

KERALA EDUCATION GRID

MANAGEMENT OF REFEREED CONTENT GENERATION AND UTILIZATION FOR FORMAL HIGHER EDUCATION

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of Kerala Education Grid*

ABSTRACT: As universities, colleges and premier institutions are getting increasingly connected and with network services improving, a key issue is how to add educational services of value to the vast number of students and teachers. The challenge is to generate quality content in large scale and in hundreds of courses, with associated facilitation of the university and college system. This is sought to be done through processes that help realizing the value proposition of quality education to all concerned irrespective of geography. Such content and associated processes are to be imbedded in the higher education system in ways that facilitate the triad of students, teachers and education administrators and help enhance the quality of learning efforts. This paper shows how the Kerala Education Grid project initiated by the Government of Kerala proposes to manage the content development and authoring. This paper outlines the approach centred around a refereed and quality assured development of rich content. We show how this scheme addresses the diverse components of the pedagogic processes involving all the stakeholders in higher education.

1. OVERVIEW OF THE KERALA EDUCATION GRID PROJECT

Ministry of Human Resource Development, All India Council for Technical Education, University Grants Commission, ERNET India and several other agencies of Government are working towards setting up a countrywide educational services network through several associated programs such as National Programme for Technology Assisted Learning (NPTAL), broadband connectivity for education, and ISTE initiatives in developing learning materials. The Kerala Government has taken the major initiative of Kerala Education Grid Project with plans to link the institutions of higher education through a collaborative knowledge network of education servers over the Internet. The Department of Higher Education of the Kerala Government and the Indian Institute of Information Technology and Management – Kerala [IIITM-K] took the steps to launch the Kerala Education Grid as a state-level plan initiative. The Governing Council and an Apex Project Coordination Unit [APCU] of the project have been constituted through necessary Government orders. This approach paper is being proposed following the discussions and views of the project member-experts and officials of the Governing Council and APCU.

In the context of Web-assisted education over a network of academic and research institutions several issues arise. To appreciate the issues, we briefly describe below the features and approach of what the Education Grid Project is about.

1. The participating colleges will be linked over a statewide Education Network. Each college will host an Education Server with learning management system (LMS) collaboration tools, groupware, digital library and e-publishing facilities.

2. Premier institutions such as NIT – Calicut, CUSAT – Kochi, College of Engineering and IITM-K – Trivandrum will each host an Education Grid Resource Centre [EGRC]; IITM-K will host the Education Grid Operations Centre [EGOC] that coordinates the entire project.
3. The project is steered by an Apex Project Coordination Unit (APCU) of academicians, experts and key officials such as Directors of Technical and Collegiate Education. Project Governing Council chaired by the Principal Secretary Higher Education will monitor and oversee that policy and monetary inputs to the project are forthcoming.
4. Each course that is taught formally in the various colleges across the universities or different institutions (starting with Engineering and Sciences disciplines) will have course specific refereed and approved content with specific teachers orientation and assistance for scheduling of course events such as sequence of topics covered, mid-term and end-term examinations, tutorial and practical, assignments and discussions, etc.
5. Each course content and collaboration environment with digital library support and pedagogically effective management will be set over an Intranet of distributed Course Knowledge and Collaboration Space (CKCS) over the Internet. Each CKCS will also manage a portal for interaction with the outside world.

The challenge addressed in this paper is to identify and classify the pedagogically distinct components of content with the associated processes that constitute the conduct of any course. This paper outlines an approach to developing such components of content that includes refereeing processes acceptable to the university system so that the same may be recommended for regular classroom and study use. For the benefit of authors, referees and content developers, the paper also includes in fair detail what one looks for in such content as it pertains to the pedagogic effectiveness when it is used in the learning process.

2. A PEDAGOGIC FRAMEWORK FOR WEB-ENABLED COURSEWARE

In contrast to the traditional printed content, **IT facilitated methodology is much richer in both the presentation format and ability to incorporating course management processes.** The goal of designing and developing web-enabled content is to strengthen the traditional college education and not to substitute it. It leads to improved quality of instruction and study efforts on the part of both the teachers and students. There are several pedagogic frameworks available with considerable overlap in their approach and scope. Our traditional classroom - examination centric approach is one of these. B.F. Skinner's personalized system of instruction is well suited for mentor assisted self-paced learning through self-study. David Merrill [www.id2.usu.edu] describes a few pedagogic models including such ones as the Problem Based Learning [PBL] or pebble in the pond model. In recent years, the problem based learning approach appears to be gaining in popularity for web-assisted learning in formal instruction. It is possible that we can mix the different pedagogic models in a learning situation. PBL has the advantage of an umbrella framework over which we may build different pedagogic models as suited to the learning objectives and methodology in a given topic.

We shall describe how we can structure the different components of content with reference to the pedagogic PBL model (Fig. 1).

