Content Feature for Web-based Instructional Module Development (IMoD) System

Vishnu Menon
Department of Engineering
Arizona State University
vmenon3@asu.edu

Abstract—Creating a brand new course or setting out to transform an existing course can be a daunting task for new as well as experienced instructors. Although courses vary in size, subject matter, level, and intended audience, a systematic process will help instructors plan and structure their course offering(s) so as to effectively reach the desired instructional objectives. A precursor to achieving this goal, and a vital step in the process, is to clearly identify and state the learning objectives of the course. These objectives then need to be aligned with the course topics and assessments. Furthermore, having a clear understanding of the interrelation among topics that have to be taught, their priorities with respect to level of learning, and a realistic schedule to achieve the instructional goals within a set duration will all contribute to a more comprehensive course design that can lead to an improved learning experience for both instructors and students. Current Knowledge Management Systems (KMS), Electronic Performance Support Systems (EPSS) etc., do not lay as much emphasis on the content feature as the Instructional Module Development (IMoD) system. Emphasis on the actual course content that forms the heart of the subject being taught is essential for meeting the set learning objectives of a course. This report presents an IMoD system that offers an instructor a systematic process to create, prioritize, plan and organize content topics for a particular course and hence meet all the desired learning objectives.

Index Terms—Client side programming, Server side programming, User centered design, Instructional module, Web application.

I. INTRODUCTION
There are a variety of course/knowledge management tools available to educators but none really encompass all the activities of course planning and development starting from the initial stages of providing a course overview through mapping learning objectives to course topics, and allowing dynamic scheduling and organization of topics to be taught. These tasks eventually help educators in obtaining a clear picture of the curriculum (course plan of study). A tool that provides a combination of all these functions would clearly take a weight off the shoulders of educators who would otherwise have to synchronize and plan their courses either manually (which is labor intensive) or electronically by synchronizing among multiple course/knowledge management tools. Most new Science, Technology, Engineering and Mathematics (STEM) educators have little, if any, formal training in planning course work and imparting knowledge effectively. Building a tool i.e. Instructional Module Development (IMoD) system that would guide educators through the complex process of course and curriculum design and allow them to efficiently plan and meet course objectives is the main idea behind this project.

A) Problem Statement:
The identification of topics to be taught for a particular course is a difficult task because these topics should map directly to the learning objectives of the course. More often than not this task is not taken into consideration during course planning which might result in the course not meeting its objectives. Even if this mapping is done conceptually, a tool that would help the instructor to explicitly associate content topics with learning objectives would undoubtedly be of great use. Mapping of individual course topics with learning objectives ensures that each course topic being topic contributes towards the set learning objectives of the entire course[6]. Furthermore the topics must be allocated time while taking into account both their learning objective and priority. Every topic is assigned a priority based on its relevance to the course and its contribution to attaining the associated learning outcome. The aim of the semantic web-based Instructional Module Development (IMoD) system is to present a framework-informed by the scholarship on curriculum design- for conceptualizing and representing an instruction module (i-mod) i.e., a single course that can span over a specified duration of time, particularly in the areas of engineering and computing. This system will provide a scaffold via various help and support features to guide the users through the i-mod development process. The scope of this project is to create the content page feature in the IMoD system. This feature will allow the user (instructor) to (i) identify course topics; (ii) dynamically link topics to their related learning objectives; (iii) prioritize topics based on level of learning; (iv) show the interrelationship among topics, such as, is a sub-topic of and is
a precursor of; and (v) schedule the instruction of topics. The functionality of this feature will be represented graphically in a visually aesthetic manner that is both intuitive to the user and effective in capturing information. The expected outcome is a tool that provides a rich user experience and lessens the labor intensity typically involved in course design.

II. RELATED WORK

The following section provides a brief review of 2 categories of IT tools that currently support instructional curriculum design activities.

A) Electronic Performance Support System (EPSS):

An EPSS is any category of software systems that helps in improving user performance. In *Electronic Performance Support Systems* [7], published in 1991, Gloria Gery defined EPSS as: “an integrated electronic environment that is available to and easily accessible by each employee and is structured to provide immediate, individualized on-line access to the full range of information, software, guidance, advice and assistance, data, images, tools, and assessment and monitoring systems to permit job performance with minimal support and intervention by others”. Its typically used in situations where employees need to master/understand a particular topic before they can start working on it and hence is particularly useful when skilled employees spend a lot of time helping their counterparts when their time could be better spent on high-value tasks. It is quite similar to the IMoD system in that it guides users through a complex task in an organized and systematic manner.

