An Effective Design Approach for e-Learning mode using Data Grid Technology

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***Abstract* - This paper centers and addresses on the effective design approach suitable for engineering programme to be offered through e-learning mode using learning grid, which certainly needs lot of pattern reformation in the existing curriculum and syllabi. The engineering programme offered through regular classroom mode at the university departments, affiliating colleges in India go behind different curriculum and syllabi time to time. Even the curriculum and syllabi of the same programme offered in any one university through different modes are even different. E-learning is a global element which requires uniformity. Problem based approach such as David Merrill's First Principles of instruction is the best approach for curriculum and syllabi development and designing the learning content. The e-content shall be created as module-based sharable learning objects in alignment with the Sharable Content Object Reference Model (SCORM) standard such that they could be used for different courses of different programme or for the programme of same discipline that could be offered as a problem-based learning. Hence the module/object/problem reusability would be accomplished that will certainly save and minimize the effort, time and cost of creating e-learning content. If such knowledge objects are created and deployed at the web server once then that could be well used for e-learning modules through Learning Grid (Data Grid technology) created for that purpose. Learning objects from such Data Grid could be widely accessed for better e-learning environment establishment.**

Keywords: e-learning; Problem Based Learning (PBL); Unit-based Syllabi; SCORM; Reusability; Learning Grid; Data Grid.

I. INTRODUCTION

Gone are the days where people put an end for education after they pursue their professional career. Nowadays, Education is a life long learning and unlearning process which has become an integral part of life and work life. Computers, tablets and mobile phones have become ubiquitous among people which have made e-learning a feasible mode. The readiness to enroll in any programme offered through e-learning mode of education is in the dominant phase. Any programme that can be offered through e-learning should have the basic ingredients that are part of regular classroom mode of education.

Almost all of the organizations are now trying to find solutions in order to implement e-learning services by using e-learning portals, virtual classrooms, web applications and many others technologies [14]. Most of the Universities in India offer several Computer Science and Engineering related programme at under graduation and post graduation levels like B.E., B.Tech., M.E., M.Tech., MCA, M.S. and so on, with various specialization in regular mode through University departments, Affiliating colleges and Distance learning. MCA is a unique programme which is offered for the duration of 3 years with 6 months being a dedicated project period in which the learner is expected to undergo a real-time training by developing a project/module individually. The pattern of study like Semester or Non-semester, total number of theory and practical courses offered in each semester, the nature and type of courses offered in each semester, the specific syllabi for each of those courses significantly differ from each mode of the same programme [3].

This paper narrows down the focus to MCA programme, for instance, in particular. But, to offer the MCA programme through e-learning mode, the existing curriculum and syllabi are not uniform. Hence, a uniform curriculum and syllabi need to be developed which then needs to be converted from unit-based syllabi [3]. For MCA programme of all universities in the country, a uniform competency based or problem based course curriculum using any proven educational taxonomy should be designed. The generic problem based e-learning content has to be developed using David Merrill's instructional design model. David Merrill's First Principles of Instruction exactly fits into object oriented approach

so that learning content can be created in the form of knowledge objects [12].

Learning Grid is the Grid network solution that is used to appendage e-learning environment in a greater share. Learning materials designed for online or e-learning could be reused, provided they are available on a sharable network. The developed e-learning content could be maintained on the web servers so as to access them all over the internet from the client e-learning environment during the actual learning process only. Since they are in a centralized point of storage; they can be well maintained and updated using the features of object oriented approach.

Normally, courseware meeting SCORM standards is sharable with other e-Learning platforms. Most e-Learning platforms however are unable to share courseware directly on the Internet. Data grid technology allows the integration of different SCORM platforms into a huge e-Learning environment. Therefore this work uses SCORM and data grid [14].

II. BACKGROUND

Recent research in orchestration [10] has pointed out several of these shortcomings, which need to be considered if we want to move beyond the safe boundary line. The work from [21] brings out the elements of a new theoretical framework, which considers design for learning ‘‘in medias res,’’ i.e. as an on-going procedure for improving mainstream educational settings and processes rather than as a methodology that only works well in the protected niches of project-based innovation. The framework states the importance of these elements: i) Design needs to be understood as having an indirect effect on learning; ii) Teachers are often essential actors at learn-time; iii) Design for learning needs to find ways of working with the dialectical relationships between structure and agency ; iv) All design is future-oriented, of course [8,16,17].

