Enhanced Learning through Learning Knowledge Object

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Abstract: Most research and academic institutions own and archive a great number of documents which are stored and used over a longer period of time by lecturers and researchers. Some of these resources have already been converted into Learning Objects and are Structured in a meaningful way, thus enriching classical teaching. The Tactics Knowledge of an experienced faculty can be collected and stored in a Knowledge Management System as Knowledge Objects. A Knowledge Object can be any information artefacts. Learning Objects which are digital entities used to teach a topic in a curriculum can be integrated with Knowledge Objects and can be made available together as Learning Knowledge Object in a teaching module. Thus the Learning Material defined for a particular subject and the in depth knowledge of experts in the same subject can be combined together and delivered as one whole unit to the students for higher order learning. These Objects have a diversity of Metadata. Using these Metadata we can classify and cluster them. In this paper a novel approach is proposed so that we can provide efficient delivery of Learning and Knowledge Objects together for a student during learning and thereby provide an enhanced learning environment.

Keywords: Learning Objects ; Knowledge Objects ; Classification; Clustering; Learning Knowledge Objects

I. Introduction

Pedagogical dimension is an approach of teaching and learning, content delivery and how students acquire it. Constructing effective learning processes that satisfies various educational goals is of great importance in technology supported pedagogy learning system. The issues like Learning styles (visual, auditory, kinesthetic, logical, social), Learning process (Concrete Experimentation, Reflective, Abstract) and Learning needs have to be focused. The Learning process has different values in terms of Learner’s satisfaction and Learning content exploitation. Learning contents can be represented as Presentation, Explanation, Analysis, Evaluation, Reasoning and Problem Solving in a Learning process. These Learning processes support different Learning modes. Today a technology supported Learning mode is used for providing a dynamic way of constructing a Learning scene. The three main factors Analysis, Evaluation, Reasoning of this Learning scene is a part of higher order learning processes. A Learning Knowledge Object (LKO) proposed in this paper is an approach to provide dynamic construction of Learning content which mainly addresses the users of higher order thinking skills. The current shortcomings of LMS’s prevalent today are exchangeable, incompatible delivery mechanisms which support pedagogical learning and lack of flexibility to meet learners' needs.

In our approach, by generating LKO for a learning environment will provide support and guidance to the learner for acquiring the knowledge. By adding KO with LO, we can tailor to the need of students under pedagogic learning style. We are aware that learners have different need at different time of learning. The architecture of LMS needs to be designed where different study content should be provided as per users’ knowledge, starting from prerequisite to deep learning. This will definitely improve the efficiency of learning and delivery thereby enhance the overall effectiveness of LMS.

II. Literature Survey

A. Learning Objects

Learning Object (LO) according to the experts is a reusable digital entity used in technology learning which are structured in a meaningful way and has a learning objective [1] [2] [4] [7]. A Learning Object refers to any digital educational resources and it has content design, development and delivery. Instead of providing all material for an entire course, a particular topic or a lesson can be delivered during technology-supported learning [9]. Broadly speaking, Learning Resources usually refer to documents or collections, whereas Learning Objects are components of a document or collection.

B. Structure & Metadata of LO

Many Structures of Learning Objects have been proposed and its key features are: a) Learning Objective b) Meta Data c) Assessment d) Performance goal [3] [5] [6] [7] [8]. Basically LO comprises of an asset (image, text, video, web page) and an Information Object teaches a single concept like illustrating a principle, explain a concept or explaining a process. Granularity of an object in its smallest level can be a picture or a text and at the largest level can be a set of courses.
Metadata refers to description that facilitates & administrates these objects. Metadata is a structured information that helps to locate, fetch, use, and manage a LO. Metadata is often called data about data. The various Meta Data Standards for Learning Objects are Dublin Core Metadata [10], IEEE Learning Object Metadata [2], The IMS Global Learning Consortium [9], e.t.c. The IEEE aims to develop accredited technical standards, recommended practices, and guides for Learning Technology.