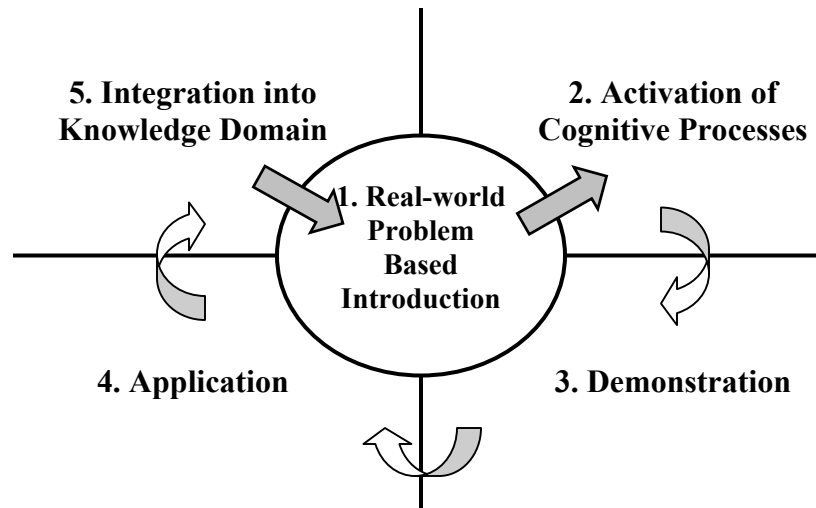


Fig.1: Merrill's Pedagogic Components in Problem Based Learning

It is assumed that a course syllabus consists of a series of learning modules. In a semester long course, we teach typically 10 – 12 modules. Each module is a topic that is fairly complete in itself in the sense that it has clear learning objectives, exercises, group work, study materials, and a small test. A typical module is covered typically in 2 to 4 lectures, a tutorial for case studies and examples, associated exercises, a test and if needed some practical as well. There are five pedagogic components that we need to have in a typical learning module. The purpose of each of the five components is stated here.

2.1 Real-world Problem Based Introduction

The first step is to motivate the students by showing how the problem or topic under discussion is related to a real-world scenario. Thus, for example, if we are teaching solving second order linear differential equation, we should show where such equations arise in the real world – either exactly or as approximate description of some reality. These may arise as approximation of a 'simple pendulum', or as the oscillation of weight hanging on a tensile rope (as in the case of a crane lifting a weight) or in a spring mass system. They also arise in electrical oscillations in LC networks, etc. We may provide java applet and compressed video or animated illustrations of such scenarios in the linked library.

It will be highly motivating if we add anecdotal information relating to the topic, or how historically the problem was discovered and the solution approaches evolved. Related historic papers in the digital library may be linked from this part of the content.

2.2 Activation of cognitive processes

This may be construed as the normal part of what is given in the class lectures. Here again, imaginative organization and support materials for the teachers will be of great help. It is important to recognize that in our colleges, teachers are seldom trained to teach. The aim of this component is **to trigger the thinking or cognitive processes of the learner from the prerequisite or preparatory level of the class and in ways that improve the efficiency and quality of efforts on the part of both the teacher and learner.** The spirit is to effectively

communicate the nuances and essential descriptive knowledge components of the topic covered in the module. The key aspects of this are

(i) Problem description or statement;

(ii) The model and assumptions behind the solution;

(iii) ***Communicating the approach*** to the topic: Even knowledgeable teachers often overlook this aspect. Good teachers are very efficient in ‘setting the stage’ before working out the details. Most students can understand or appreciate the overall approach of solving a problem. But only the better ones and those who sincerely make efforts master the nitty-gritty and details of the steps in the solution. Such good students also benefit by understanding the approach taken. Teachers too are better off if they do this part of classroom lecture effectively. **Often the lack of association between the model, assumptions and the approach to the solution raises most of the doubts in students’ minds.** Hence adequate emphasis needs to be given for this part of the content. If possible we may include a video clip from the best of teachers in the linked content to emphasize this aspect.

(iv) The descriptive part as we see commonly in the textbooks. This needs to be tempered at the level of preparedness of the class. To reduce fat, this section may refer to the relevant pages of good recommended textbooks.

2.3 Demonstration

Once the specifics of the problem, model and solution approach are communicated and taught, the next logical step is to show how the theory is applied in practice. We do this by examples, case studies, practical, web-based illustrations and demonstrations. We also emphasize the different ways in which the concepts taught are applied under different problem scenarios. This aspect again is very much enriched by web-based and course specific links to digital library content.

2.4 Application

While under 2.2 and 2.3 above we have assisted the instructor or teacher playing a crucial enabling role in the classes, it is important to focus on ensuring the quality of efforts by the learners outside of the classrooms. The application part is the exercises or homework that we normally give. The web as a medium provides useful multimedia and interaction (as in self-test) capabilities to enrich this component of the learning activity. It will be useful if students too are enabled to submit solutions to assignments online and in web-based solutions format if necessary. We may add a Self Test for the module that will assist discovering oneself how well one has understood, and what knowledge gaps exist in one’s understanding. The self-test exercise should be designed such that the students walk through the components of learning in the module diagnose gaps and navigate to the concerned components for plugging the gaps.

In practice and to have a head start, it is best we begin posting solutions to the recent past years’ examination papers of the recent past, homework and allow for release of solution after a time delay. This will attract the students and also help build question banks.

2.5 Integration into Knowledge Domain

Through the components 2.1 to 2.4 described above, we shall have ensured that the student has been taught well. We need a part to challenge the student to check for himself/herself how well he/she has internalized or assimilated the learning objectives. This is best done by challenging the student to apply what has been taught to areas somewhat outside the syllabus and provoke the student to extend the concepts. Arthur Koestler, in his monumental work “Act of Creation”, shows how new ideas (and we may add understanding) emerge at the boundary of two subjects and not from within a subject. Challenge problems (that help discover one’s assimilation and mastery of what is taught) and related examples or problems in other subject areas address such trans-subject learning experience. This part need not be evaluated. But it helps motivated and bright students as a pointer to things outside of the syllabus. It is provided as self or group study material to help measure how well one has internalized the lesson.

