International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 11, November-2014

An Intelligent Recommender System for Effective E-Learning Environment

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***Abstract*— The integrated growth of information and communication technology transfigures the Teaching–Learning process. E-learning is a new paradigm of Learning, spotlight the quality of semantic web based methods used in knowledge transfer at anytime and anywhere. This paper focuses an Intelligent Recommender System for Effective E-learning Environment (IRS-EEE), which gives recommendations to the Tutor to tailor the content to the level of the user needs and recommends the students not only to choose the recommended content but also recommends learning time improvement, increase speed etc. IRS-EEE also gives recommendation to the Teachers after careful mining using Concept Based E-learning Algorithm (CBELA). The performance analysis shows that the recommender system using evaluation and feedback generation is better than the existing system.**

Keywords*— Semantic Web, E-learning, Intelligent Recommender System, Evaluation, feedback generation.

I. INTRODUCTION

Learning is the process of acquisition of knowledge or skill through study, experience or being taught. E-learning is learning conducted via electronic media typically on the internet. In other words E-learning system provides interaction between students and teacher through Information and Communication Technology. Successful E-learning depends on the self-motivation of individuals to study effectively. IRS-EEE tries this by using concept maps as knowledge representations and to guide the flow of topics in predefined blocks and within each block. Students' differ in their performance even if they learn the same content, in the same environment because of their difference in background knowledge, goals and objectives, skills already learned, perseverance and their preference of methods used to transfer the knowledge. A recommender system is one generally give suggestions to the learner to select the content or the learning path or a tool to identify interesting items from the large number of learning materials [1]. In this work a recommender system is proposed to make effective learning of the content. Section 2 highlights the related work that has been done in this domain. Section 3 describes the proposed architecture (IRS-EEE). The algorithm and its flow is discussed in Section 4. Section 5 describes the Evaluation and experimental results. Section 6 concludes the paper and gives directions for future enhancements.

II. RELATED WORK

Various literatures were collected and analyzed. From the papers it was found that there is lots of research focuses on ontological and context management in E-learning.

In the E-learning field, ontology maps educational domains. It is used to build, organize, interact, update and management of learning resources. Ontology plays a greater role in resource management or content management as it reflects the upcoming changes as every field is with new words and new concepts. Ontology evolution is inevitable which incorporates the changes by modifying the ontology, by introducing new concepts in the right place of the taxonomy, linking via further relations to other concepts. But current systems are in primitive level to incorporate this effective ontology evolution [2].

The E-learning system need to compose relevant resources together to retrieve and reuse. The semantic gap between the user requirement and user satisfaction are to be filled by combining resource ontologies. There is an increasing emphasis [3, 4] of recent resource management mechanism by the use of ontology for explication of implicit and hidden knowledge for the problem semantic heterogeneity of resource [5, 6]. It has to use the benefits of ontology modularization and ontology versioning [7] that is to access data through different versions of ontology.

Large-scale domain ontology acts as a semantic mediator for integrating heterogeneous resources. The resources of similar topics in common can be grouped together and form sub-ontology [8]. At present this sub ontology concept is applied in static course development environment. It should be dynamic and at the same time it should be context specific.

This paper [9] gives clear guidance to the author by providing the idea for the design and development of an E-learning platform, which accelerate learning process, based on user profile. It gives more emphasis on user modeling, but it lacks in covering content management, conceptualization etc. In order to address the above issues, a new architecture is proposed in the next section.

III. IRS-EEE ARCHITECTURE

The Proposed architecture IRS-EEE (Fig. 1) is based on the semantic structure, promises a powerful approach to satisfy the E-learning requirements with suitable recommendations. This Semantic architecture of E-learning is classified into four layers such as User Layer (UL), Service

Layer (SL), Content Management Layer (CML) and Database Layer (DBL).

