CONCURRENT INSTRUCTIONAL SERVICES OVER NPTEL CONTENT FOR QUALITY EDUCATION IN THE COLLEGES

Alternate Title: "Building and Managing the Knowledge Infrastructure for Higher Education"

A Proposal under Education Grid and NPTEL Phase - II

Submitted to the NPTEL and Director of Technical Education, Kerala

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Vision of Education Grid: "Enable, Educate and Empower Every Citizen and Community Through Knowledge"

ABSTRACT OF THE PROPOSAL

The National Programme on Technology Enhanced Learning (NPTEL) is a major initiative of the seven Indian Institutes of Technology (IITs) and the Indian Institute of Science (IISc) to develop content in more than 200 courses for the undergraduate studies in the engineering colleges. The NPTEL Program is funded by the MHRD. The objective is to enhance the quality of education in the large number of engineering colleges and technical education courses through technology enhanced learning. In this paper we look at several issues and approaches related to deploying and using such content in the colleges so that the intended objective of enhancing the quality of instruction in the engineering colleges is realized. In parallel with the NPTEL initiative, the Kerala Government, through its Higher Education Department has undertaken the initiative of the Kerala Education Grid (KEG) project. We review the approach and methodologies adopted in the KEG for content management and instructional services supported over the Internet and Web. Based on these two developments, we propose the launch of NPTEL Phase–II where we establish subject specific portals and manage Concurrent Instructional Services, or, CIS for the colleges that wish to benefit from the NPTEL content. We show that CIS is best established as networked collaboration and resources access environment organized over a Virtual Learning Campus. We also bring out that a system of establishing and maintaining subject-specific portals are necessary to support the CIS. Such portals will help provide innovation driven learning ambiance in the colleges of the country. We believe that such approach of live CIS in the different subjects should form basis of NPTEL Phase-II. This will largely overcome the deficiencies in our country's higher education system and make it learning centric for all concerned. This in turn will establish the core knowledge infrastructure for higher education in the country that can be replicated in areas other than technology education also.

1. INTRODUCTION

Under the National Programme on Technology Enhanced Learning [NPTEL], the seven IITs and IISc have mobilized nearly 350 expert faculty to develop content. This content will be available over the next few months in nearly 120 courses in the form of video recorded lectures and web-accessible form in 112 courses. The volume of lectures recorded by the IITs amount to 5000 hours approximately. The large number of engineering colleges desirous of benefiting from the same will have access to this content. The courses are targeted for enhancing the quality of education offered in the colleges. Most of the engineering colleges suffer from acute shortage of quality and experienced teachers. The challenges that NPTEL as part of its next phase should address are: (i) to develop and deploy such learning activities and processes by which the colleges will put to use such content in ways that enhance the quality of education; (ii) establish systems and processes that will make technology enhanced learning and research a part of academic infrastructure; and (ii) how to sustain the process of content development and use it as a way to modernize the curricula and adapt them to keep pace with emerging trends in the subjects.

This paper first addresses several issues related to imparting quality learning for our students, supporting teachers in their instructional tasks, generating more quality teachers and equipping the colleges and universities with resources to manage the instructional processes effectively. In the process, we arrive at a seamless web-enabled and managed national educational infrastructure over broadband network for the country. **This infrastructure exploits the synergy across institutions over the emerging broadband and EDUSAT network and make the same into an effective national knowledge infrastructure for the country as a whole.** Our goal is to address the issues related to enhancing the quality of education in the colleges, universities and the higher education systems in general through building better learning infrastructure and processes and addressing support for life long learning for those who have already graduated and/or employed. We briefly review the kind of steps being taken today and and their limitations in the next section.

2. CURRENT DEVELOPMENTS IN HIGHER TECHNICAL EDUCATION

Our governments and society have taken several steps to increase the number of seats in the professional and higher education in general by opening large number of engineering and other colleges and courses. This is particularly impressive in the southern states. In

Kerala alone there are now almost 80 engineering colleges. In Tamil Nadu there are over 280 engineering colleges. So are the cases in Andhra Pradesh and Karnataka. Other states in India are also following the lead. There are major Technical Universities like the Anna, Viswesvarayya and Jawaharlal Nehru Technical Universities in Tamil Nadu, Karnataka and Andhra Pradesh respectively with large number of affiliate engineering colleges. The regular established universities also have a large number of affiliated engineering and other professional colleges. Besides, a number of specialist professional institutions like the IIITs have also come up. **But, providing quality education, or, education with relevance to current and emerging trends in these institutions remains a dream.** There are several reasons for this, main ones being the lack of quality, experienced and motivated teachers, capacity to make adaptations to the curricula aligned with emerging trends and capacity to manage modern information and computational systems and services.

The reasons for the difficulty in providing quality education are not far to seek. With the huge demand from the large young and growing population for professional education and in industry particularly in the IT related sectors, we have successfully taken the first step of catering to the numbers – the quantity of seats offered through the large number of new colleges that have come up in the country. Even as this happened, **our university and the technical education system have lost the agility needed to keep pace with the fast changing reality.** Also teaching and research as professions are not attracting the best talent due to lack of good career opportunities. The older universities have steadily been loosing even their earlier capabilities for basic research and postgraduate education in basic sciences and arts. They are mostly reduced to centers of examinations and are struggling to be centers of education, higher studies and research. The approaches of major national bodies like the UGC, AICTE or others under MHRD are more passive or reactive like accreditation and assessment in terms of physical parameters. **They appear tied when it comes to building new systems that enable and empower the higher education system.** They are strangulated for resources and lack the necessary imaginative approach to mobilize the resources in society to enable new systems and solutions to emerge. Hence, **we need to do urgently something refreshingly different than our conventional approaches to build and manage quality in higher education and research.**

In building the new systems and solutions we have to keep three large perspectives in view. **The first is the observation by Albert Einstein that, "There exists no solution to problems within the conditions that created them in the first place."** Hence we have to come out of the system and synthesize the structures and solutions needed to impart

quality education. **This coming out becomes possible** if we ensure that the universities are not closed and the different departments in them do not function in compartments. Further, **the colleges have to align their educational processes in tune with the reality of modern information systems, collaborative environment, digital libraries and e-learning environment and instructional management.** They must build some competency and capacity to effectively exploit the opportunities provided by the emerging broadband network, information systems, computing and collaboration environment that is available today.

Several opportunities emerge from the unique NPTEL initiative of the IITs/IISc and funded by the MHRD (visit: www.iitm.ernet.in/nptel) that makes available authentic video, web and multimedia content in more than 200 courses conforming to the Indian syllabi for the engineering colleges. To arrive at this synthesis, we first provide an overview of the different parameters that constitute quality education, quality learning environment and ambiance. This review is based upon the several initiatives taken under the Kerala Education Grid project and partly delineated in the different publications associated with it [see references 1 to 5].