2.6 The value of the five-component pedagogic model for content

A relook at the five components presented above shows that the first component namely “Real-world Problem based introduction” is targeted at both the teacher and student; the second “activation” and the third “demonstration” part are primarily oriented to the teacher’s efforts, the fourth and fifth components are aimed predominantly towards the students efforts. In all the five we must always keep both parties in mind.

Our traditional education system does not pay special attention to the very weak or very strong students. The former fail and drop out and the latter get bored. The five-component pedagogy model addresses the need of the very weak through 2.2 and 2.3 and the very strong through 2.5.

Besides the above five pedagogic components of PBL, we need to ensure that the course is efficiently conducted and the concerned teachers are effectively equipped and prepared before conducting each class. Towards this, we shall add supplementary materials in the course space. These are outlined in the next section.

3. SUPPLEMENTARY CONTENT AND COURSE MANAGEMENT FUNCTIONS

The five components of content briefly stated above provide a well-organized skeletal structure for E-Courseware within a module. When we place this courseware at the colleges, we also need to ensure that there are course management and teachers’ mentoring processes in place that help conduct the course efficiently. Typically these are helped by the following additions to the content.

- (i) Syllabus, prerequisites, target learners group, learning objectives, and formal credits attached to the course.
- (ii) Schedule and sequence of activities (number of lectures, tutorial, practical, group work, self-study, etc. and their sequencing) related to each module.
- (iii) Teacher’s material, power point presentations, approach to the topic, highlighting key concepts and their explanations, etc.
- (iv) Online quiz or test for the module.
- (v) Associated Module / Course-specific Portal with Digital Library and links to sites outside, including those related to industry. On its front page, the portal will provide

information on (a) the course syllabus; (b) prerequisites, (c) who may take the course, (d) no. of credits the course carries, (e) relation of the course to other courses in the curricula and (f) the essential printed texts and references that will be of use.

- (vi) Links to relevant popular journal articles and content areas of similar courses in other institutions, historical papers on the subject and information on industry or profession that uses the ideas.

We need new information systems based development and management structures to ensure that the above structured approach to content is well managed and actively used to improve the quality of instruction and efforts by the teachers, students and education administrators across the network of colleges,. These are outlined in the next section.

4. THE CONTENT QUALITY METRIC FOR E-COURSEWARE

Having stated the five pedagogic components of content for a given module as outlined in section 2 above and the supplementary part of content in section 3, we develop a refereeing and rating process for E-Courseware. We call this rating as the Content Quality Metric (CQM). The CQM is necessary to provide a periodic health check on the quality of E-Courseware and assess its worth in placing it for the formal education. Secondly, CQM helps build and maintain an active database of the large number of modules with attendant Configuration Management and Version Control functions. Thirdly, without a CQM type tracking approach, it is difficult to make E-Courseware a formal part of the university processes. As we go through the different sections it will be increasingly discernible how CQM will really help in making a significant impact on the quality of instruction and effort by all concerned.

The approach to CQM is straightforward. We study each of the five pedagogic components of content as given in Section-II, namely (i) Real-world Problem based introduction, (ii) Activation of cognitive processes (refer this simply as ‘Activation’), (iii) Demonstration, (iv) Application and (v) Integration into knowledge domain (referred as ‘Integration’). Merrill recommends a star rating for each of the module. A course having all in good condition is given 5 stars. He further suggests that each be given one of 3 types of stars – Gold, Silver or Bronze. We may borrow from the spirit of Merrill’s star rating of courses and extend the same to develop our CQM. Instead of star, we may give each of the 5 components of a module the CQM rating as a single numeral. An example of how such a rating can be assigned is illustrated in the following table pertaining to the first component.

Component Title	Basis of rating	Value of Metric
1. Real-world problem based introduction	a) Absent	0 (poor)
	b) Inadequate	1 (poor)
	c) Is it textually stated well and relates to a real world scenario?	2 (satisfactory)
	d) Above + clear statement of learning objectives.	3 (fair)
	e) Includes quality statement of prerequisites and links to such prerequisite content in the links to the digital library and literature.	4 (good)
	f) Includes refereed pre-diagnostic test.	5 (very good)
	g) Real world scenario is illustrated well using quality visual, flash or applet material.	6 (high quality)

	h) Includes anecdotal and historical information with links to classic papers in the area.	7 (Excellent)
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It may be noted from the above table that it is broadly in conformance Merrill's model of rating as passable (bronze), good (silver) and excellent (gold). We have put together some explicit details of items that constitute the component. This will help E-Courseware authors, the course expert groups and the referees to know what is expected of them and how to work together in the creation and management of the content. CQM will also help us in costing the efforts – time, expertise, volume of work and money that will be needed or incurred in the development of the module.

What is given here is a sketch on how to judge the components. The third column need not be linearly mapped to the second by a referee. The second column is indicative of the details of such content that enhance the learning experience of the student. The referee may use his/her judgment in assigning the metric with an explanatory note added. In ways similar to the first component, we may give a CQM value to the other components as per the following tables.