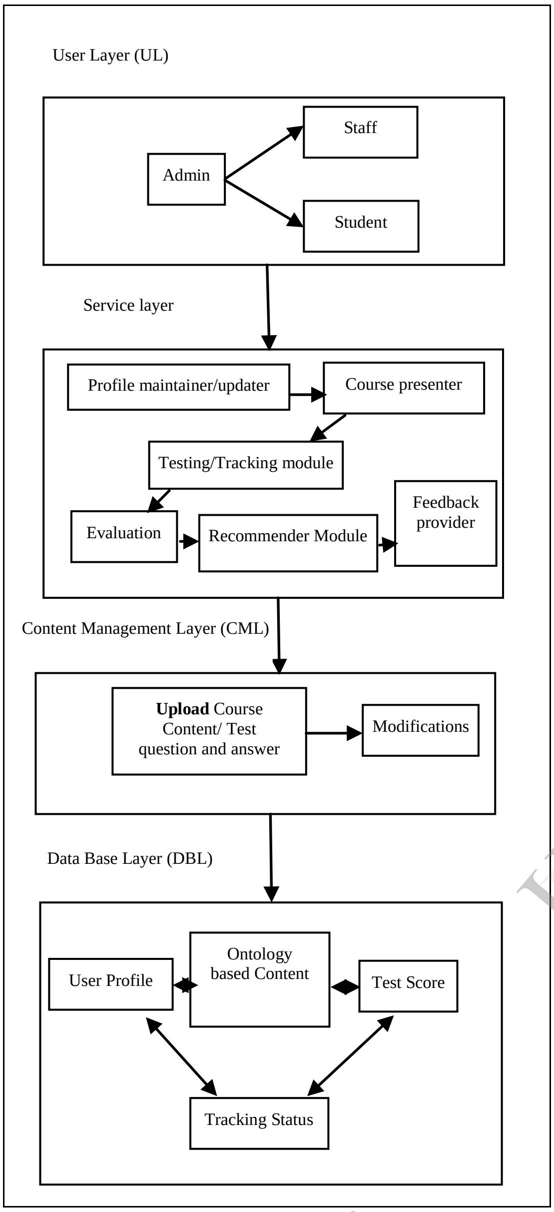

Fig 1. IRS-EEE Architecture

1. User layer

This layer consists of three roles, they are Admin, Learner and Staff. This learning system completely functions around the users. The entire scheme as well as its functions differs according to the role selection. Every user has its profile that is updated as and when the changes happen.

A. Admin

The role of admin in this system is to monitor user's profile, content updation, assessment outcome and learner's performance and tracking the performance of the entire system.

B. Staff

The major role of this system is handled by the Staff that includes many works such as preparing, presenting the content, adding and updating the content, questions, conducting and correcting tests, maintaining and accessing test scores etc. The entire learning system details are included and sustained by this user. The Fig. 2 illustrates the work flow of the Staff.

The concepts in a particular topic are included by the staff based on that topic. Before including the concept, the topic or course factors would be attached. Then the staff would affix the content details to those topics. Before introducing the content, the type of the content format is specified. IRS-EEE supports multi content format (ppt, ppt with audio, video).