2. ISSUES RELATED TO QUALITY IN EDUCATION

There are several dimensions related to quality in education. The first is that **as David Merrill states, "Instruction is not information".** Information may be textual, or, multimedia, or even passively (browsing type) interactive. **Quality instruction involves a set of learning processes through which the learner is taken through and in its conclusion, the learner can say with some confidence that he/she 'understands'.** Information in different media has to be imaginatively used in the learning processes for effective instructional delivery.

We are increasingly getting large volumes of content in diverse forms accessible over the Internet and digital storage media. Some of them are from authentic sources like the Open Courseware of MIT, the NPTEL, from academicians in many universities, from the content design and publishing industry, the regular book publishers and eminent authors who increasingly back their text and other books by portals on the web for continuous updates and interaction. **Content is a necessary construction and constitutes the base on which we build and manage our instructional processes. The second aspect of content, if it is to be of effective use in instruction is that it needs to be focussed to**

achieve the intended instructional objectives. Hence there is the need to structure the content available in learning modules with clearly stated instructional objectives and having the different components of learning activities and guides clearly delineated in ways that help conduct quality instructional processes. One may evaluate the usefulness of content on the basis of its capacity to assist effective instructional through a Content Quality Metric, or, CQM as outlined in [1].

In today's syllabus - class - exams – marks type education, we appear to have lost our focus on the real objectives of formal education. Here below we reiterate its objectives and the need to restore formal education to its real goal of producing scholarly and employable graduates.

2.2. Objectives of Quality Education

Quality education needs to be looked at from multiple perspectives. The first is to ensure that the education offered results in the quality of learning imparted, not mere rote learning as it is often reduced to in today's education. This is possible if we respect the following objectives while imparting the learning.

i) **Reduce the gulf between what is taught in the course and the way it is used in the real world.** Make learners think like professionals, or, as genuine scholars.

ii) **Learning is about building the capacity to see the abstraction, understanding patterns, to arrive at informed decisions and to take appropriate action.** Learners should get an appreciation of how to face real world problems, develop understanding, abstract the issue, analyze and synthesize a solution in the light of what they have learnt.

iii) We must keep in mind that learning is a highly personal experience for each learner. **Learners need sense of purpose, motivation, direction in the form of instructional objectives** and go through such activities that teaches them how to observe and abstract when confronted with real world problems. It is 'Man Making Education" as Swami Vivekananda says.

iv) We must respect that the process of instruction is much more than classroom or tutorial type interactions. The instructor himself/herself should have an appreciation of the world of the subject he/she teaches. Instructors should be equipped with such content that help them communicate the 'idea', 'concept' or the 'approach' that is taken in understanding

and solving the problem. **Instruction is about communicating that which is not easily put into words or pictures, a tacit process that is only approximated, or pointed at by the explicit instructional activities.**

We must recollect that **the original objective of examination was to discover the knowledge gaps that one has in the understanding of a subject and its concepts. The real purpose of examination is served when we use the outcome of examination to direct the learner's effort to fill such gaps.** Instead we have degenerated the examination system into a painful test of rote learning that detracts one from pursuit of knowledge. Good systems of the future may as well moderate the weights given to exit examinations with measures that indicate the engagement of students in learning activities. Certainly, **there is much we can innovate and do with the emerging web-based learning environment in the context of instruction pacing and assisting the instructors for effective communication of ideas and concepts.**

2.2. Three dimensions of well-rounded education

The major reason students join higher education is to enhance their competencies and employment opportunities. **Good education should produce employable graduates who are productive both on the job and in life. It must give them not only some mastery and proficiency of the subjects they learn, but also inculcate the sense of professionalism, responsibility, capacity to be a team player and to be a life long learner as well.**

We illustrate in Fig. 1 below the three dimensions of education that have to be addressed in professional higher education. The processes of instruction in colleges should provide ample opportunities in imparting effectively all the three dimensions. Of the three, the foundations, concepts and contextual skills are the ones primarily addressed in the colleges. Here again, due to lack of agility, inexperienced teachers and examination oriented system, the foundations and concepts are not imparted with adequate depth, nor with the insight needed to show how what is taught is applied in real world situations.

It is important to build professional competency while doing a course. This may be done by involving the students to do term papers, study real world problems and see how the context of the subject world appears in them. They should be able to guesstimate things like cost, sizing the problem, awareness of professional societies, associated industry, the journals, different stakeholders in the subject and such others. This

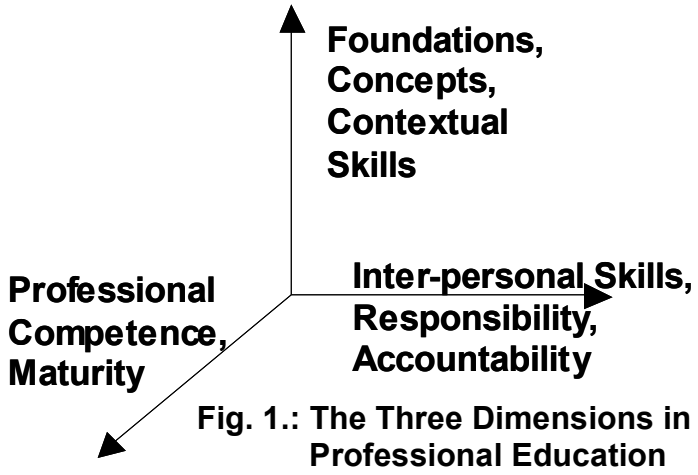

Fig. 1.: The Three Dimensions in Professional Education

will lead to the kind of maturity needed to be a professional. Lastly, all professionals today must develop inter-personnel, communication, documentation, nature of negotiations and such other soft-skills. **They must understand their role in being responsible persons in any activity they indulge with accountability for what they have done. These latter two dimensions are now increasingly sought by the industry today.** But the colleges do not adequately address such soft-skills development among students. The students are left to pick up such capabilities on their own with some assistance from the society at large.

When we say that graduates should be employable, the real intention is to build the capacity in them to be a life long learner who are productive both on the job and in life. This needs adequate attention to the development of soft-skills like ability to communicate and work in teams with responsibility and accountability.

The problems in the Indian colleges are compounded by the situation that they lack the ambience of good universities or institutions. **Good universities and institutions exploit the synergy between their postgraduate programs, research, projects and the undergraduate programs.** This allows for experienced and doctoral level faculty to work in the good universities. But most Indian universities and colleges with postgraduate programs have slowly withered over time, with little enthusiasm left among the faculty for institution building. In many old and established colleges with postgraduate programs, there are no quality doctoral level faculty in several departments. The IITs have managed to survive this Indian problem, but they have the potential to do much better if they look beyond their respective four walls, address the three dimensions of education and nurture much more the

synergy between postgraduate research and undergraduate education.