III. OBSCURITIES IN THE CONVENTIONAL CURRICULUM, SYLLABI AND INSTRUCTIONAL DESIGN

Conventional curriculum comprises of unit based syllabi which is due to the need for continuity in giving the concepts to the learners in an increasing order from fundamentals to advanced topics. In this intention, unless the order is followed, it is very difficult to proceed further with complete learning. Let us consider a course named ‘Object Oriented Programming’, where the Unit-2 “Inheritance” cannot be learnt unless the Unit-1 “Classes and Objects” is learnt prior which forms the basis or entry behavior. The conventional approach gives an opportunity to leave the problem solving part left untouched. When the learner undergoes learning with the unit based syllabi which includes concepts without any problem solving aspect of learning which will result in not developing application and integration abilities pertaining to the course [2].

If the curriculum and syllabi is to be updated, then it is mandatory to redesign the entire curriculum and syllabi content as per the industry needs and trends which keep evolving frequently involve a considerable amount of time and effort repetitively. Obviously this issue hinders the state-of-the-art syllabi being practiced by the learners time to time which need to be addressed at the earliest time.

IV. APPROACH FOR E-LEARNING USING DAVID MERRILL’S PHASES OF INSTRUCTION

Learning on a topic is completed only when the learner is able to apply the acquired new skills in a new situation that the learner faces. Hence, the curriculum, instructional design and learning approach are to be designed and developed in a systematic way with proper strategies [19].

Merrill’s approach of putting a real life problem into the center of instructional episode is particularly suited to problem based learning approach. As Information and Communication Technology (ICT) education is a problem-based study, Merrill’s theory is best suited instructional design for e-learning, in particular, as its approach is independent, dependent, sharable, reusable and modular. [11,18].

As per the Merrill’s design theory, first principles of instruction emphasizes the following aspects: the value of using the real-life problems in the instructional event; importance of activation of existing knowledge of the learner; the role of demonstration; guided problem solving and the integration of new knowledge with the existing knowledge [12].

Merrill divides the instructional event into four phases which he refers as 1) Activation, 2) Demonstration, 3) Application and 4) Integration. Central to this instructional model is a real-time problem as shown in Fig.1. Learners are engaged in solving real-world problems. They are shown the task that they will be able to do or the problem they will be able to solve as a result of completing a module or a lesson.

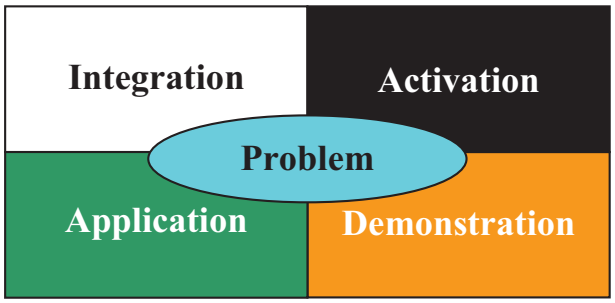

Fig.1. David Merrill's First Principles of Instruction

V. PROBLEM CENTRIC MODEL

Problem based approach and David Merrill's phases of instruction might serve as the better approach to fit the curriculum and syllabi development respectively, as it is based on problem-based knowledge objects or model of information processing theory. Problem Based Learning (PBL) is perceived as a perfect approach to education and learning [21]. The term PBL is used to describe a variety of projects from research and solving case studies to guided design and design of engineering projects. It is both a curriculum and a process. Merrill explores several elements in the process of PBL as shown below. Learning to solve problems involves four levels of instruction:

- The action level
- The operation level
- The task-level and
- The problem level

Disciplines or branch of study for which PBL would be suitable are:

- Information and Communication Technology
- Computer Science
- Mathematics
- Physics
- Chemistry
- Statistics and more.

Once the modular-based problem centric syllabi are constructed, the e-content for problem based learning can be created.

