learning resources database for reference by future students. The interaction with courseware materials is, however, only one element of the interactivity built into the course approach. Interaction with other students, teaching staff and other experts, who act as mentors, can be achieved through the use of Computer Mediated Communication (CMC), primarily through the deployment of asynchronous discussion groups. Students are encouraged, and in many cases required, to communicate through various electronic discussion groups, established for specific content areas as well as for informal social interaction. Fundamental to online pedagogy is the effective use of asynchronous CMC for ensuring effective interactivity,

which is generally regarded as an essential feature of effective pedagogy. It is worth noting that there is a qualitative difference between a traditional on-campus tutorial (real-time verbal communication) and computer conferencing (asynchronous written communication) with the reflective and precise nature of the latter being very different from the spontaneous and less structured nature of oral discourse in either a face-to-face, video or audio teleconference context. As Garrison (1997) highlighted, "The reflective and explicit nature of the written word is a disciplined and rigorous form of thinking and communicating it allows time for reflection and, thereby, facilitates learners making connections amongst ideas and constructing coherent knowledge structures". Computer conferencing is therefore not just another technology, its capacity to re-humanize distance education represents a qualitative shift which has the potential not only to reshape learning at a distance, but also to pervade conventional education systems. Further, and more importantly, in the context of fifth generation distance education technology, CMC provides a rich source of thoughtful interactions, which can be structured, tagged and stored in a database and subsequently exploited for tuition purposes on a recurring basis through the application of automated response systems. It is this judicious use of automated response systems, which has the potential to transform the cost-effectiveness of distance education and thereby to meet the growing demand for access to lifelong learning.

The effective use of CMC is presently constrained in an important way. It is still a function of what Daniel (1999) recently referred to as the "cottage-industry model", which entails the traditional working practices of universities, wherein the same academic staff member usually does everything, including teaching, providing academic support and assessment for a group of students. In effect, the current applications of fourth generation Internet-based delivery tend to generate resource allocation models similar to tutorial-based on campus teaching. Indeed, it is still a fear of many academics initiating an online teaching program that they will be overwhelmed by email requesting support from individual students. While such fears can be allayed by the use of "one-to-many" communication systems such as bulletin boards, mailing lists and threaded discussions, the underlying resource model is not significantly different from conventional on campus teaching, with a staff member being necessary to manage groups of approximately 20 students to maintain a reasonable quality of interaction and academic support. In contrast, the fifth generation Intelligent Flexible Learning Model has the potential to deliver major economies of scale in managing teaching and academic support through the exploitation of automated response systems. Many teaching staff make use of discussion groups, which entail students posting "reflections" via the asynchronous CMC system. The teaching staff also post comments, which are aimed at engendering student engagement and ensuring that the focus and depth of the online threaded discussions are appropriate to achieve the learning outcomes. In the same vein, members of the teaching staff respond to student questions posted to the discussion group. These contributions are often quite complex and typically serve to enhance the quality of interaction. Development of a detailed response to a searching student query naturally takes time. The benefit of the system is that the communication is on a "one-to-many" basis, so that all students may benefit, not just the one who asked the initial question. Further, experience demonstrates that other students often comment on the issues raised thereby enriching the depth and quality of the dialogue. The value of these contributions is particularly useful where students are giving examples of applications in different cultural contexts. Such interactions may take place in conventional classroom settings, but the difference is that they are ephemeral and not documented for detailed reflection as they are in the CMC system. There is no doubt that many of the comments posted to the asynchronous discussion groups are valuable for tuition purposes. Storing such interactions in a relational database is technically straightforward, and provides a rich resource for mining by key word/matching, so that such pedagogical resources can be used to assist new students time and time again through the operation of the automated response system.