We may note that in the order of quality universities and institutions, none from India are anywhere in the top. There is hardly any sustained encouragement or environment to innovations in any of our institutions. This may be redeemed if the established institutions and universities set up and manage the proposed CIS and nurture a web-assisted innovations driven learning environment.

3. LEARNING AS TACIT-EXPLICIT INTERPLAY

Formal education systems are intended to provide a structured learning environment wherein the learners, students, instructors and learning resources are dynamically involved in both formal and informal ways of directed interaction and effort. **Learning is effective as group activity when the members of the group are about the same level of maturity.** The selection process of admitting students to a course is supposed to take care of this. We need to keep in mind that **imparting quality education is set over a learning**

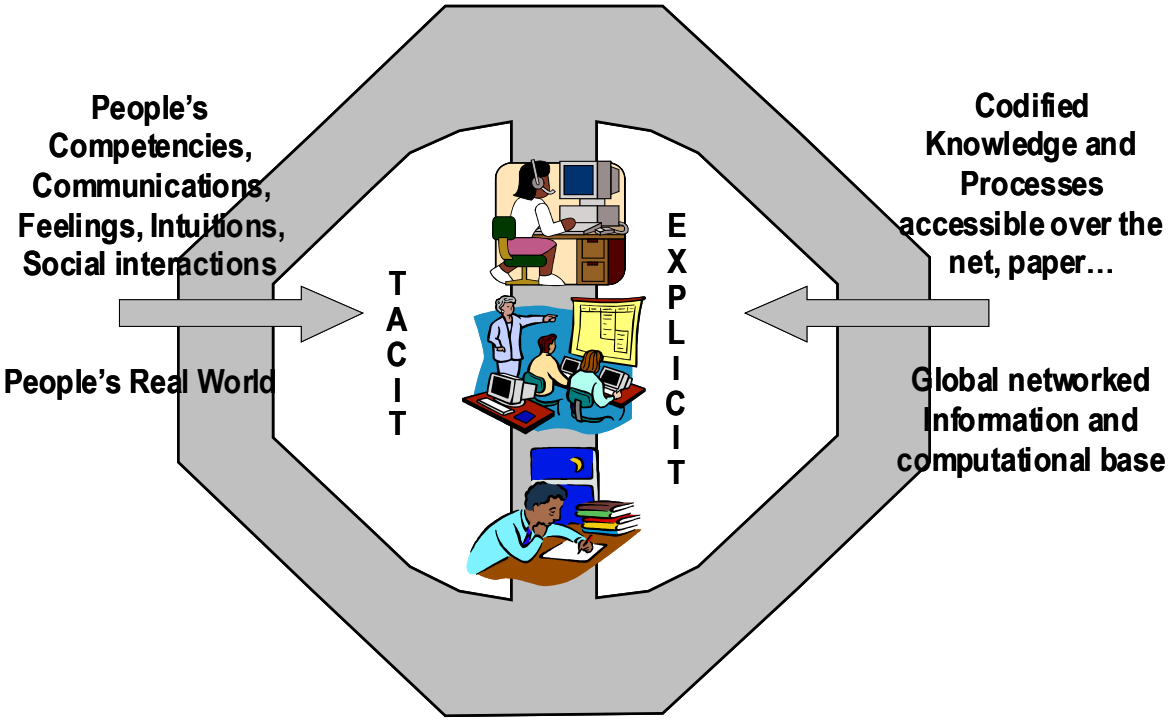

Fig. 2: Illustration of the Tacit – Explicit World of Learning

environment and it is not a mechanical process. The nature of this learning environment needs to be understood and its dynamics mastered for proper management of both the learning resources and the learning processes.

Learning resources in the emerging web-accessed world of content include books, computing resources, relevant digital library, multimedia and web-accessed content, lectures in the form of video-on-demand, interactive remote classrooms, simulations, the laboratories, computational methods, databases of different kinds, datawarehouses and relevant records of real world observations and events as well. Besides, we also have the availability of convergence tools like the search engines, discussion boards, chats, conferencing and other forms of synchronous/asynchronous interactions facilities. What is important is to understand and master the nature of this complex setting and devising appropriate learning processes and their management.

We say that the entire world of learning resources accessible over web and libraries as the explicit knowledge of the subject world. This explicit knowledge has been created by diverse institutions, groups and individuals over centuries. With the arrival of the Internet and the browsers and web-services as access interfaces to the Web (i.e., the world-wide web) with its vast ocean of explicit information, programs, processes, and databases, we now are in a position to build effective and focused web-communities to support the education processes in colleges anywhere. As shown on the right half of Fig. 2, **we call this vast Internet accessed world of information and codified programs, monitors, controls and processes the *explicit* part of the knowledge world.**

We, as humans are restricted by our limited 'input – output' devices and modes for communications – the eyes, ears, mouth, limbs, touch and nose, expressions and body language. The Upanishads of yore call these as the five instruments of action, and the five instruments of knowledge (pancha karmendriyas and pancha jnanendriyas). Thus imparting effective education has to take cognizance of the limited modes of human communications. **Ultimately, learning in an individual results in *Tacit Abilities* – the knowledge world of our competencies, intuitions, innate sense of right and wrong, contextual understanding that provides the semantics to gain knowledge from information, feelings, emotions – all these constitute the tacit world as shown on the left half of Fig. 2.** In [2], it was stated that while machines are good at data collection and their processing to present relevant extracts as information, it is we humans who apply our insight to view the information and infer knowledge. Again, it is we the humans who

juxtapose that knowledge with real world situations and constraints to judge the course of action that leads to results. Imparting scholarship is aimed at building this innate capacity for mature understanding of the situation and arrive at sound judgments leading to effective real world actions. In a technology enhanced learning environment there is much to innovate and build the several simulations, scenarios, case studies and exercises whereby this communication, or, competency transfer to the learner is achieved by synthesizing and practicing a variety of tacit-explicit interplay exercises that keep the focus around the instructional objectives.

4. KERALA EDUCATION GRID AND KNOWLEDGE INFRASTRUTURE

The Kerala Education Grid was proposed by the Indian Institute of Information Technology and Management – Kerala (IIITM-K) and funded by the Department of Higher Education of Kerala. It has attempted to put together the knowledge infrastructure and learning support systems for higher education based upon the perspectives outlined in the earlier section. **The aim of the project is to provide structured support to the formal learners and the teachers anywhere through web-communities of experts backed by networked resources.** In addition, the project conducts regular short courses for teachers in specific subjects and workshops related to different facets of technology enhanced learning.