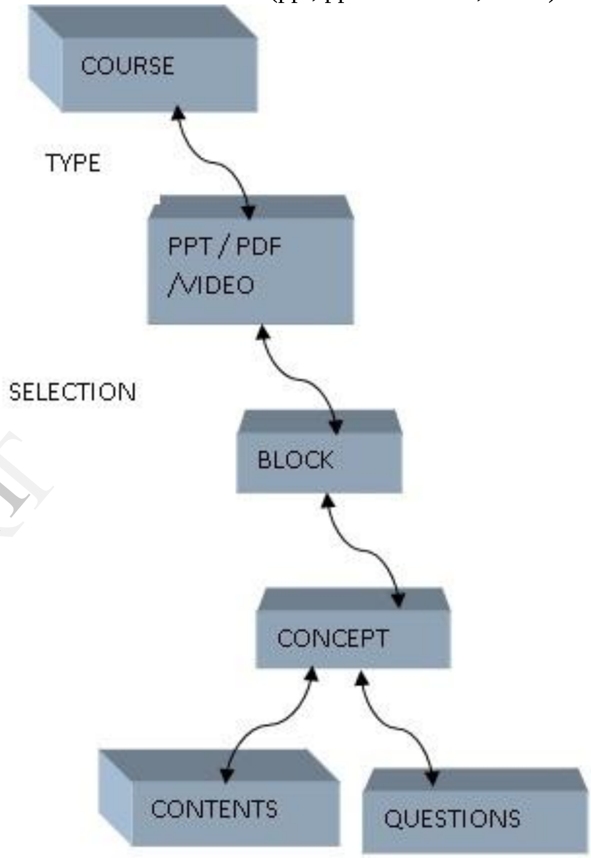

Fig 2. Staffs' Work flow

After including the factors of a particular concept or a topic the instructor include the content details in one of the format. This type of work flow would be iterated by the instructor to complete the entire concept or sub-concept details. Then questions for every concept of the block will be included.

C. Learner

The learner is the next stage user. The content of a particular concept or sub-concept is observed and learned by the learner. An effective learning environment is provided with the help of ontology and sub-ontology based concepts. In addition, the chapter and the contents are classified into blocks of related concepts. The blocks are mapped as ontology and the related concepts within blocks are mapped as sub ontology. In this context, the learners should concentrate an assessment before beginning to learn a concept known to be pretest.

2. *Service Layer*

This second layer provides Course Admin Service. This has testing with pre-test (before learning course content) and post -test (after learning course content), assessment of the test performance and permitting back tracking services whenever necessary. It also interlinked with Content Management Layer.

The function of the Profile maintainer will maintain all the related information about the learners, staff etc. Whereas, updater keeps track of the consistency of data by proper updating process.

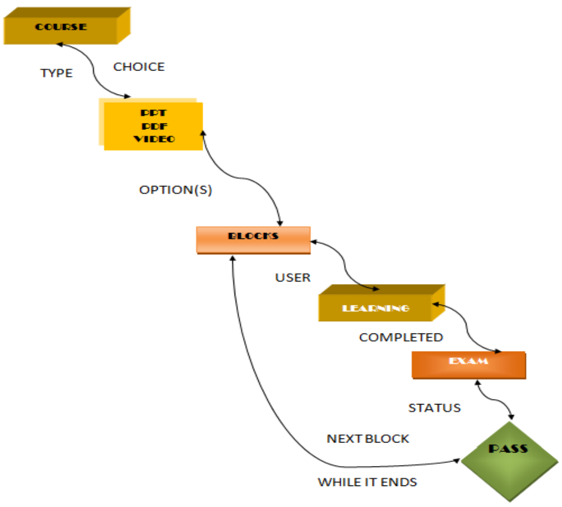

Fig 3. Learner's Work flow

The Course Presenter Module presents the content in the window with three components as topic map structured course content outline, corresponding content and its concept map. Each click on the topic map displays the corresponding content on the right of the screen. The concept map is displayed below the topic map structure to enhance the understanding of the learner.

D. Testing / Tracking Module

While the learning process is going on, the status of the learner is stored in the database. The learner is allowed to learn a block and block test is conducted. On the basis of the outcome the recommendations are given. If the outcome is above threshold value then the learner allowed to access next block. Otherwise the system switches back and made to read again.

E. Evaluation

Once the student has finished all the blocks, final post-test is offered and the results are compared with pretest to assess the improvement of the user and the skills of the user. Test results are Tracked and stored in the table and the sample performance is given in Table 1.

TABLE 1. LEARNER'S TEST RESULTS FORMAT FOR PERFORMANCE EVALUATION

Concept ID	No of Questions (nqs)	Answered	Correct Ans (ca_J)	Unanswered (ua)	Wrong Answers (wa)	Threshold (nqs * 35% of nqs) βJ
1	5	4	3	1	1	1.75
2	7	3	2	4	1	2.4 5
3	10	8	6	2	2	3.5

F. Recommender module

Khan suggests that [10] students should be allowed to submit comments for example on courseware design and delivery. Their feedback will be fed into our recommender system in turn it will recommend the teacher to improve the content if it is the learners need. In this paper the recommendation is given to the learner depends upon the value of their performance. The flow of decision is shown in Fig. 4.

IRS – EEE finds the poorly learned and well learned concepts among n number of concepts of every student and suggest the students to repeat it if necessary that is the score of the student in that particular concept (C_J) is less that the threshold value (β_J).

