

A learners' quanta model based framework towards building dynamic web-based courseware

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The courses on web are primarily pre-designed to cater the requirements of a broad base of learners or target groups. However, the target group in web is geographically spread all over the world with varying socio-economical background. If a course is designed to cater a wide spectrum of participants all over the globe, most of the participants would find a lot of redundancy. The present work aims towards providing an algorithmic solution for making the design of web-based courseware that can cater a wide spectrum of learners as well as satisfies the varied need of each learner in some tailor made approach. In our earlier work [6], we have proposed a learner-centric, modular approach, named LQ model, in which the course modules are dynamically selected from a pool and then an appropriate sequence of the selected modules is set to frame target specific and cost-effective courseware for individual learners. This LQ model has been utilized and extended here to build a framework towards developing dynamic courseware based on the exact requirements of individual learner while keeping in consideration, the background knowledge of that learner on relevant subject area. A prototype has also been built and tested following the proposed LQ model.

Key words: Computer Aided Distance Learning, Learners' Quanta, Knowledge Factors, Reusability, Prototype.

1.Introduction

The design, development and implementation of successful and effective web-based course for the use of distance learning are being considered as a challenging problem all over the globe. Several efforts in this regard have been reported which are mostly course-specific.

The non-linear way of storage of computer-based document or information in the form of hypertext has brought a revolutionary change in the teaching-learning process [4, 5, 13]. Multimedia documents with appropriate hypertext links are also being widely used in education, and can be considered to be a very high potential and powerful tool for teaching-learning process [1, 2, 5, 7].

The utilization of multimedia based documents as supplementary educational tool raise several research issues that are very contemporary and wide spread [4, 5]. Several other research activities in the study of various issues in this connection [1, 3, 4, 13] evaluated hypermedia document as a learning tool. Vasileva and Deters [12] designed a Dynamic Courseware Generator tool based on AI planning techniques, but emphasis had been given more on pedagogical and other issues rather than techniques of adaptability of the courseware.

The working group IEEE "1484 Learning Technology Standards Committee (LTSC)" has designed an architecture called Learning Technology System Architecture (LTSA) to standardize web-based content delivery for all learning technology systems [6]. Several other researchers [8, 9, 11, 14] have identified the necessary issues required in the effective delivery and the learning of course content. G. Zhang [14] has designed a computer based knowledge system for assisting persons in making decisions and predictions upon human or data-mining knowledge. This work is one of the closest researches as we are doing. However, in spite of having an almost identical goal to offer maximum flexibility to the individual

learner, the approach to meet the target is distinctly different.

The Algorithmic Design of Adaptive Web-Based Courseware by R Ray, N Chaki, R Dasgupta [10] presents the LQ model where course is sub-divided into several topics. The user may choose one or more topics or the entire course as per his requirements and knowledge level at the beginning of the course. The present work is an extension of this LQ model. As has been established in the remaining sections of the paper, the courseware using LQ model is built dynamically considering the need and knowledge in the relevant subject area for individual learners.

2.The Learners' Quanta Model

In this model a course is sub-divided into several topics. A participant may choose one or more topics or the entire course as per his requirement. There shall be a large number of LQs for a subject area or topic of study. These LQs together form a LQ cloud for the specific topic of study. In other words, a topic is constituted by a suitable combination of LQs as chosen by the course coordinator in accordance with the requirement/learning style of the participant.

2.1 Characteristics of the participant registering the course

Each participant intending to register any course under this scheme will have

- a) A precise description of his initial knowledge level (may be determined after a pre-test)
- b) A clear description of the requirements by the intended learner

2.2 Characteristics of Learners' Quanta of Study:

- i) A Learners' quantum of study obeys atomicity in the sense that a learner cannot study a LQ partially. On completion of each LQ, a learner will attain a set of objectives.
- ii) An LQ covers only one or multiple objectives of learner that are closely related. It depends on the designer of the LQs who would decide the content of individual LQs and therefore, shall effectively decide on how many and which particular objectives a LQ will cover.
- ii) For completion of each LQ, an estimated time may also be mentioned. Once again, the author of the LQ can prescribe this. The actual time for learning vary for different learners.
- iii) For every course meant for an individual learner, there is at least one Start LQ and one Finish LQ. However, depending on the requirement of participants, there may be more than one Start and Finish LQs.
- iv) Every LQ has a unique LQ-id.
- v) Except the Start LQ, every LQ has one or more pre-LQ-id. This, pre-LQ-ids indicate the pre-requisite LQs, that need to be studied before a LQ may be taken up by the learner.
- vi) Two sets of LQs are said to be equivalent if both the sets cover the same set of output objectives. A learner may be offered the any one of alternate equivalent LQ sets, based on external parameters like learning time, associated cost, etc.

3.Adaptive Algorithm for identifying appropriate LQs from LQ Cloud (LQC)

Given

I: Input knowledge set of the learner

R: Requirement knowledge set specified by the learner

O_i : Objective set attained by a learner on completion of the i^{th} LQ

P_i : Pre-requisite knowledge set for the i^{th} LQ

Now the problem is to identify the required set S of minimal LQs from the available LQ cloud (i.e. the knowledge pool) so that any learner with given Input knowledge background I can reach to the level R . The condition of minimalism depends upon various factors according to the requirements and preferences of the learner. The detailed algorithm is not presented here for limited space. The reader, may however, refer the same [10] in our earlier work.

4. Developing a Prototype

In order to validate the proposed design, we have developed a prototype for the system. We have used an object-oriented platform for the purpose. The prototype has been developed in three stages. At first, the class modules have been compiled into a Dynamic Link Library (DLL). A setup package has been made just for the deployment of the classes in a development environment. It is compatible with all MS languages supporting the ActiveX / COM model.

In the next phase, a standalone ActiveX component LQBox is defined. A setup package has also been made for this control such that any user can use this component as a *black-box* without worrying much about the implementation logic behind the scenes. The LQBox component is also compatible with all MS languages supporting the ActiveX/COM model. Finally, an application is developed to depict the working of the modules mentioned above. Data entry, validation and solution generation can be hence shown.

A test case has been demonstrated in figure 1. The target set of knowledge factors $R=\{419, 461, 405, 63, 260, 7, 478, 153, 226, 379\}$ and learner's input knowledge factors $I=\{93, 94, 255, 95, 476, 96, 249, 97\}$ are being considered. The figure 1 shows the LQ sets that has generated in multiple iterations. The screen shot, however, does not show the all the steps. The process, as explained in section 3, starts from the objective set of learning and identifies the required LQs in a reverse direction. Only the first few iterations starting from the target set of KFs is shown in figure.

Target KFs	Pass 1 LQs	New KFs	Pass 2 LQs	New KFs	Pass 3 LQs	New KFs	Pass 4 LQs	New KFs
419	6	82	1	83	2	274	1	65
461	17	314	4	402	3	167	4	126
405	27	367	11	17	4	204	7	89
63	39	324	17	98	5	407	13	474
260	42	393	19	109	7	438	15	379
7	59	325	21	274	9	166	16	213
478		117	23	166	13	1	23	493
153		174	26	57	16	246	29	282
226		167	28	126	17	127	31	60
379		337	29	177	18	460	43	54
		32	37	65	19	357	49	402
		469	79	89	24	382		32
		20		474	34	98		204
		342		379	59	88		191

Figure 1: The LQ set corresponding to Selected KFs

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