B) Learning Management System (LMS):

An LMS is a category of software applications that helps in the administration, documentation and reporting of progress in classrooms. LMS systems may sometimes replace the role of teachers in classrooms by providing an interface via which students can view subject notes, answer questions relating to topics and even generate automated tests and grade them. The IMoD system in contrast is a tool which helps the instructor of the course to plan the coursework according to learning objectives decided by him, rather than have an automated tool do the same.

C) Knowledge Management Systems(KMS):

KMS is an IT based program which helps to organize and manage knowledge via sharing of user experiences, recording shortcomings and successes to aid future workers [4]. It also helps with creation, storage and spread of information. It is related to organizational learning as opposed to the IMoD system that focuses on institutional educational learning. Some KMS make use of ontologies as does the learning objective part of the IMoD system [6]. Blackboard [8] and Moodle [9] are examples of KMS where instructors can create course modules and share it with students.

<table>
<thead>
<tr>
<th>Features</th>
<th>Proposed IMoD System</th>
<th>Electronic Performance Support Systems e.g., CASCADE</th>
<th>Knowledge Management System e.g., Blackboard &amp; Moodle</th>
<th>Repositories e.g., NIST and Correlation</th>
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<tbody>
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<td>Provide Research-Based Pedagogical Principles</td>
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<tr>
<td>Allow Sharing of Curriculum or IMoD</td>
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<td>Knowledge Representation</td>
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Table 1. Comparison of IMoD Development System with existing Curriculum Development IT Tools

III. THEORETICAL BACKGROUND

The content feature working with the learning objectives will help the instructor to target specific goals with the realization that not all goals are equal and not all goals can be met with during the duration of a single course period. In particular, the instructor must avoid aimless coverage of content and isolated activities that are disconnected from the target objectives. All too often learning objectives are not met with because while they are clear in the instructors mind they are not clearly associated and structured with the course topics being taught. The instructor must pace his/her teaching by attaining certain short term goals before targeting the long term ones. In some cases there may be ambiguity in the associations between the topics being taught and the learning objectives they complement. These can be avoided by having a clearly structured hierarchy wherein these associations are brought to the fore for the instructor’s perusal.

The content feature allows the instructor to categorize topics and subtopics based on their priority. It is not feasible to target all the objectives of the course with the same level of priority. But it’s the relation between the learning objectives of the course itself and the individual priorities of the topics that’s important. Justifiable decisions have to be made on the topics that have to be taught, topics that have to be emphasized upon and topics that can be left out. If there are no long-term objectives/goals the instructor would lack a sense of perspective and hence resort to attaining only content related, short term objectives. Typically a course topic in itself might
encompass too much content which can be reasonably addressed during the course of a single academic term – which again brings forth the importance of prioritizing them [1]. A good idea to realize efficient prioritization is asking yourself if the students of the course can clearly identify what are the core ideas of the subject, what the minimum requirements for course completion are, how do the individual pieces connect to the larger idea etc. A learner can get this understanding if he/she is able to comprehend the ‘big ideas’. A big idea may be considered as a linchpin. It is absolutely essential that learners understand all the big ideas of a particular subject if they are to succeed in it. A thorough understanding of the ‘big ideas’ will serve to distinguish those who have merely memorized theory from those who have understood the actual concepts. In essence they have a comprehensive, workable knowledge of the subject in real life scenarios. For example, a student of Shakespearean literature would list the core ideas at the heart of Macbeth as honor and loyalty. An idea cannot be considered as ‘big’ by only taking into account its intellectual scope, it must manifest itself in the learner by making him/her able to adapt adequately to respond to situations wherein the knowledge (s)he possesses may be applied, make unfamiliar concepts and ideas seem familiar and make reasonable judgment calls based off this new knowledge. The content feature of the IMoD system incorporates four user-interface sections each of which contribute something specific to the task of topic addition, prioritization and organization. The four sections are:

- Topic Addition Grid
- Topic Hierarchy
- Topic Prioritization and
- Scheduling

IV. CONTENT FEATURE OF IMOD SYSTEM

The content feature of the IMoD system consists of four sections:

- Topic Addition Grid
- Topic Hierarchy
- Topic Prioritization and
- Scheduling

A) Topic Addition Grid:

The topic addition grid (shown in figure 1) enables instructors to create topics/sub-topics, set an associated learning objective, set a level of learning (priority) and add resources. An instructor can click on the Add Topic button on the grid to begin creation of a new topic/sub-topic. Instructors can click on the Remove Topic button to remove a selected topic/sub-topic from the system. Once instructors are done entering information, (s)he can save the information by clicking on the Save button located on the toolbar of the IMoD system.