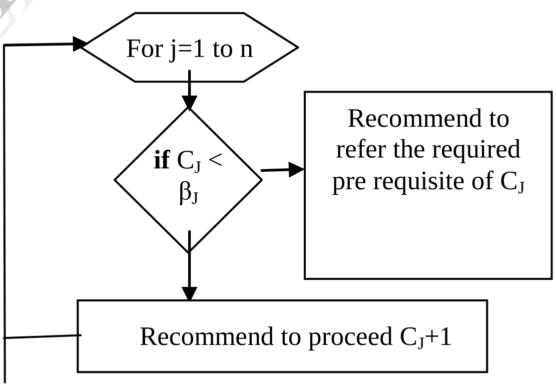

Fig 4. Flow of recommendation.

G. Feedback Provider Module

This module allows the learner to give feedback about the presentation of the content, ease of Navigation, and at the same time it provides the facility to give feedback about the performance of the learner by the staff.

3. *Content management layer*

This third layer displays the Course Content of the course of interest. This layer facilitates the learner through multimodal presentation including Power Point, visuals and etc. This layer also includes the operations such as upload, add, edit, store to manage content presentation and maintain the course content.

CML displays the course content prepared based on SCORM, (sharable content object Reference Model) Standard. The LO's of this model are granules of concepts. The learning objects are constructed based on "instructional grounded criteria"[11] . According to that, the learning object should be in three hierarchical levels. The levels used here are course, blocks and concepts. CML presents and preserves the hierarchical course structure with their semantic relationship between the concepts like " is part of ", " is subtopic of " ," is pre-requisite of ". Content of a course is delivered with corresponding concept maps which express the interrelations of the sub-concepts of the selected concept.

4. Database layer

The database components of user layer contain all the required information about learners, staff and admin. This layer maintains the databases with users' profile, ontology based content, test score and Tracking status of the every learner.

IV. PROPOSED ALGORITHM

The following Concept Based E-learning Algorithm (CBeLA) used in the proposed system depicts the flow of logic. The list of parameters used in the algorithm is listed in Table 2.

This algorithm is aimed to enrich the learner's knowledge. Prior knowledge of any concept is one of the most important factors that influence the performance of the learner. The learning progress of a student should be assessed after completing each concept. Each concept has four associated parameters:

1) Correct Answers (CA)
2) Wrong Answers (WA)
3) Expected learning time (elt)
4) Actual learning time (alt)

TABLE 2. LIST OF PARAMETERS

Parameters used	Explanation
cID	concept ID
sID	student ID
alt	actual learning time
elt	expected learning time
ca	correct answer
wa	wrong answer
nqs	number of questions
ua	unanswered
n	number of concepts
C_J	score of jth concept
β_J	Threshold value of jth concept
noblks	number of blocks
Nocs	number of concepts

Algorithm CBeLA {Concept Based E-learning Algorithm}

Input: alt,elt,ca,wa,ua, β_J, noblks, nocs.
Output: Recommendations
Get the value of number of blocks

```
For I = 1 to noblks
  {
     For J = 1 to nocs
       {
         Get the noqs,alt and elt
          Display the questions
          Get the answers and evaluate ca,wa,ua.
          // categorize the user
       If (alt > elt) &&( ua+wa>=ca and ca<= βJ)
then add cJ to unknown list

And recommend the learner to' refer
pre-requisite of that concept'.
       If (elt <=alt) && (ca> βJ and ca<= 2*βJ)
then add cJ to known list

And recommend audio content/
video to enrich that concept.
       If (elt <=alt) && (ca>2*βJ) then add cJ to
well known list
       }
  If more learners retrace the same concept
recommend the staff to simplify the content.
  }
```

Each concept in the ontology based content has any of the three associated states such as unknown, known and well known. Following equations are helpful to calculate the values.

$$\text{unknown} \Leftarrow \text{If } (alt > elt) \,\&\&(\, ua+wa>=ca \text{ and } ca<= \beta_J) \quad (1)$$

$$\text{known} \Leftarrow ((elt <=alt) \,\&\&\, (ca> \beta_J \text{ and } ca<= 2*\beta_J) \quad (2)$$

$$\text{well known} \Leftarrow (elt <=alt) \,\&\&\, (ca>2*\beta_J) \quad (3)$$

Based on this tracking process [12], the system evaluates the student's progress and suggest to make a revision of that module or to continue the sequence.