Component Title	Basis of rating	Value of Metric
2. Activation of cognitive processes	a) Absent	0 (Poor)
	b) Inadequate descriptive content	1 (Poor)
	c) Plain description of the model, problem to be solved or method.	2 (satisfactory)
	d) Clear statement of assumptions, and how it is related to the model or method.	3 (fair)
	e) Communicating the approach: How the solution or method is evolved, why the approach is taken.	4 (good)
	f) Quality notes (in printable form or with pointers to relevant textbook sections) and rich illustrations on the approach to the problem and the method.	5 (very good)
	g) Summary video lecture by eminent faculty on the module.	6 (High quality)
	h) Quality graphic and multimedia illustrations that add value to understanding the method and its corollaries.	7 (Excellent)

Component Title	Basis of rating	Value of Metric
3. Demonstration	a) Absent	0 (poor)
	b) Weak illustrations, examples.	1 (poor)
	c) Fair worked out examples.	2 (satisfactory)
	d) Examples worked out in close relation to 'Activation' content.	3 (fair)
	e) The worked out solutions explicitly articulate the underlying assumptions and the difference between the assumption and reality.	4 (good)
	f) Case studies added.	5 (very good)
	g) Interactive examples for practice.	

	h) Multimedia / simulated content and links to sites on how the ideas are used in industry or in the field concerned.	6 (High quality) 7 (Excellent)
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Component Title	Basis of rating	Value of Metric
4. Application	a) Absent b) Weak, problem set. c) Acceptable problem set with worked out solutions. d) Quality problem set in close relation to 'Activation' content. e) Worked out solutions with explanation for crucial steps. f) Self-test that helps assess one's knowledge gaps in understanding. g) Group and simulation exercises, improve cooperative problem solving among small groups of learners and/or practical/lab exercises. h) Java applets based interactive or simulation exercises.	0 (poor) 1 (poor) 2 (satisfactory) 3 (fair) 4 (good) 5 (very good) 6 (High quality) 7 (Excellent)

Component Title	Basis of rating	Value of Metric
5. Integration (to test how well the learner has internalized and can apply to real life situations in related areas).	a) Absent b) Weak statements of application in real life situations. c) Real life problem situations in the field or related area where the idea is applied. d) Links to industries, sites with brief description on how the concepts are applied. e) Interpreted real life examples on how well the model or method taught helps address the problem. f) How extending the concepts are made possible by relaxing the assumptions to address better real life problems. g) Pointers to advanced courses in the area and links to certification courses and other such areas that help the learner in making a career in the area. h) Pointers to current journal papers in the area; a flavour of 'bisociation' as to how the idea applied in an alternative subject context leads to solutions.	0 (poor) 1 (poor) 2 (satisfactory) 3 (fair) 4 (good) 5 (very good) 6 (High quality) 7 (Excellent)

The term 'bisociation' in the last part of the Integration component refers to the word Arthur Koestler coins to explain the capacity for associating two seemingly different subject areas by the same underlying paradigm or perception that may have been evolved in the module. It may not be relevant for every kind of module. For example, the concepts in 'Group Theory' in Mathematics are shown related to an area in Biology or Crystallography. This helps the learner

think deeply in ways where words and visuals fail to communicate. It is important and interesting to note in all the five components of the module, good to very good rating is achievable without recourse to complex multimedia or expensive simulation type content.

As an example of how the CQM helps, let us say a learning module has the rating 2 – 4 – 3 – 5 – 2. In one stroke the metric tells the following: the LM has (i) satisfactory or usable problem based introduction; (ii) good descriptive part that communicates effectively the approach to the problem; (iii) fair demonstration, case studies, etc.; (iv) very good home work and self-test to help check learner's understanding; and (v) satisfactory integration part that challenges the learner's capacity to apply what has been taught. **CQM is a vector rating allowing for a fair assessment of the different dimensions that constitute the codifiable parts of learning processes.** In one stroke, CQM allows us to see how good the content is and where we need to strengthen it. The supplementary content stated in section 3 should also be included.

The above approach to CQM is given as a guide to referees who are requested to evaluate a given module. The model is certainly suited to the Engineering Sciences. By subjecting the e-courseware to periodic (say annual) reviews, we may put in place a healthy process that helps updating the syllabus or in preparing new course material of high quality. The database of modules with CQM scores helps in managing the content generation, syllabus upgrading and courses management for the large number of courses we need to handle in the Education Grid. IIITM-K is working on sample courseware to illustrate the above components.

5. COURSE EXPERT GROUP AND COST OF EDUCATION GRID SERVICES

Education Grid envisages the setting up of Resource Centres in premier institutions that have good faculty. In each subject area at a given level (say UG core, UG elective, UG senior and PG) the project will identify a Course Expert Group (CEG) of three faculty (from the best available in the subject) and associate an Education Grid Resource Centre (EGRC) for the content development. CEG will identify the courses to be taken up for content development and come up with the syllabus broken appropriately into modules. CEG will submit this to a central Education Grid Operations Centre (EGOC) as a proposal for funding by the project for content development.

Once a Course Development Proposal is received, it is scrutinised as per the guidelines of the Apex Project Coordination Unit (APCU). Funds for its development will be given from the project. The CEG will be rooted in one of the EGRCs and may co-opt experts and eminent faculty from anywhere in the country to help develop the course. EGRC will be adequately equipped with the tools for content development and web-hosting servers. The EGOC at IIITM-K will act as the master repository of the course content and host the open homepages for every course under the project.

The collection of CEGs and their enthusiasm in maintaining the standards is at the core of success in Education Grid processes. Technologies like Internet, Education Servers, Digital Library and multimedia content form the physical and information framework. These will be funded under the Education Grid in the launch phase. Of course the technology and management framework are very challenging, but not beyond the means of IIITM-K and the University framework. To ensure the enthusiastic participation of CEGs, faculty and teachers in the college, remuneration, recognition and incentives would be given as per the norms set by the APCU.