The original approach of the project is given in [1]. Here we summarize what has been achieved till date on a pilot scale. A good part of the learning processes and support systems associated with the knowledge infrastructure that are being explained here are in practice at IIITM-K. For ongoing activities related to Education Grid, the reader is referred to www.edugrid.ac.in. In the process of developing the innovative technology support base, the project has resulted in several useful byproducts. One of it has been the technology incubation of a new class of enterprise integration servers for education. The core principles that form the base of the education grid are reviewed here

4.1. Establishing the Education Grid as a Facilitation Layer in the Colleges

The first step in establishing the knowledge infrastructure is to establish relevant systems as part of the institutional set up. This is illustrated in Fig. 3. It shows that we have to address four layers in the management of different functions associated with managing courses in an institution. The lowest is the bare essentials of buildings, civic infrastructure and people related administration. **The next is the important information and knowledge**

infrastructure that is becoming central to the emerging learning environment.

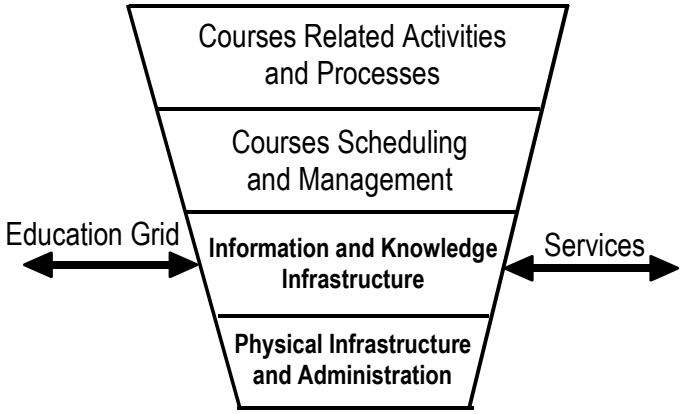

Fig. 3. The Four Layers of Management in an Educational Institution

By knowledge infrastructure we imply the systems and tools used by people to interact with the explicit world and also to communicate with each other in a variety of ways. These include libraries, labs, networked information and collaboration systems, message boards, chats, simulations, computational systems and services. Here, we gain much by integrating with similar resources in other institutions and building web-communities in different subject areas. The top two layers are specific to the planning and management of learning and evaluation related course-processes. Hence, whatever knowledge infrastructure we establish under the Education Grid should encourage participation by the learners in this rich learning ambiance of future institutions. In Fig. 4. we illustrate the varieties of advanced IT systems and services needed in any good college in the coming years.

Most of our colleges are specialized in a few subjects with little or no postgraduate study or quality research. The students do not have the benefit of studying in a genuine university environment that has multiple disciplines and programs from undergraduate to postgraduate and research levels. This weakens their ability to look at the cross-disciplinary connections of ideas and applications. **Arthur Koestler in his book, "Act of Creation" states that new ideas and understanding come at the boundary of two subjects, and rarely by study within a subject itself. This point is almost missed out in our country's higher education system.** So we end up providing only skill-sets with limited usefulness and over time becoming not all that relevant in the real world. The result is an education that prevents nurturing innovations and creative thinking. There is hardly any genuine university ambiance in universities with departments working in isolation and

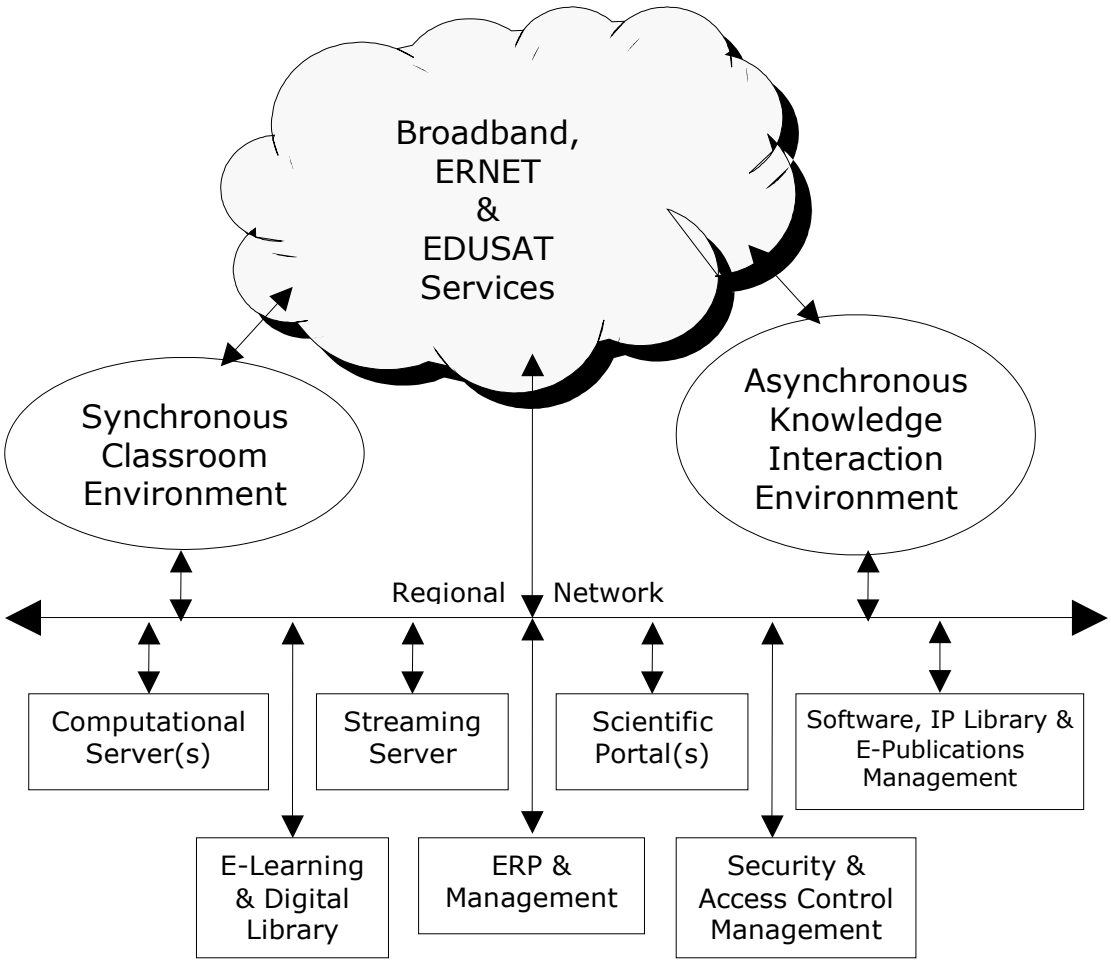

Fig. 4: Future Information Infrastructure for Education

without cross-disciplinary interactions. We propose in section 4.2 that the kind of systems shown in Fig. 4 is set over a Virtual Learning Campus to overcome this shortcoming.