V. EVALUATION AND EXPERIMENTAL RESULTS

This implemented system IRS-EEE is built on windows 7 professional environment using Intel core2dual processor with 1 GB RAM and also 250 GB HDD and developed in visual studio .net 2008 environment using asp.net and SQL server 2005 is adopted to be the database. For this study , Bachelor of Science in computer science , programming C course content was taken as a dataset and the learners are the students of Bachelor of Science in computer science from different colleges which are geographically distributed Learners from urban, semi-urban and rural colleges are participated in this study.

This work is tested with these limitations/assumptions such as:

1. Learner should have knowledge of computers.
2. Learner should learn at least one concept without break.
3. Too many repetitions to be avoided.

4. Staff should have thorough knowledge on the course content.

Once the learner enters into IRS-EEE he/she has to sign-in and enter his profile. The admin approved the learner .The learner selects the course. Select his learning preference/learning style (ppt, ppt with audio, video). If the learner is beginner he /she is permitted to view the content in sequential order. The course content is presented as they prefer for the medium and advanced level. There is no pretest for the beginner, but medium and advanced level users are separated depending on the result of pretest. The selected course is divided into blocks of related concepts. After careful learning of the concepts in each block, a question set containing 20 MCQ (Multiple Choice Questions) is given. MCQ assessment is one of the best and often used Formative Assessment tool [13].Using the result of the block test, the concepts within that block are categorized as unknown, known and well-known. Then the recommendations are given as per the algorithm discussed earlier. After completing all the blocks, post-test is conducted to measure the knowledge improvement in the domain and the efficiency of the system. While learning the concepts the actual learning time is observed and recorded to compare with the average expected time, as it's the important data to assess the learner [14].

The evaluation for E-learning includes assessment of learner, evaluation of the instruction and learning environment. Assess the learner is a continuous process. Outcome of the assessment is used to update learner level and to append course material are dynamic.

1. Performance analysis

The learners who are timid on face-to-face learning are enjoying the emergence of E-learning, since learning is not in a fearful and one-fit-for- all environments. The proposed system provides options to choose their learning style or lesson interface , as each student has different preferences(ppt, ppt with audio, video)[15]. The performance in terms of retaining and recalling using this system is shown in Fig. 5.

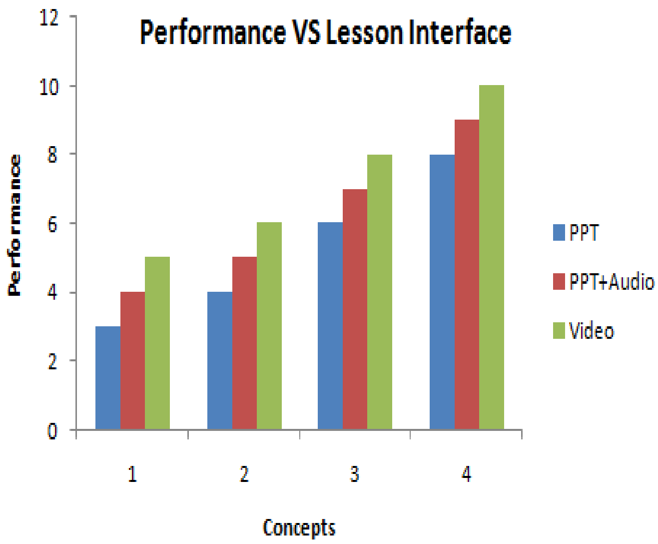

Fig 5. Effectiveness of Lesson Interface

The learning time is another important factor which has great influence on performance and also it is associated with concept difficulty. Here the content difficulty is less at the introductory concepts and its gradually going up towards the complex concepts. The following graphical results (Fig. 6) illustrate the even the long learning time taken for complex concepts maintains the performance in standard level in the proposed system.