5.1 Financial viability of Education Grid

In the long run we propose to the APCU that **a course with minimum good to very good content rating in each of the five components in at least 70% of the modules will be placed in the colleges for a price**. For each student taking such a course, the user college will be asked to support the Education Grid activity through a levy of Rs. 200/= per student per course. Economies of scale show the following. Suppose we address 500,000 students, each taking 10 courses in a year. Let us say 10% of the courses are mature enough within one or two years for service charges. The collection at Rs. 200/= per course amounts to Rs. 100 million per year. Over time as more courses mature the collection will be several times higher. This is for Kerala alone. At national level, the collection will be at least ten times higher. Out of this collection, a part - say 25% - will fund the college's IT infrastructure servicing and teacher's training. The remaining will be ploughed back to support content development, maintenance activities and network services under the Grid. This will ensure that the Education Grid becomes self-sustaining in the long run. In the process, Education Grid has the potential of becoming a movement whereby good teaching gets rewarded, higher education system becomes the engine of progress in the emerging knowledge economy and education as a career becomes attractive.

6. WHAT IS THE COURSE KNOWLEDGE AND COLLABORATION SPACE?

The way the diverse component activities are proposed to be maintained across geographically distributed institutions is to establish and maintain Course Knowledge and Collaboration Space [CKCS] for each course. **A major challenge of the Education Grid Project is to establish and maintain this CKCS consistently in the respective Education Servers of the participating colleges.** This space is figuratively shown in Fig. 2. What the figure implies is that such a well maintained information and collaborative space with refereed content as explained in section 4 and supported through processes by the CEGs as stated in section 5 for each applicable course will be made available through the college Education Server under the Education Grid.

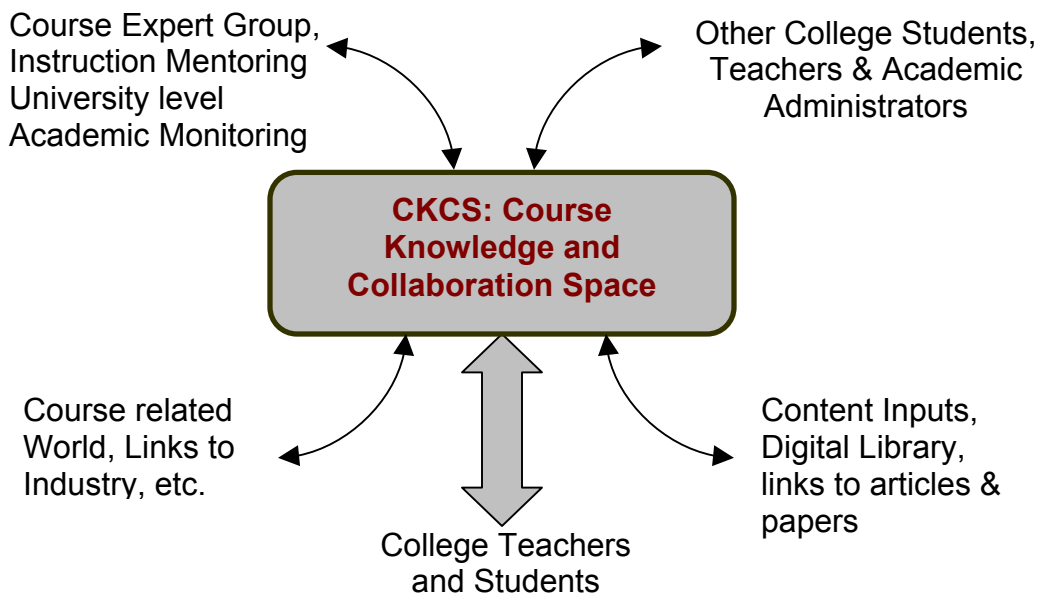


Fig. 2: Course Space as the meeting ground of different stakeholders.

Consistency of course content and related processes needs both a technology framework and administrative discipline. The technology framework is addressed as a networked system of Education Servers with one server per college. For sometime to come, the quality of Internet services in the colleges will not be capable of full-fledged synchronous collaboration environment. Experience and studies show that much of the gain in quality of instruction is well achieved using asynchronous interaction and collaboration between teachers, mentors and students over the network of college servers.

Two key assumptions in the approach to content creation and management are that (a) there is a reasonable quality of Internet connectivity across the colleges (this may be solved by requesting ERNET to install and maintain the network) and (b) each college is endowed with quality Education Servers and LAN based access. The servers should have (i) Learning Management System, (ii) Groupware with Collaboration tools to provide distributed Intranet support for the course experts, mentors, referees and teachers across the colleges. The servers should also support adequate digital library and e-publishing facilities in the colleges. The Kerala Education Grid Project is an initiative where a network of such servers will link the colleges to well equipped EGRCs in a few premier institutions, with a central EGOE at IITM-K assisting and monitoring them. It is useful to take stock of the availability of quality servers and the costs associated with it.

6.1 Choice of suitable platform for the Education Grid

Till date a few institutions (such as some IITs and IIMs) have installed various popular Course Tools packages such as WebCT, Blackboard, Virtual Manhattan (Free Software) or similar ones (almost all from North America). A good comparison of several such tools in the market is available in the site www.edutools.info and in the comparisons therein by *Bruce Landon* of the University of British Columbia. As standalone web-enabled course servers, these are quite satisfactory. From the Education Grid point of view, we are looking for the following features in the server platform.

- i) Learning Management System
- ii) Groupware and collaboration tools with group specific documents library, workflow support for e-publishing, published documents, directory services, informal knowledge repository, etc.
- iii) Support for recorded multimedia streaming services.
- iv) Master Digital Library with personalised library view through links and bnookmarks.
- v) Grid transport framework that maintains consistency in relevant group spaces and LMS areas across geographically distributed servers.
- vi) Low life cycle cost of ownership.