VI. MCA THROUGH PROBLEM BASED LEARNING APPROACH

Master of Computer Applications programme is a combination of Information Technology and Computer Science disciplines. The courses in MCA follow unit-based syllabi under any university through any mode. To apply the concepts of problem based learning for MCA, the existing syllabi need to be converted which involved redesign of entire syllabus on problem centric approach. This massive change in the syllabi might lead to removal or the addition of certain lesson and topics from or to the course in the existing syllabi. Through this process, the Unit system is eliminated from the new syllabi and the list of problems pertaining to each of the concepts to be covered are designed. Hence, the learning will be learner centric and problem oriented which involves learner in solving the problems associated with each concept rather than the teacher alone solving problems for a sample. A sample for one of the course tried through the above approach is given in Appendix 1.

It is expected that the approach intends to involve the learners with clear understanding of the concept from the teacher's contribution by activating the existing knowledge with a sample demonstration to stimulate the demonstrative ability and apply the acquired knowledge and skills on the problem related to that topic with immediate effect. Hence, the learner's understanding is well ensured in the classroom itself. The integration of acquired skills in a new environment will be assured as an output [1].

VII. REUSABLE E-CONTENT DEVELOPMENT

The problem wise e-content will be developed as separate modules or objects for each problem from the list of problems for a particular course. The e-content once designed and developed for each module should meet with the standards of SCORM (Shareable Content Object of Reference Modules). Such objects of a module can be reused whenever it is required for yet another course of the same programme or any other programme [15].

Indeed, this approach will be flexible enough for doing any content update or content addition by simply creating only one sharable object of SCORM standard. Further, it can be referred in every course which needs this new information to be added.

VIII. SCORM COMPLIANT LEARNING GRID (DATA GRID)

A Grid is a collection of distributed computing resources available over a local or wide area network that appears to an end user or application as one large virtual computing system. An increasing interest by important IT companies like IBM, Microsoft and Sun Microsystems for applications and systems, Oracle for database permits to the consideration of Grids as the future technology for distributed applications. Innovative and active service provisioning can take

advantages from this technology using its features to improve quality of service. The platform results will be a simpler and flexible grid structure highly optimized for asynchronous and distributed processing [20].

Grid computing is a natural evolution of distributed computing that attempts to better utilize unused compute capacity by exploiting the computing power of a large numbers of server computers, desktop PCs, clusters, and other kind of hardware [7,13]. The Grid is a distributed infrastructure that coordinates resource sharing and problem solving in dynamic, Multi-institutional virtual organizations. A virtual organization consists on a set of individuals and institutions sharing resources regarding a set of rules [6].

Data Grid with that of SCORM, a step that would allow the independent LMS to share the SCO on the Grid environment [4]. As long as each and every Data Grid has the node duly installed and tested and the SCO meets the SCORM standard, an environment in Grid Architecture for sharing of SCO courseware would be available. In such a case, the LCM suppliers would not have to make courseware which is already available in other Grid Nodes, so as to save on cost and make the best use of present learning resources. On otherhand, learners can learn more courses without having to be affiliated with other LMS. A huge amount of software and hardware equipment purchasing expenditure can be saved and the goal of complementation and sharing of resources among schools and different departments can be achieved [5].