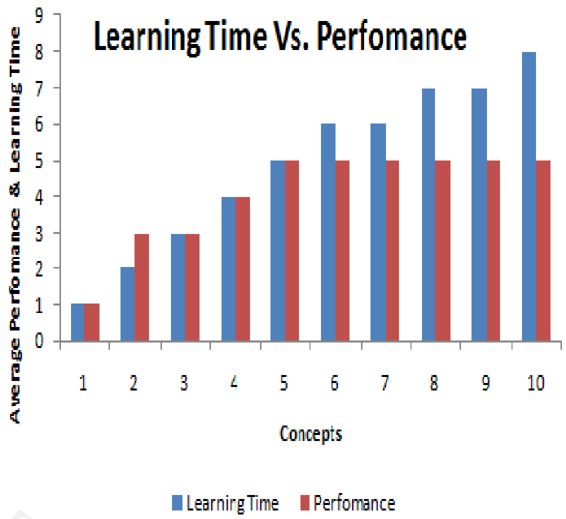

Fig 6. Influence of Learning time on Performance

Among the participated learners, a sample group of 80 students takes part in assessing the usefulness of the system in its curriculum. The response of the students welcomes the system that is shown in the following bar graph.(Fig. 7).

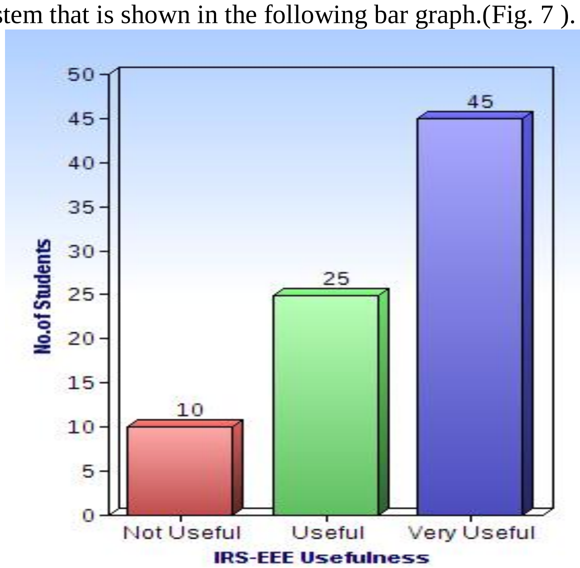

Fig 7. Student survey on usefulness

For the selected course the content difficulty and performance of the existing system is compared with the proposed system. The resultant graph in (Fig. 8) shows the proposed system is effective and efficient than the existing system.

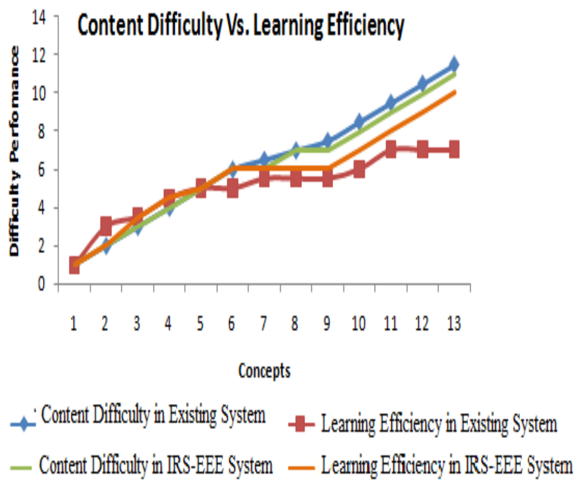

Fig.8. Comparison of existing and proposed system

VI. CONCLUSION AND FUTURE ENHANCEMENT

This paper presents a personalized E-learning environment with the help of semantic technologies. The detailed Architecture and its implementation provide ease of information organization, access the course content, integrate and reuse the content. Concept maps express the ontological relation between concepts. This type of system is critically needed for students with lack of resources. Future work involves the expansion of our system towards Global Campus (GC) environment. Including dynamic question Answer System, learning style detection, student modeling are another direction of enhancement to make the system more effective.

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