The ready available servers mostly from North America are best suited for expert teachers to establish support their own courses. Except for the Virtual Manhattan, the packages cost (~ Rs. 5 to 10 Lakh per year as license fee) makes them expensive for the Indian colleges. Their inadequacy in supporting several of the functions stated above coherently make them inadequate for the Education Grid. In addition, we also look for efficient web-enabled administration of component services, and API type interfaces for custom functions to help develop new component functions by the owners.

It was in the above context that a major programme in developing a new technology class Education Servers was initiated at IIT Kanpur in 1999-2000. The group of IIT Kanpur developers shifted to IIITM-K at Trivandrum in May 2001. Augmented by local engineers, they completed the early version of this server by Dec. 2001. By that time IIITM-K became the first fully web-enabled institute in India with this package with a server farm supporting the diverse kind of services from behind. The new technology class Education Servers are now fully supported by the original developers moving over and forming the first company to be incubated in IIITM-K and now established in Technopark, Trivandrum.

This new company is called Transversal E Networks (P) Ltd., or TeN for short. TeN has already delivered whole new generation of servers and portals for Education, Enterprise Knowledge Portals and Digital Libraries. The users include IIT Madras, IISc, IIM Ahmedabad, IIITM-K, Cochin University of Science and technology, Technopark – Trivandrum, Aeronautical Development Agency, Regional Research Laboratory – Trivandrum, Medical Council – Trivandrum, ER&DCI and several others. The server is being developed further to include the functionalities needed for the management of Education Grid. For details one may visit www.iiitm.ac.in and www.transversalnet.com.

The CKCS over this network of servers is best visualized as one among several such course intranets (or as we call it a transversal network) across the servers in the multiple colleges and EGRCs and the EGOC. This is shown in Fig. 3 below. Each course has three ‘Intranets’ of services. The first is the Learning Management System (LMS) that is used by the registered

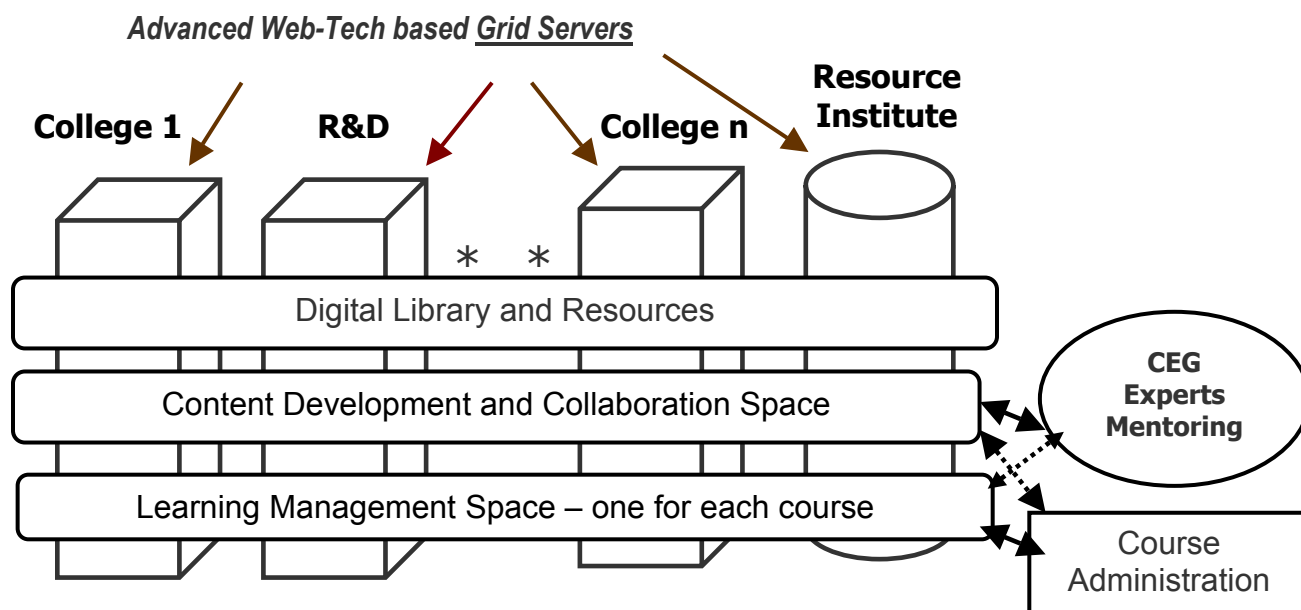


Fig. 3: Course Knowledge and Collaboration Spaces over Education Grid

students of the class and the instructor(s) in the respective colleges. Common content including the refereed content as approved by the CEG and permitted by the university, threaded discussions boards, FAQs, linked libraries, etc.

The second is the Content Development and Collaboration space. This is like the shadow space behind the LMS part. This is an area for collaboration driven by the respective CEGs and used for refereed content generation, teachers’ training and orientation, supplementary informal

content exchange and the back-office work for the portal management of the course. The third is the Digital Library and other resources that are accessible and common to all the courses. This can be made very rich by including professional and popular journals in the different subjects, linked libraries, etc.

In summary, the approach taken in the Education Grid of establishing and maintaining the CKCS practically defines a new IT enabled approach for the formal higher education sector. **Education Grid integrates holistically the different components and requirements of applications and services intended in the several projects that are being initiated by MHRD, UGC and the AICTE.** What is needed is that the Education Grid services are duly recognized by the university and higher education system. How this is done by considering the Education Grid as an IT facilitation layer is presented in the next section.