C. Knowledge Objects

Knowledge Objects (KO) are defined as a record of information that serves as a building block for Knowledge Management System. It has content, method of organizing a Knowledge Base, rules to identify and categorize Knowledge Components. Horton [13] says, ‘A KO is an electronic content that can be accessed and must have a goal to accomplish’. The Knowledge Object should consist of goal, content, Metadata and KO security information [12]. It is a viable approach for dealing with the situation [17] As Entwistle and Marton say KO as a ‘a tightly integrated bundle of ideas and related information and experience’ [14] [15]. The components of KO are: - Information Component (name, subject, date, status), Parts Component (objective, keywords, abstract, content ), Properties Component (other attributes that describe an object), Activity component (view, search, print ) and Processes Component (sets of actions performed to satisfy a goal or set of objectives) [16].

D. LMS&KMS

Learning Management System (LMS) has been widely used in higher learning institutions as a mechanism to aid teaching and learning process. LMS is a platform through which Learning content is delivered and managed [18]. Knowledge Management System (KMS) refers to a system for managing knowledge in organizations for supporting the creation, capture, storage and dissemination of information, so that an organization can obtain the greatest value from the knowledge available to it.

III. Convergence of LO & KO

In any institution there are various Learning and Business Processes involved. Knowledge takes place within this context and involves a mix of insights, experiences, values, judgments and ideas. It is dynamic within the social environment, because it triggers ideas and actions. Knowledge can be classified as explicit or implicit.

A. Explicit Knowledge:

In a Learning Institution Explicit Knowledge is collected or found in the form of course plan, lesson plan, assignments, quizzes, seminars in the portal of college or in organization website or in blogs, twitter. The other important information that can be conceptualized into Knowledge is received from feedback from students/learners in the Feedback Management System, Result analysis etc.. The valuable knowledge of these processes can be structured and stored in a Knowledge Base with a corresponding Metadata.

B. Implicit knowledge:

The knowledge of an individual in a particular subject is a valuable source of a Knowledge Object which can be used to teach a variety of topics in different subjects in a particular course or in various courses. The Knowledge Based System in any institution provides the means for computerized collection, organization, and retrieval of Knowledge from applications like Innovation system, Research Management System etc. These nuggets of Knowledge can be summarised or extracted and integrated along with a Learning Object in a Learning Repository and can be delivered to a Learner [19] [20].

C. Learning Knowledge Object

Learning Knowledge objects can be used as an Instructional object. It is meaningfully conceptualised, structured and is a viable source of information to a learner.

A Knowledge Object as such lack instructional feature but if combined with Learning Object it can be used in education or for training. Many ways are proposed to form a LKO. A method proposed by Amal [11] is by extracting document content (LO) and construct a concept map for each document and by identifying the important concepts and relations between them results in a LKO. An ontology model was proposed to generate LKOs based on instructional theories by Amal [21] and Wang [22].

D. The proposed approach for Generating a LKO.

For the formation of LKO we are combining a Knowledge Object as aforementioned instructional components with a Learning Object through classification technique to get a LKO based on the Metadata. It is as a self-contained instructional unit and can be delivered to learners who have the basic prerequisite are in need of a pedagogic learning experience.
IV. Need for LKO

Following are the needs of a LKO in a technology supported learning environment:

A. Need for a Learning Knowledge Object as a Quality indicator

The Learner can retrieve a Learning Material on a particular topic from the Learning Object Repository or can browse the topic tree to access Learning Materials on the topics of his/her interest. The LMS identifies the Learning Materials according to the learner’s requirement based on searchable attributes such as title, author, keywords, date, location, description and subject. The objects that are fetched and delivered are of static nature. According to MECOA model [23], there are 6 indicators of quality of Learning Object. They are content, representation, competence, self management, significance and creativity. The most important indicator of an object can be ‘content’. The value of content can be increased by tagging one or more Knowledge Objects to a Learning Object.

B. Need for a Learning Knowledge Object in pedagogical perspective.

Pedagogical principles are important for the good practice of teaching. LKO can be considered as a contribution oriented pedagogy by students, researchers. They can contribute in creating a KO by providing feedback of LO and also help in creating KO by asking questions and participating in discussions etc. Embedding the KO with a LO gives a context-driven architecture in which the learner is provided with facts and information, thus multiple perspectives on the content are made available. Hence quality resources can be delivered to the student.