IX. PROPOSED SYSTEM ARCHITECTURE

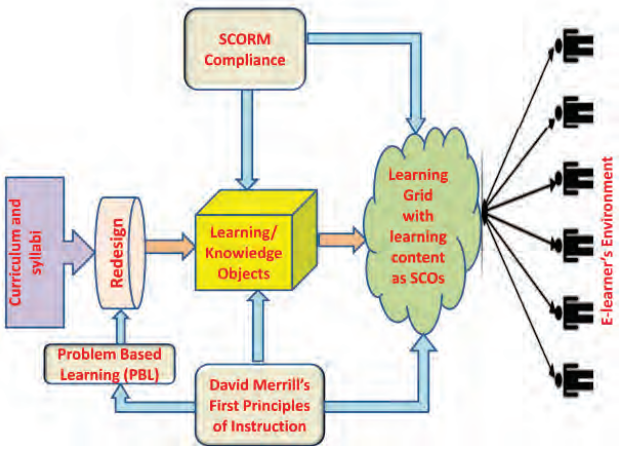

Fig.2. Proposed System Architecture

The flow of the proposed system is brought out in the Fig.2. The existing curriculum and syllabi need to be redesigned in Problem Based Learning approach with David Merrill's First Principles of Instruction as background for devising PBL. The Learning objects or knowledge objects are to be created in line with David Merrill's Instruction cycle and SCORM compliance. These knowledge objects are stored on the Learning Grid for use at the time of e-learner requests. While the content is selected for response to e-learners from the learning grid, the SCOs are referred as per the David Merrill's Instructional Design approach.

According to [5], it is noted that the data grid is used as sharable e-learning platform. This proposed work adds to [5], the following:

- Problem Based Learning approach for curriculum and syllabi revision
- Instructional design strategy namely David Merrill's First Principles of Instruction

As the above two components precedes data grid deployment and use at Chao and Hsin's work, the proposed system is supposed to function successfully.

X CONCLUSION

The conventional curriculum and syllabi of MCA programme is not well suited to launch the e-learning mode of any programme, in particular a computer science related programme MCA. Hence, the existing curriculum to be reorganized to fit the problem based learning approach (each course is described with a list of problems to be solved by the learners to learn the course) and the e-content is to be developed based on the David Merrill's Instructional Design Model which insists the learners to undergo the following sort of activities during the Teaching-Learning-Process: Activation of existing knowledge; observe from the Demonstration by the teacher as a sample presentation; invoking the learners to Apply the learnt lesson on a problem and solve it; and acquire skills to practice the learned skill in a new situation or a real problem area. While creating the e-content suitable for e-learning, the SCORM standards has to be met which will provide flexibility to update any course by simply incorporating a change globally on the e-content developed. Such SCORM compliant content is stored on the Learning Grid that is available to all e-learners on demand from the e-learning environment. Hence, this system gains its appreciation the acceptance without even any experiment.

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Appendix –1

Let us consider a course titled "Theory of Programming Languages and C" from the syllabi of MCA programme offered by Periyar University through regular mode at the affiliated colleges. The Unit-II syllabus content of the above mentioned course is given below:

UNIT –II

An overview of C – Keywords and Identifiers – Constants – Variables – Data Types – Input – Output Operations – Operators and Expressions – Decision making and Branching – Loop Control Structures.

As a first step, the above-mentioned syllabus content to be redesigned in PBL method, as set of problems which addresses all the topics mentioned in it. The following are the set of problems:

1. Write a simple program using printf statement to print all the keywords in C as a comma separated list.
2. Use escape sequences to print the rules for the following as a bulleted and numbered list using printf statements.
   a. Rules for identifiers
   b. Types of constants and variables
3. Demonstrate the creation of a table using printf statements with the following heading:

S. No.	*Data Type*	*Key-word*	*Size of Memory*	*Range of values*	*Control string*

4. Write a C program using scanf and printf statements to accept the values for 3 products. The input specification is under:
   a. Name of the product – 5 characters
   b. Quantity - integer value
   c. Cost per unit – rupee value in float datatype
5. Create a table for operators, expressions and its hierarchy using C.
6. Write a C program to find the biggest of 5 numbers using all types of if constructs.
7. Demonstrate the use of switch statement to print the months in number as name of the month. (eg. 4 – April; 8 – August)
8. Apply the concept of ternary condition operator to prepare the student mark details for result processing. Let the input be 5 marks and let the output be 'Pass" or 'Fail'.
9. Write a program to demonstrate the looping concept using simple 'goto' and 'label' statements in C.
10. Differentiate the output generated by while and do…while loop for printing numbers from 100 down to 70.
11. Develop a C program using for loop to process and print the salary statement of 20 employees of ABC Ltd.

As described above, the syntax and concept explanation are to be given by the teacher as a part of sample demonstration. While the learner applies the knowledge and skill to solve the list of problems related to the topic, the student acquires through knowledge and skills on the topic/concept required for integrating those skills in a new situation/real world problems.