Information stored in the topic addition grid can be dragged and dropped onto the neighboring tree structure (on right-hand side).

a) Naming of Content Topics:

Instructors must name the content topics/sub-topics at the time of creation. This is a required field and must have a valid input before it can be saved into the database. At the time of creation there is no differentiation between topics and sub-topics.

b) Topic Prioritizing:

The content feature of the IMoD system uses a prioritization framework (shown in figure 2) which classifies topics and subtopics of a particular course as one of the following:

- Good to be familiar with
- Important to know or understand and
- Enduring understanding.

In figure 2- consider the area outside the largest circle as the field of all the content areas, which are included under a particular course. It is not possible for a teacher to completely examine all possible areas in class. All content topics that the lecturer feels a student should, at the bare minimum have a basic understanding of will be placed into the largest circle i.e., good to be familiar with. With the second concentric
circle *i.e.*, important to know or understand*, we target all those content topics which have an associative power and those that which a student in the course should have a broader understanding of. The core ideas of the course are included in the last concentric circle *i.e.*, enduring understanding. It is here that we include the content topics that form the base of the course, the content topics that are central to the understanding and application of the subject being taught. The three concentric circles technique has been proven to be very useful to teachers[1].

The IMoD content feature implements this technique by having the user set a priority for each content topic/sub-topic as they are added into the IMoD system. This feature is implemented using a drop-down field from which the user can select a priority designation. This value is then saved into the database when the user clicks on the save button on the content page. The user can also choose to leave the drop-down empty and later update the priority field as and when (s)he is ready.

c) Learning Objective:

A learning objective describes what knowledge a student of the course must know or have learnt by the end of the course. Learning objectives should be stated as clearly and precisely as possible. It should not be ambiguous and open to interpretation and should be pertinent to the course. Experts often use the S-K-A (Skills, Knowledge, Attitude) acronym to help with understanding the purpose of using learning objectives [2]. It encompasses all the skills and knowledge that the student should have gained and his/her overall attitude towards the course field.

In the Topic Addition grid, instructors can choose a learning objective from a drop-down that lists all the learning objectives that have been created by the instructor.

![Add Resources Grid](image)

**Fig 3. Add Resources Grid**

**d) Add Resources Grid:**

Once the user is done entering the topic title, mapping with a learning objective, and priority (s)he can click on the 'Add Resources' hyperlink to add resources associated with the current topic/sub-topic. Once the user clicks on the hyperlink, an Add Resources grid (shown in figure 3) is displayed wherein the resource information can be provided. The structure of the Add Resources grid is very similar to that of the Topic Addition grid. The user can add new resources by clicking on the Add resource button and delete a selected resource by clicking on the Remove Resource button.

On the Add Resources grid instructors can enter the title of the resource, upload the actual resource and set the type of the resource. The type of a resource can be one of:
- Document
- Chapter
- URL (Uniform Resource Locator) and
- Book.

Once the user is done filling in this information they can click on the Save button on the grid to save this information into the IMoD system.

![Topic Hierarchy](image)

**Fig 4. Topic Hierarchy**

**D) Topic Hierarchy:**

The IMoD system employs a tree structure (shown in figure 4) to organize topic/subtopic information and also distinguish between the topics and sub-topics.

Once the user is done creating a topic, they can select and drag a topic from the Topic Addition grid onto a selected node on the Topic Hierarchy tree structure. The user is made aware that a grid row has been selected by means of a tool tip that explicitly informs the user that one row has been selected. Furthermore, the user is made aware of the drop zone by a green tool tip icon. The root node of the tree is by default set to the i-mod title that was input by the user on the Learning Context page of the IMoD system. When the selected node is dropped onto the root node it becomes a child node but when its dropped onto a child node it becomes a leaf node of the tree. Currently only two levels of entries into the tree structure
are allowed. It is with the tree structure that the distinction between the topics and sub-topics are done. All the child nodes of the root node are topics whereas all the leaf nodes of the tree (or the children of topics) are the sub-topics. Once an instructor is done creating the tree or during tree creation (s)he can drag and drop topics/sub-topics within the tree.

The prioritization information obtained from the Topic Addition grid is displayed using a pie chart (shown in figure 5). The user can add new information into the Topic Addition grid, save it into the IMoD system by clicking on the Save button on the toolbar.

![Fig 5. Topic Prioritization](image)

![Fig 6. Schedule](image)

D) Schedule:

Once instructors are done creating and organizing content topics, the IMoD system provides them with a means to plan the schedule for instruction. This section of the content feature provides a means to graphically organize the order in which the content topics are to be taught.

The schedule grid (shown in figure 6) is similar to the Topic Addition and Add Resources grid. The date column of the grid is automatically populated with dates corresponding to the course schedule information obtained from the instructor on the Learning Context page of the IMoD system. The Topic Name can be populated by dragging and dropping entries from the Topic Addition grid.