7. PLACE AND ROLE OF EDUCATION GRID IN FORMAL HIGHER EDUCATION

The present administrative discipline of the university and colleges system has three layers: (i) Program administration, monitoring and accreditation; (ii) College level curriculum, instruction planning, scheduling and evaluation processes, and (iii) lectures, tutorials, practical and related work. Each may be described in detail, but that is not the objective of this paper. We need a fourth layer in this education hierarchy – namely the **Facilitation Layer with Learning Environment and Content Management processes built into it.** In this, the ‘across’ functions of the colleges under the Education Grid are invoked. These Education Grid functions are fundamental in ensuring the effective use and management of the learning processes and learning environment of the colleges. This four-layer model is illustrated in Fig. 4.

We call the Education Grid support services for the learning environment and content management as the Online Assisted Learning Environment, or, OALE for short. With the rapid expansion and reach of IT and Internet in the colleges, Education Grid has the potential of becoming an indispensable component in the formal education.

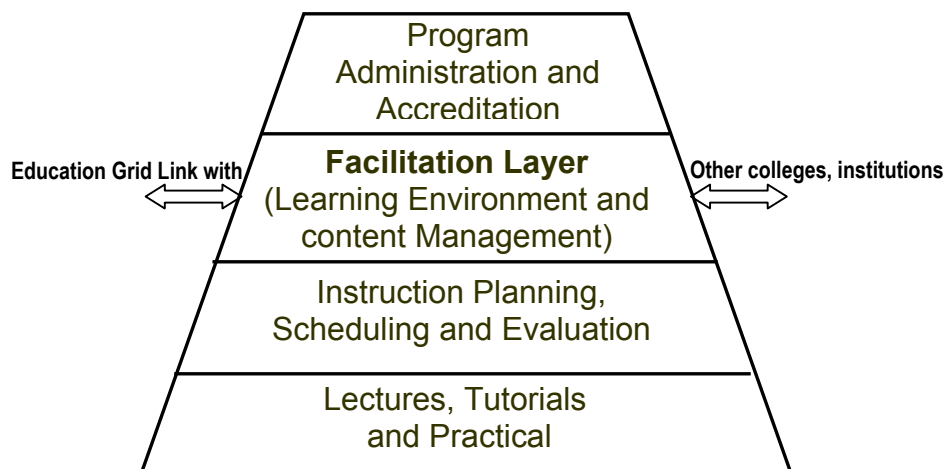


Fig. 4: Layered View of Learning Processes and their Management in Formal Higher Education

There is a great deal of work to be done in commencing, installing and entrenching Education Grid as a regular part of the Higher Education System. In USA and Canada, extensive research

and study have gone into effective Web-enabled Virtual University systems. The models there are well suited under the assumption that dedicated and knowledgeable faculty are available. However, in the Indian context, the shortage of dedicated quality teachers is severely acute. Hence, we recommend the Education Grid approach for addressing quality education.

If one carefully looks at the facilitation approach presented here, we see that the same facilitation layer is tunable according to whether it is Skinner's self-paced study, close knit 'Gurukul' style of learning, IIT campus style, college type of classroom – exam centric learning or the distance learning mode. Through the CKCS approach imbedded in the university facilitation under the Education Grid, any institution in principle may support any of the kinds of learning and the programmes - from classroom to distance modes, formal to non-formal, or the HRD programmes for industry.

7.1 Education Grid As Unifying Infrastructure For Higher Education

Today, any limited use of web-enabled content in the few institutions that use them is informal and maintained by the concerned faculty by themselves. To give adequate weight to the whole process, the universities, institutions and colleges need to give formal recognition to establishing and maintaining the following processes under the facilitation layer supported by the Education Grid. This function presupposes that there exists an Education Grid (or equivalently, an Educational Services Centre of an Institute) with formal processes to establish and sustain the OALE functions. The different aspects of the OALE function are summarised below.

- i) Recognition of Course Knowledge and Collaboration Space that has content of sufficient quality and worth in improving the standard of instruction in the course. This is done by a due approval process through formal sub-committee of concerned Academic Councils in the university/institutional system.
- ii) The above presupposes that adequate content is available through an initial thrust under the Education Grid project. Recommended content with the set of Learning Modules and refereed CQM rating as outlined in Section 3. Education Grid itself will be an 'outside' (of the concerned university) group driven formally by a collaborative body of experts set up by the state-level/UGC/AICTE and other education bodies. In the case of Kerala Education Grid case, this has already been done through the necessary Government orders under the Department of Higher Education with active participation of the DTE and DCE.
- iii) A set of approved printable materials – notes, homework, case studies, and textbooks, etc. made available for teachers and students to take home and practice.
- iv) A process of formally registering, assigning, administering and modifying the list of students accessing and using the CKCS by the concerned colleges.
- v) Recommended schedule and calendar of events to be managed over the CKCS. The schedule will help improved synchronisation of the diverse functions associated with management and conduct of the course.
- vi) Recognition and liaising with the experts and mentors associated with the course by the Education Grid. This group will be a standing body actively involved in assisting the teachers of the different colleges who conduct the course.
- vii) Approved teachers' material, references, classroom assistance, and mentoring network access.

- viii) Course specific teachers training and orientation programs, teachers' evaluation and certification processes.
- ix) Development and deployment of course-specific online assisted examination and evaluation systems.
- x) Course portal management and authoring assistance from EGO and EGRCs.
- xi) Maintenance of course-specific Digital Library and reference collections maintenance; monitoring of IPR and copyright concerns in the course materials.
- xii) Role and orientation of librarians and academic administrators of member colleges as Knowledge Officers/Managers and administrators of relevant OALE components in their respective colleges.