The set of systems in Fig. 4 together constitute the typical base for managing the knowledge infrastructure. The figure illustrates that there are five broad environments served by the knowledge infrastructure as given below.

1. Information, Digital Library and Publications services.
2. Computational systems and access to databases in relevant subjects.
3. E-Learning support systems including streaming services for video-on-demand.
4. Administration and Management support for different enterprise functions.
5. The Systems and Network Services administration of the systems for all the above.

Even the best of institutions or universities in the country do not have either the competency or capacity to establish the above different systems and manage the services indicated in Fig. 4. Hence we have to look for an alternative approach the establishment and management of the above knowledge infrastructure. We say that this is best built as a Virtual Learning Campus (VLC) that was described in an earlier paper [3]. We briefly review this next and how this is best built through a Quality Higher Education Mission next.

4.2. The Virtual Learning Campus

Virtual Learning Campus, or, VLC is an approach that divides the responsibility of building, commissioning and running the different systems of Fig. 4 under centers of specialization in different institutions in different disciplines. Students in any college may access the services shown in Fig. 4 over the web. The college itself needs to maintain basic e-learning and library portals for convenience. Such IT and knowledge infrastructure in the college is readily standardized and used with reasonable broadband access to the VLC. Such a VLC is illustrated in Fig. 5.

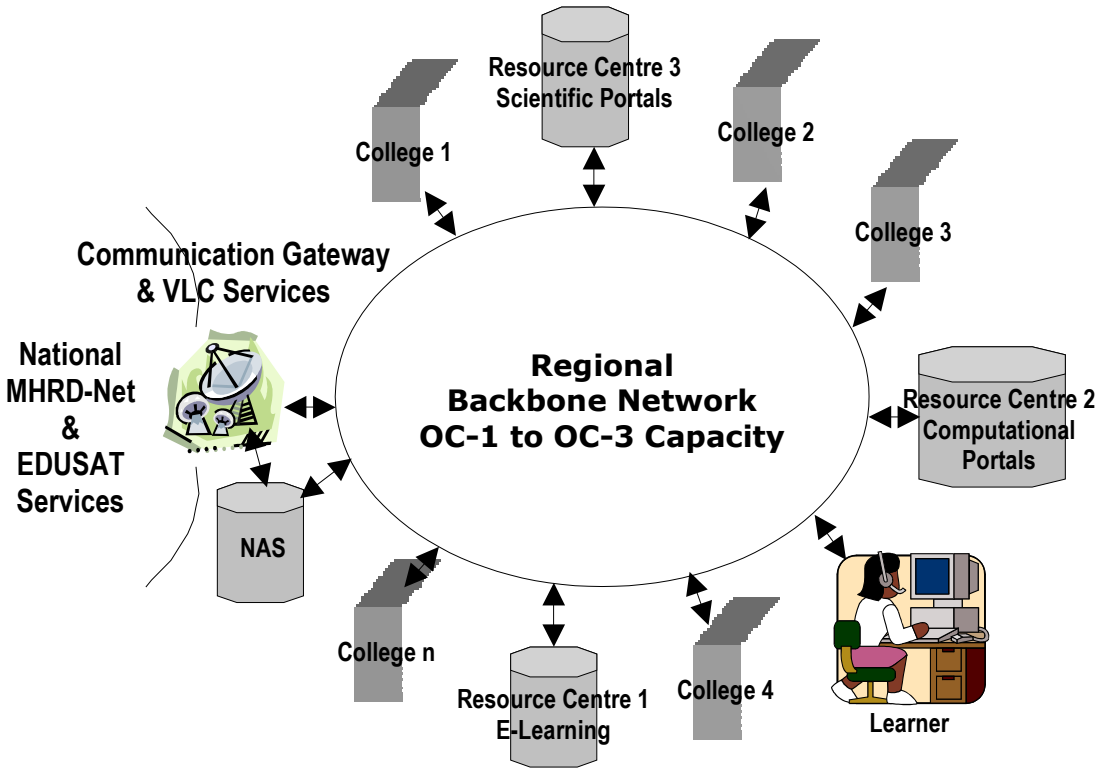

Fig. 5: Virtual Learning Campus

What we show as Information and Knowledge Infrastructure for the colleges in Fig. 3 amounts to seamless access to the VLC of Fig. 5, with the different systems shown in Fig. 4 distributed among different institutions. In our context, every region having about 100 to 200 colleges may be brought under one regional VLC. All these VLCs may be connected over a national backbone network that may be formed by integrating different national networks like the ERNET, Garuda I-Grid and State Wide Area Network (SWAN) initiatives of the IT Department. This VLC is best facilitated by addressing the following three major issues.

(i) Bring focus into the diverse ongoing networks and information services initiatives in the country in the context of the VLC. These include, besides the ERNET, Garuda I-Grid efforts such as the State Wide Area Networks (SWAN) initiative, the AGRISNET, UGC Infonet, Inflibnet, the Mission 2007; "Every Village a Knowledge Centre", the PURA (Provision of Urban Amenities in the Rural Areas) and such others.

(ii) The major components of the VLC like the computational systems, e-learning content repositories and such others are readily built in the technology and sciences field as Phase-II by a cooperation of the IITs, IISc, IIITM-K, ERNET and CDAC using a nationally sponsored approach similar to what went into building the ERNET, or the current NPTEL Phase-I itself. The advantage is that the large IT infrastructure and competencies available within the IITs also support national services to enhance higher education and research. This will help the IITs also to enhance their own knowledge infrastructure and resources.

(i) The building of the VLC and commissioning the diverse services requires a dedicated Mission Mode approach. We may call it the Quality Higher Education Mission (QHEM).

Such a mission like QHEM requires a coordination center. We call this mission center as the **School of Advanced Informatics (SAI).** What this SAI is briefly outlined in Section 5 of this paper and delineated in [5]. IIITM-K in India has done considerable work under its Education Grid and Technology Incubation initiatives in building systems and processes to provide effective services for colleges for enhancing the quality of education through technology assisted learning. **We propose that the present Education Grid is upgraded to the SAI to drive the QHEM as a mission mode program to be conducted under the joint supervision of IIITM-K and IIT Madras in the Kerala and southern Tamil Nadu region.** Before we state the role of the SAI, we complete the review of Education Grid and the processes that need to be addressed in quality higher education.