E) Topic Prioritization:

Achieving the right mix of the three levels of learning (priorities) is essential to planning a good course. If there are a high percentage of content topics classified under *Enduring understanding*, it’s usually safe to assume that the instructor is aiming for too much. On the other hand, if a large percentage of topics were classified under *Good to be familiar with*, students may not be able to achieve the desired level of learning objectives. The decision of topic/sub-topic prioritization is completely dependent on the instructors’ judgment. It is useful to have a graphical tool to help analyze the priority assignments and change them if required.
V. IMPLEMENTATION

The system requirements, database design, server-side and client-side scripting and implementation of the content feature of the IMoD system is discussed in this section.

A) System Requirements:
The IMoD system must ensure that all users are authenticated before making any changes into the system.

Authenticated users can edit content topics of an i-mod, create new content information for an i-mod, organize and prioritize content information. Before saving content topic data the system must ensure that a topic name is assigned for each entry.

Fig. 7 shows the use case diagram for the content feature of the IMoD system.

B) Database Design:
MySQL 5.5.16 serves as the backend storage engine for the IMoD system. It was chosen because of its following features:

- Cross-platform support
Some of the important tables used to store information from the user (relevant to the content feature) are:

a) Content table

The content table is the primary and most important table which stores the topic information, priority and associated learning objective. This table also has a field to keep track of the i-mod that topics are part of.

b) Resource table

The resource table stores resource information including the resource name, resource title and resource type. This table also has a field to keep track of the content topic with which a resource is associated with.

c) Content hierarchy table

The content hierarchy table stores the ID's of the content topics into two separate columns to distinguish between parent and child topics.

d) Schedule table

The schedule table collects information from instructors regarding the scheduling of the course. Figure 8. displays the database schema for the content part of the II IMoD system.

F) Server and client-side scripting:

PHP 5.3.8 [3] is used for server-side scripting, to store information retrieved from forms into the MySQL 5.5.16 [10] database. PHP can be deployed on most Web servers and also as a standalone shell on almost every operating system and platform free of charge [4]. For client-side scripting ExtJS 4.0 [5], a JavaScript library to create interactive web applications was used. The entire user-interface of this project was created using ExtJS 4.0.
V. VERIFICATION AND TESTING

A) Verification:

The IMoD system was developed under the supervision of Dr. Srividya Bansal, Assistant Professor, CTI Department of Engineering at Arizona State University and Dr. Odesma Dalrymple, Assistant Professor, CTI Department of Engineering at Arizona State University. Dr. Bansal and Dr. Dalrymple verified the tool. The intent of verification was to confirm if the product of a given development phase satisfies the requirements of the project.

B) Testing:

The IMoD system has been tested and found to meet all the requirements mentioned in the section (III-A). The application has been confirmed to work in multiple browsers like Mozilla Firefox 3.5, Internet Explorer 8, and Google Chrome 7.0. The functionality of the system is tested by creating a new topic in the topic addition grid, dragging and dropping it onto the tree hierarchy, testing if the pie chart renders information correctly, by checking if drag and drop functionality is working for the schedule grid and if all this information is being saved into the database. Some sample test cases have been shown in the Appendix section.

V. SUMMARY AND FUTURE WORK

The content feature of the IMoD system helps the instructor to organize and analyze the topics to be taught. ExtJS, a JavaScript framework for creating rich UI interfaces has been used for this project. Server side scripting has been done with PHP with a MySQL database serving as the backend.

The content feature of the IMoD system can be further Enhanced to make it more intuitive, user-friendly and useful. Below is the future work for this module:

- The learning objective part of the i-mod under creation is not currently being populated from the database. This must ideally be displayed as a drop-down from which the instructor can choose the relevant learning objective for the content topic.
- Validation of the topic addition grid to ensure that every content topic has a learning objective associated with it before saving into the database.
- A sliding help section(similar to the one used on the Learning Objectives page) that guides instructors through the content feature.

ACKNOWLEDGEMENT

I would like to thank Dr. Srividya Bansal and Dr. Odesma Dalrymple for providing their valuable guidance and advice throughout the work and giving me the opportunity to work on this project where I got a chance to learn and apply new technologies. I also extend my thanks to Dr. Timothy Lindquist for serving as a committee member.

REFERENCES:


APPENDIX A:

1. User can add new topic and set a learning level(priority):
Users can use the grid panel to add, edit or delete topics and Set a desired priority for each topic.

2. User knows where to drop a content topic with by a yellow background and a tool tip:
As soon as the user drags a content topic there are indicators guiding him as to where it can be dropped.
3. **User can populate the tree structure by dragging and dropping content topics:**

A user can select a content topic and drag and drop it onto the tree. If he drops it under the root node it becomes a node and if he drops it under a node, it becomes a leaf.