C. Need for a Learning Knowledge Object in higher order thinking skills and deeper learning

The Bloom's taxonomy has six levels. They are knowledge, comprehension, application, analysis, synthesis, and evaluation. Analysis, synthesis, and evaluation are skills of the highest order and they are important in critical thinking. LKO to an extent can satisfy the need of higher order thinking.

D. Assessment

Assessment is an important part of learning. It reinforces the learning approach a student adopts. Both summative and formative assessment are required to test the knowledge and competency of a Learner. Most LMS provides an assessment by MCQ or short answer questions (SAQ) forms of formative assessment. However, there is a need for assessing students through projects, assignments, and case studies which are various forms of summative assessment. Through this assessment we can demonstrate students’ achievement and whether their Learning Objective is fulfilled or not. Learning Knowledge Object helps the student to get that extra edge of Learning and prepare them for various forms of assessment thereby improves their cognitive skills.

E. LKO an important element in new age learning

The LKO enhances the findability property, an important element in the next age of learning. The next step in online learning depends on the findability (keywords, tagging) of a resource. Enhancing findability requires a new optimizing technique. The Knowledge Objects made as an open educational resource when added with Learning within the course and curricula learning not only help in findability but can be more robust.

V. Proposed Model for Delivery of LKO

A. Steps of Proposed Model

1. Creation of LO and Metadata in LMS & Creation of KO and Metadata in KMS
2. Extraction of a LO from LMS and KO from KMS based on user need or user query with the help of Metadata.
3. The Convergence of these KO from LO through data mining techniques like classification. The classification technique uses the metadata of both LO and KO.
4. Generation of LKO - For each LO, may have one or more associated KO which is considered as a part of an Instructional unit.
5. To enhance the search and delivery of a relevant Learning Object to a learner, Clustering of LKO with the help of a clustering engine can be done. K-Mean or Self Organising Map clustering algorithms can be used. Thus a set of reduced and relevant LKO can be delivered quickly to a user in a technology supported learning environment which can act as a viable and effective information.
B. Description of the Proposed Model

Figure 1: Conceptual model of LKO for Enhanced Learning

The proposed model of LKO can be explained using “Figure.1”. The detailed steps involved in it are as follows:

**Step 1: LMS & Generation of Learning Objects**

LMS is a software application that plans, executes and assesses a specific Learning Process. It provides a combination of software tools that have a variety of functions related to online and offline training, administration and performance management. LMS tools like Moodle, share point portal can be used to store Learning Objects and its Metadata.

**Step 2: KMS & Generation of Knowledge Objects**

All leading business organizations are now working on the principle of Knowledge management where knowledge of its people is considered the most valuable resource of an organization. Knowledge Management is essentially about facilitating the processes by which knowledge is created, shared and used in organizations. These Knowledge objects along with Metadata is stored in KMS.

**Step 3: Role of Metadata in Query extraction**

The primary purpose of Metadata is its ability to describe a resource and allow the user to fetch it. Fundamentally, Metadata is an enabler. Metadata attributes used are abstracts, keywords, subject, file formats authors, producers, copyright and usage restrictions, e.t.c.. Meta data plays a bigger role in the delivery of a quality of an object, administration and exchange of learning objects.

**Step 4: Convergence of LO and KO**

KO stored in the Knowledge Repository of KMS is extended with a goal, content and Meta data. Data mining classification algorithms like decision tree, rule based classifier can be used for converging KO with the corresponding LO. For each LO we may have one or more associated KO which can be further considered as a part of Instructional unit. These can be considered as a LKO.

**Step 5: Delivery through clustering engine.**

To enhance the search and delivery of a relevant Learning Object to a learner data mining techniques like association [27], rank clustered objects [28] etc. can be used. Here delivery of LKO can be done with the help of a clustering engine. K-Mean or Self Organising Map clustering algorithms [24] [25] [26] can be used. Thus a reduced set of objects can be delivered to the user. Clustering based on Metadata of LO and Metadata of KO can serve different other purposes like identifying similar or related content and this data can be reused often (and possibly in different contexts). The clusters formed can be evaluated using measures like entropy, purity, precision, recall and F-score [26].