4.3. Servicing Web-Communities of Learners in Different Subjects

A key aspect of the Education Grid is to establish and service web-communities of teachers and learners through subject specific portals. This has been successfully piloted in the Education Grid project in a few subjects. Fig. 5.shows the approach for the different services in each subject.

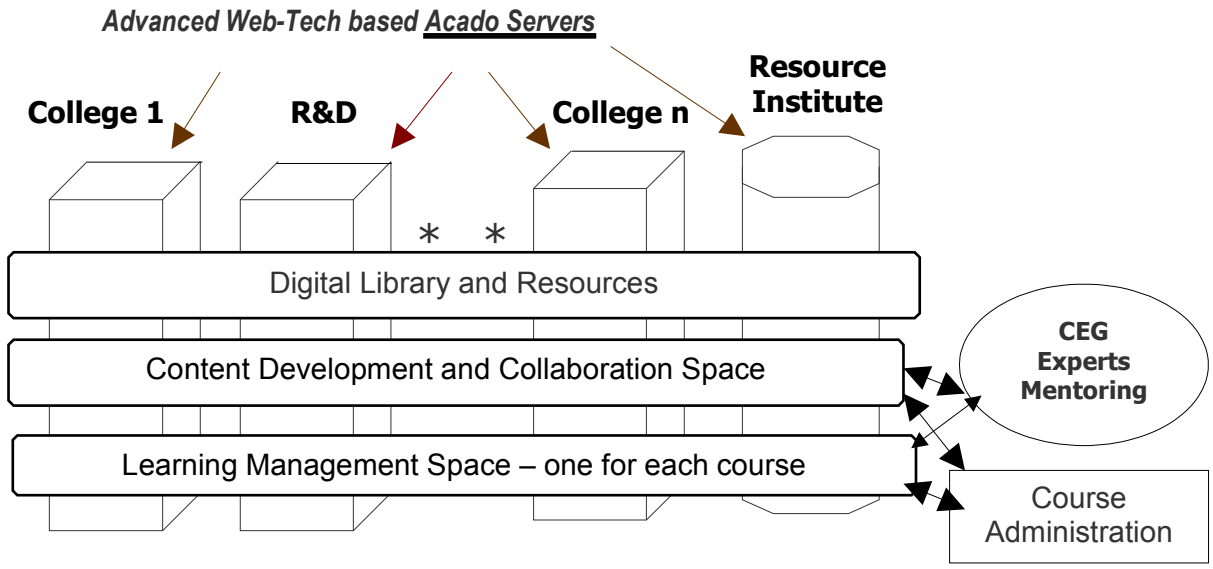

Fig. 6: Course Knowledge and Collaboration Spaces over Education Grid

Fig. 6 assumes that each college has access to a central portal area in each subject that is serviced by an appropriately equipped institution as Resource Centre (RC). For example, in the area of Web-Technologies in IT, IIITM-K acts as the RC. The RC maintains the Digital Library, e-resources, e-publications services and discussion board in the subject. The teachers and research scholars in the subject form the web-community and have a restricted group collaboration area inside the portal accessed through suitable permissions and authentication. This web-accessed subject collaboration area allows for sharing of copyrighted e-content, private message boards and several other group-specific information/computation access tools. As proposed later in this paper, this group area and associated open discussions area are serviced by experts in the field nominated under the NPTEL/Education Grid.

Thus every subject area is maintained and serviced a closed group web-community of teachers in the colleges, related instruction team and supervised by expert faculty in the

subject area. Such expert faculty support may be given by the IITs, IISc, relevant experts from R&D organizations and industry. This system is illustrated in Fig. 7 and forms the basic unit of Instruction Support for NPTEL Phase – II set over the Education Grid framework.

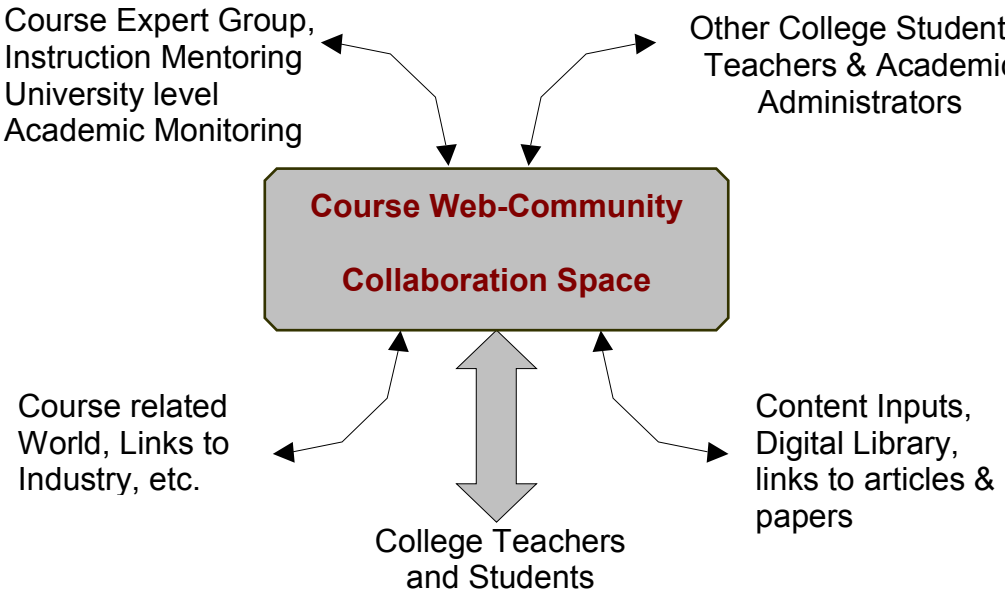

Fig. 7: Course Space as the Meeting Ground of Different Stakeholders.

The IT tools need for the above have all been developed and commissioned into service by IIITM-K and the Education Grid. The Education Grid team at IIITM-K have gained good experience in servicing such web-communities.

When we put together content for any subject-specific learning needs, what we have to do is to build such course-specific portals for the web-communities in ways that they focus the target group of learners and the instruction team effectively in their learning activities. As an initial effort, IIITM-K in association with IIT Madras is setting up one such subject-specific scientific portal in the area of Computational Chemistry [6]. Building a web-enabled technology enhanced learning environment in any subject calls for a structured approach for both content development that keeps the pedagogic or instructional objectives in view and the backing of subject-specific portals as the place of reference and interaction for the associated web-community. The content structure may be assessed in its various components in terms of the Content Quality Metric, or, CQM that was delineated in [1]. The CQM was based upon the David Merrill's five components of instruction involved in a typical Problem Based Learning situation as illustrated in the Fig. 8.