Development centred globalization addresses issues such as internationalised knowledge systems, the changing patterns of communication, and the penetration of technology into the social, educational and cultural fabric of communities, suggests the need for institutions to form strategic bonding in reviewing and managing the changing face of the global educational arena. These projects aim to demonstrate distributed electronic communication technologies that can be configured to provide mass instruction with pre-packaged materials that coexist with and

complement highly individualized instruction, combine wireless and wire-line technologies into an integrated system at reasonable cost at almost any site, and promote experiential and collaborative learning. Short-term goals are to demonstrate single, integrated distance education systems that have the following features:

- appropriate for each given cultural and economic situation synchronous delivery of "special event" programming
- asynchronous delivery of pre-packaged lessons, simulations and demonstrations
- just-in-time access to presentation and self-teaching materials interactive teacher-student sessions
- collaborative learning activities among geographically dispersed students.

Educational strategies vary from country to country depending on economy, culture, infrastructure and capabilities to identify the appropriate mix of wireless, telephone, satellite and computer-based communication techniques. Understanding of the distributed electronic communication technologies will help to demonstrate integrated networked education systems having features such as, delivery of simulated lessons, integrated student-teacher sessions, and learning activities in geographically dispersed schools and colleges.

Looking at how theories of innovation have been incorporated in S&T education methodologies. The role of technological awareness in the educational system has been highlighted. In the recent management theory, the concept of "learning", and updating the skills of the teachers has become an important feature. Education, training and re-training has become a standing requirement for the speculative scenarios of the future educational institutions. The professional development of networks through learning and training has been emphasized in recent times. This needs to be followed by a comprehensive evaluation of the training programme. As the intelligent object databases become more comprehensive, enabling personalized, immediate responsiveness to an increasing number of student queries, the institutional variable costs for the provision of effective student support will tend towards zero. The effective use of such technology not only improves the responsiveness of the institution, but also frees up student support personnel to provide personal assistance via email dialogue or telephone as necessary. Further, every interaction is tracked from initiation to resolution, including flexible routing of enquiries based on explicit rules-based escalation protocols to ensure timely and successful responsiveness, and subsequent statistical reporting of system performance. Tracking interactions with prospective students enables the collation of the effectiveness of institutional marketing strategies, an increasingly important strategic issue for universities in the emerging global learning economy, which demands a highly effective public e-Interface with the University.

A central feature of this model is the development of a customizable e-Interface, a campus portal through which students, staff and other stakeholders can engage with the university in a highly interactive and compelling manner. In Norris' (2000) terms, a well designed campus portal will engender "pervasive, perpetual interactivity", which will enable universities to provide such efficient service to students that it is likely to build effective, enduring relationships that could last a lifetime. To be successful in the emerging global lifelong learning market, a university needs to create a campus portal that will achieve a degree of interactivity, user friendliness and personalization that does not exist in the vast majority of campus web sites today.

It is becoming almost impossible to mention education and development in developing countries without distance and open learning. It has become the hallmark of comprehensive national development. One sometimes wonders how the world, especially the developing world, has survived without distance and open education the way we know it today, given the tremendous role it has played in the recent past in all countries of the world. Second, distance and open education is undergoing phenomenal transformation in all parts of the world. Contemporary developments have shown that distance and open education has now become a household term in almost every part of the globe. It is even more significant that the so-called traditional universities which have all along contributed to this innovative and practical form of mass education are now emerging as the major players in its provision even though it will not be out of place to say that their major motivation may not be congruent with the one which the typical open and distance

education providers have been associated with. It will not be too long before all universities in the world take their queue in search of their part of the global pie of distance and open education.

Our experience is in what we would like to regard as a successful experiment in using the most cost effective and broad based mode of education to catch the majority of the masses who yearn for education both for personal and national development. It is true to say that but for distance and open learning, the majority of these people would never have had the opportunity of higher education. In this sense distance education is not only a champion of education for all, it has also provided a level playing field for good participation. In the developing countries, therefore, at least as far as the developing countries of Asia are concerned, we can confidently say that we have mastered how to take the distance out of education for anyone who is interested. The 'distance' aspect of education has been redefined in India, as a shared vision. Based on the results of the study, a number of recommendations have been suggested relating to policy on professional development, training opportunities and methods to encourage student-teacher networks for constant interactions. In addition, the opportunity to share my thoughts with you today is also significant because I am eagerly looking forward serving the CASTME-Asia actively in the coming years.

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