VI. Experiment Results & Analysis

1. A Set of seven Metadata is considered for KO and LO. They are Object id, Title, Topic, Sub Topic, Educational Level, Author and Type. A Data Set of 100 Learning Object Meta Data is considered during the training Phase and a set of 15 of Knowledge Objects are considered for the test Phase as shown in “Fig 2”.

Figure 2: Loading of Metadata of LO&KO

<table>
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<tr>
<th>ID</th>
<th>TITLE</th>
<th>TOPIC</th>
<th>EDUCATIONAL LEVEL</th>
<th>AUTHOR</th>
<th>TYPE</th>
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</table>
2. Rapid Miner, a Data Mining Tool is used for Analysis. The classification algorithm decision tree is used to classify the LO and KO using the Metadata to form LKO as shown in “Fig 3”. The classification algorithm builds a classifier by analysing a training set and their class labels. The classifier is a model in the form of decision tree, rules or mathematical formula. Test data are used to estimate the accuracy of classification rules. The various classification algorithms are decision tree, artificial neural network, fuzzy logic, genetic algorithm.

![Figure 3: Graphical view of DT](image)

3. From “Fig 4”, In the first row LO1, LO4, LO8, KO1 are grouped to form LKO1. In the thirteenth row LO8, LO9, LO11, KO2 are grouped to form LKO2.

![Figure 4: Matrix of true LO/KO & Pred. LO/KO](image)

4. The confusion matrix show in “Fig 4” also gives the total recall and precision of Learning Objects and Knowledge Objects. The precision is the ability of the classifier not to label as positive a sample that is negative. The recall is the ability of the classifier to find all the positive samples.

5. These measures are taken as input to form Clusters. K-Means a partitioned based clustering algorithm with the “k” value taken as five is used to form clusters. A total of 28 items (True LO and KO) is clustered into five groups and are shown in “Fig 5” & “Fig 6”.

![Figure 5: Cluster Model](image)

**Cluster Model**
- Cluster 0: 23 items
- Cluster 1: 1 item
- Cluster 2: 1 item
- Cluster 3: 1 item
- Cluster 4: 2 items
- Total number of items: 28
6. According to cluster 1 as shown in “Fig6”, LO1, LO2,… with KO1, KO2” can be delivered together to a user.

Figure 6: Clustered LKO

VII. Conclusion

It is a well established fact that imboring knowledge concept in learning mechanism provides higher level learning experiences. The Knowledge along with information about a subject or a topic will provide higher learning experience. Together they provide a better base for learners. The implicit and explicit knowledge of an individual in a particular subject is a valuable source which can be converted into Knowledge Object.

In this paper we have converged the KO with LO using the model shown in “Figure 1”. This Enhanced Learning Model will provide a large quantity of KO and LO so that a better understanding of a given topic can be achieved. Further we can cluster LKO using clustering techniques (K-Mean) based on the attributes like course, topic or subtopic. By this approach we can definitely improve the efficiency of learning and delivery thereby the overall effectiveness of LMS can be improved. Many factors like Entropy, Cluster Cohesion (SSE) & Cluster Separation (Squared Error) which are evaluated by WSS (within cluster sum of squares) and BSS (between the cluster sums of squares) can be used to validate the best cluster. Issues of granularity of a Learning Object from small to complex (course) have been always a matter of discussion. The combining of LO’s to form a complex object is a challenging task because of multiple layers of elements in the design of the object. Instead of a physical combination of LO, Clustering can provide a better alternate as it provides users a wide range of LO without increasing the complexity of the LO. Reusability of various objects is also enhanced.

LKO helps users of higher order thinking skills and also plays a viable source of information in deep learning. The quality of Learning Objects which is a major challenge for the different people in the process of teaching and learning is improved. We can also Summarise the LKO and the summarised content can be delivered to users of higher order thinking Skills or deep learning.

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