The details of how explicit content may be organized as per the five components of instruction are given in [1]. The same may be downloaded from

http://www.edugrid.ac.in/

Such well-organized content is readily designed to state specific learning activities associated with each of the above five components. In designing such learning activities we need to keep in mind the target learning groups of students and instructional objectives.

5. NPTEL CONTENT AND INSTRUCTIONAL SUPPORT FOR COLLEGES

Now that NPTEL is getting ready to release quality and authentic content in the form of video recorded lectures and over open or closed web from the best of faculty available in the country, and we also have the different knowledge infrastructure and services models developed under the Education Grid, our challenge is to deploy this content effectively over the VLC facilitated by the emerging broadband and EDUSAT network linking the colleges. Experience shows that distributing the content through CD/DVD or through portals is not likely to have the intended impact to enhance quality of education in the professional colleges. Instead, we need to develop effective educational support processes for its effective use. The original NPTEL intention of using the expertise of the IITs to enhance the quality of education in the professional colleges of the country will be achieved only if we come up with appropriate national institutional mechanisms to support and service the content upgrade, build and monitor effective instructional processes.

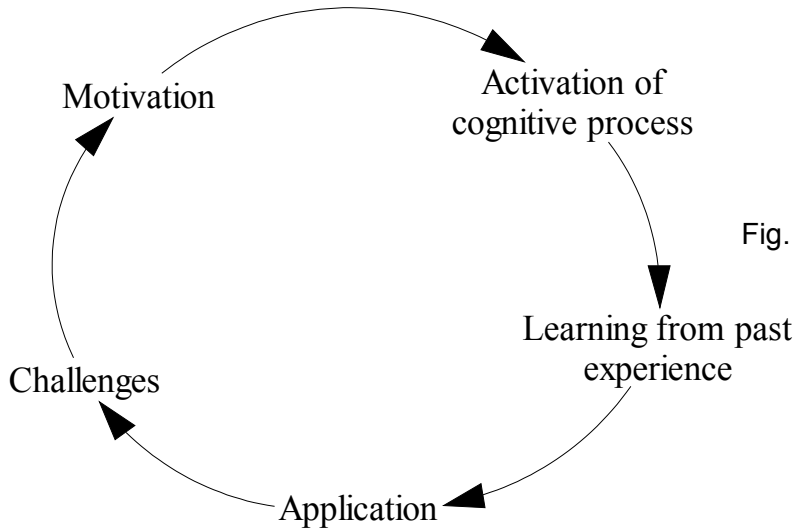

Fig. 8. The Five components of instructional steps in Problem Based Learning.

It is important to understand the nature and value of this content. Firstly, it is an unparalleled effort in any country for the best faculty from the internationally respected IITs to come together and the Govt. of India funding the same to address one of our country's major concerns – to provide quality education to the nearly a million students in the technology area. Hence it is even more important that this major national initiative is taken to its logical culmination of setting in place processes for its effective use and continuous enhancement that leads to quality education in the professional colleges of the country.

While quality and authentic content as generated under the NPTEL initiative is necessary to start, what we shall emphasize under the NPTEL Phase – II will be to build the sufficiency conditions of addressing technology assisted learning processes of relevance and value to the students and the colleges. The basic premise here is that, while no doubt what we teach is important, effective learning takes place only when we address the issue of how we teach and learn. We now have the opportunity to design and service processes on 'how we teach' through a web-assisted backdrop in every subject that helps in driving ***Innovations Driven Learning Environment, or, IDLE.*** IDLE is facilitated by effective management of the Tacit-Explicit interplay (see Fig. 2) in focussed class learning environments. Nonaka in his paper [8] states that this Tacit – Explicit interplay is made effective in any organization if we address the kinds of activities as shown in Table 1.

-	Tacit	Explicit
Tacit	Socialize	Externalize
Explicit	Internalize	Combinational

Table 1: The Four Component Activities of Innovations Driven Learning Environment

In driving the five steps of instruction indicated in Fig. 8, the process of instruction involving communication of the concept and facilitation to understanding and applying it are made effective if we incorporate imaginatively the four types of activities indicated in Table 1. These are briefly outlined below.

i) **Tacit to Tacit Communications:** This is best done by involving the students in learning situations through socializing amongst the learners and the teacher(s). Apprenticeship is one example of socializing. Group discussions and participation in course discussion

boards are ready ways of socialize. Situations of team playing, or field work may be designed and added in the course web area for teachers and the class to practice.

ii) **Tacit to Explicit communications:** This is referred to as externalizing. Here we design and involve students in learning activities where by the students study a situation, review a paper and articulate the same as term paper, or design and deliver a presentation in the class. This provides for capacity building in articulation and communication skills in the context of the subject. Such learning situations in our teaching are almost not there in our classes – exams – marks type education. It is important to look beyond the syllabus into what its relevance is real-world context. Well designed and conducted externalizing activities will overcome this lacuna in our instructional process.

iii) **Explicit to Tacit internalization:** This is what is attempted, though feebly in our text book – class notes study, homework and exams type learning. This too has large scope for improvement if we develop content as per the CQM model with rich anecdotes and presentations on the history of ideas in the topic through quality content. Every subject or abstraction gets its meaning through its association with other subject areas or real-life situations where they are applied. In the NPTEL context, several faculty have attempted to provide interesting episodes from real world that makes the subject interesting and motivating for the students. Over time, this part can be enhanced by supplementary lectures by eminent experts in the field and adaptation of new modules to keep pace with changes. This will build the much needed agility in our technical education.

iv) **Explicit to explicit communications:** This deals with how ideas taught in the class appear in real world situations or in a different context or another subject. This is hard for any teacher without experience to build and address. These are best published in the course portal area as authentic and validated case studies and examples provided by a refereed process. NPTEL Phase-II with the Education Grid approach may start a 'Journal of Effective Learning' as an e-publication to invite such case studies for inclusion in different courses material.

All the above four are best supported through course, or, subject-specific portals backed by experts. Similarly building the Virtual Learning Campus is another area to be addressed under NPTEL Phase-II. We propose such initiatives be included formally under the NPTEL Phase-II activities.

5.1. Education Grid, CIS and the Background to IIITM-K's origins

It is important to recall the original intention of setting up IIITM-K. Here we quote the relevant extract from the inaugural address of the then Hon. Chief Minister of Kerala, Shri E.K. Nayanar on the day of IIITM-K inauguration in Nov. 23, 2000.

"If Kerala should go beyond a totally literate State to a 'Knowledge Society', we need to have a pool of technically qualified manpower. The Indian Institute of Information Technology and Management – Kerala has been conceived as a Centre of Excellence in IT which will match international standards. This institute has also been envisaged as a referral institution for technical education, which will nurture other educational institutions in the region. It will also play an important role in facilitating quality distance education and online learning among schools and colleges. We are committed to ensuring the best possible teaching talent and facilities at the institute, and we are exploring the possibility of inviting internationally renowned IT faculty for teaching support. While the institution is commencing from temporary premises at the Technopark, I have directed the IT Department to earmark the requisite land for the construction of permanent facilities immediately. It is expected that the construction of the new modern campus can commence immediately."