Thus on many fronts and formally through approvals passed by the concerned academic councils, the universities will become immediate beneficiaries of the Education Grid and the development activities associated with it.

7.2 Role of the Education Grid Operations Centre

There are several infrastructure and IT related processes as stated below.

- i) Planning, configuration, installation, commissioning and management of a number of systems and underlying technologies that support the Education Grid and its services.
- ii) R&D and referral centre for technology development, system integration and maintenance.
- iii) Managing the large higher education network across Kerala. This is not addressed effectively by the ISPs in India. ERNET India does this for academic and research institutions. ERNET will function through the EGO to install and maintain the network.
- iv) Main Education Grid and course-specific portals maintenance.
- v) Courseware related configuration management, version control, consistency and integrity maintenance.
- vi) Support for the EGRCs, authors and referees for content development.
- vii) Overall project planning, facilitation, coordination and monitoring.

The EGO being established at IIITM-K will be the central facility for the above functions of the Education Grid.

8. PROPOSAL FOR A NATIONAL INITIATIVE

This paper has focused on the processes involved in developing, deploying and utilizing E-Courseware in different subjects of higher education based on a Content Quality Metric approach. The aim is to deploy quality E-Courseware that has value in the Educational Process. The goal is to substantially improve the standard and quality of instruction and efforts by both the teachers and the students. The approach is to use state-of-the-art IT facilitated information systems and methods that are in tune with the emerging knowledge era. The paper is being submitted for the readers to critically study the document holistically and send their constructive inputs (by email to director@iiitm.ac.in) so that an acceptable national consensus is evolved.

The approach suggested will strengthen and complement the current initiatives of bodies such as the Indian Society for Technical Education, UGC, MHRD and help modernizing their activities. It will also promote e-publishing industry and making it relevant to the future of higher education system. We propose to the Govt. of India to accord highest priority and make Education Grid a national thrust and initiative and thereby address the national concern for quality education.

The size and complexity of the task of refereed Web-enabled courses, their deployment and usage are not as daunting as it may appear. We are talking about a few hundred courses with a total of about 5000 modules. In at least a hundred standard courses to begin with there is much content available on the Internet. There is also a huge collection of paper based notes and assignments from eminent faculty across the country. Nor does it take more than a reliable 128 Kbps access bandwidth with a backbone of 33 Mbps across the country for the network infrastructure. If we cost a module development at Rs. 100,000, we are looking for an effort of Rs. 500 Million in content development and perhaps an equal amount in support programmes at the starting level. This is well within the means of MHRD and AICTE. Infrastructure issues are already being addressed by MHRD, AICTE and ERNET. The challenge is to create a national movement to swiftly create quality content and put in place processes as outlined here for realizing the value proposition and promise expected from IT facilitation in Education.

8.1 The Global Revolution in Education

There is a revolution on particularly in the developed world wherein education is undergoing a sea change with disciplined and free participation of very large number of teachers, students, industry, with the governments actively involved in its promotion. Gordon Moore, the founder of Intel and originator of the famous Moore's Law in Electronics in his parting address on the day of his retirement in April 2001 said, "***Education is our Achilles heel***". More than a century ago Andrew Carnegie stated that, "**The only irreplaceable capital an organization possesses is the knowledge and the ability of its people. The productivity of that capital depends upon how effectively people share their competence with those who can use it.**" Christopher Galvin, the chief of Motorola says, "Motorola no longer wants to hire people with a 4 year degree; instead we want our Engineers to have a 40 year degree program". All these together point one issue. Take care of the central role played by the higher education and the results will follow.

The progress of our country, its due position in the coming era of knowledge economy and society depends upon how efficiently we empower our higher education system to become the engine of growth in this increasingly inter-dependent and globalised world. Coming years will see increasing emphasis on creation of wealth through knowledge. This depends upon the capacity to apply knowledge to create value. This capacity is best created through quality and holistic higher education. E-courseware is not a static printed material. It involves processes embedded into it. This in turn requires the Education Grid as the framework. It appears that the approach of the Education Grid with its quality assured content and processes as envisaged here for higher education is the best way to leverage upon IT and catapult India in to the Knowledge Era of the 21st century.

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Education Grid Project itself. Management of such large finance projects in knowledge-based activities is a complex task and we need to explicitly state the deliverables against the expenditure. The approach described here was encouraged by the discussions in the Kerala Education Grid Apex Project Coordination Unit meeting and one-on-one interactions with its members. Specific interactions with Prof. S.S. Prabhu, Shri Arvind Mohan and Ms. B.V. Laxmi of IIITM-K, Prof. K.B.M. Namboodiripad of NIT – Calicut, Dr. Mangalasundar Krishnan of IIT Madras, Prof. R. Sharan of IIT Kanpur, Prof. P.N. Murthy and Mr. R. Narayanan of TCS and several others are gratefully acknowledged. They provided considerable inspiration for the delineation of the ideas herein. The constant support of the IIITM-K Board, the bold initiative of the Department of Higher Education, the IT Department and the State Planning Board of Kerala to launch the Kerala Education Grid encouraged the author to think afresh along the lines outlined here for the project's success. Special thanks go to the TeN team led by Manjul Sahay and Abhay Singhal, Engineers of IIITM-K and several of the first batch students of IIITM-K. The author wishes to thank all the experts and officials involved in the Kerala Education Grid in helping arrive at this document.

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