The Education Grid project was started as the major outreach part of IIITM-K to fulfill the above objectives. The same was submitted with enhanced scope as the Kerala Virtual University Project Report in August 2004. This was later called as the Virtual Institute of Science, Technology and Arts, or, VISTA. We may note that the proposed CIS is the first firm step in building this VISTA. As proposed under the VISTA, what the Education Grid needs is some policy support and

6. PROPOSAL FOR CONCURRENT INSTRUCTIONAL SERVICES FOR COLLEGES

IIITM-K has been closely involved with the NPTEL as part of its Education Grid project. It has an MoU with IIT Madras for joint work in areas of mutual interest. We propose that between IIITM-K and IIT Madras, we launch a pilot Concurrent Instructional Services program for the engineering colleges of Kerala and southern Tamil Nadu region. We propose to launch this program for a take-off period of three years this program partly through project specific grants from the MHRD and/or Dept. Of Higher Education, Kerala under the plan account. Over this time, this will be made self-financing through a small levy collected from the colleges. The broad outline and different services to be provided under this program are

given here.

i) The Education Grid Portal will be upgraded and linked to broadband network connection to host the course portals for the colleges.

ii) The colleges in the region will be requested to give a list of courses in the next semester in advance in which they desire to have Concurrent Instructional Service (CIS). This will be matched with available NPTEL courses in video recorded form.

iii) Education Grid and NPTEL/IIT Madras will identify the set of lectures and web-content of NPTEL that matches close to the university recommended syllabus. The same will be communicated to the Director of Technical Education or the concerned university for formal acceptance.

iv) The Education Grid portal at IIITM-K (and possibly the NPTEL portal at IIT Madras) will have the course – specific discussion Boards and e-learning support systems for the courses used in the colleges for interaction and support. While the NPTEL content may be hosted and managed by NPTEL server in IIT Madras, the Education Grid portal will provide course/subject specific digital resources and links to content from other institutions/ universities. This will provide a rich background material for the students studying the subject. Teachers in the subject will have private collaboration space to keep in contact the expert faculty from the IITs or elsewhere.

v) The lectures from the NPTEL archive will be converted to compressed streaming media format and packaged in one external hard disk and customized for each college as per their request. Typically one GB of disk may host about 6 lectures. A 40 GB hard disk can hold about 200 lectures, or about 4 to 5 courses fully. With an arrangement with NPTEL/IIT Madras, IIITM-K will take up this as a service for the colleges. The copyright of this external hard disk will be governed by the NPTEL policies in force.

vi) IIITM-K will configure a standard streaming server such as Real Server with minimal license over a basic Linux server system to which the external hard disk of the suite of lectures will be mounted. This will be placed in the college LAN for use within the colleges.

vii) There are three ways by which the compressed streaming video lectures may be used by the colleges. First is to use them directly through projection in the classroom. Second is to promote group learning approach using an infrastructure described in (vii) below. Thirdly, they are also used as video-on-demand for students to review or take make up

lectures in case they missed the classes.

viii) Group learning method involving 4 to 8 students per group to interactively play the lectures in the clas hours and supported by weekly tutorials have been proven to be very effective in instruction. For a class of say 60 students, the college should have about 10 multimedia PCs (with 6 students per PC). The group sits together (with attendance monitored) and play the designated video-lecture from the streaming server during the class hours. The group may pause the lecture at any time for discussions among the students within the group. These are entered at the end of each class in the course discussion board of the Education Grid portal. IIITM-K and the NPTEL shall orient the concerned colleges on how they will make use of these lectures effectively through group learning mechanisms backed by web-accessed courses support areas.

ix) NPTEL/IIT Madras will be requested to assign necessary faculty for each subject for moderating the CIS courses. The faculty together with IIITM-K may host training sessions for the college teachers on how to teach the subject using the NPTEL content and such activities.

x) Every week, the comments and doubts from all the students taking the course in the different colleges will be reviewed and an expert person will take the tutorial over EDUSAT or Cable TV channel during specified hours. For this, the Education Grid/VISTA related EDUSAT facilities as outlined in [10] has to be set in place.

xi) We expect the entire program will be self-financing once we have about 100 colleges per course. Expert faculty involved will be given due remuneration for the services rendered. A nominal levy of Rs. 200 per course per student (taking the course) per college for a semester long course will be collected to cover the services cost. With 100 colleges, we may collect Rs. 10 Lakh per course – a sum adequate to cover the expenses.

xii) Efforts will be taken to solicit industry support jointly for the courses enhancement and inviting expert faculty as sponsored 'chair-professor' or industry expert for supporting the courses and other course promotional activities.

Our goal in launching this CIS effort is to ensure that the higher professional education of India is revitalized and aligned with the emerging opportunities and realities of web-based collaboration across institutions. This will help the higher education system to achieve at least some of the core parameters of Malcolm Baldridge Quality for performance excellence in education [7].

Both IIT Madras and IIITM-K will work jointly to evolve the NPTEL Phase-II proposal along the lines of CIS and content upgrade/maintenance. Meanwhile, we shall also launch an example of the Virtual Learning Campus model jointly in the area of Computational Chemistry.

This paper is addressed to both IIT Madras under the IIITM-K – IIT Madras MoU and to the Department of Higher Education/ Director of Technical Education for consideration. Our joint goal is to ensure that a properly architected technology assisted learning infrastructure enabled by smartly designed learning process management is built to rejuvenate the higher education system in the country. As a byproduct, the quality of R&D will also be substantially go up the value chain.

7. EDUSAT SERVICES FOR CIS

ISRO had set up the Viswesvaryya Technical University EDUSAT classroom services. ISRO also had recently funded the IT@School EDUSAT infrastructure. Discussions with ISRO indicates that they will also support the core EDUSAT infrastructure for the Technical Education also. A proposal was already drafted and submitted to the (then) EDUSAT task force that provided for an integrated EDUSAT infrastructure. We propose that the Kerala Government seeks ISRO support for the EDUSAT infrastructure for the Technical/Higher Education. The same will be integrated with the CIS program proposed here.

It will be very effective to combine EDUSAT based remote classrooms for conducting the tutorial, while the video recorded lectures are used as per the CIS approach given here. If each IIT has one EDUSAT main classroom with colleges having the remote classrooms, the responsibility for the tutorial sessions may be readily shared by the different IITs.

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