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Learner Centric E-learning System with Decision Making Features based on Expert System Technology and Tool

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Abstract: In this fastest growing age of E-learning technology, learner needs, demands and preferences are increasing and changing day by day. Learner choices now become the primary requirement for the growth of the whole e-learning scenario. A learner centric e-learning system with decision making feature for learner in their learn time can be the only solution to meet the demand and requirement of learner. This paper presents an e-learning architecture with flexible, user friendly learning interface with dynamic knowledge representation feature. It is also explained how the proposed architecture works as a decision support system by presenting and showing the actual learning path for learner. Expert Rules are incorporated to make the whole learning environment interactive, learner centric and to make the best support e-learning software that will work and act as an intelligent tutor.

Keywords: E-learning, Decision-Support System, Expert Rules, Knowledge Representation System, Leaning path.

I. INTRODUCTION

In today's fastest growing segment of education, the learner interests, their expectations and requirements are changing very frequently and demand is increasing daily [6]. Because of the varieties of interests, the decision for learner may vary at every learning time, which cannot be predefined and is a very problematic approach [1]. Therefore, it is the time to do need analysis for learner and is to design the e-learning system by giving due preference on learner [11]. Many researchers showing and highlights their work in this context [3] [16], and showing future directions [21], its prospects, lack and limitations [24]. It is noticed that learner preferences, learner personalization are not getting much interest in E-learning research. No research is showing interest in standardizing the learner learning path [20]; that is still rigid and restricted, still not improved to work with as a learner's choice and pace. Learner-centric aspect of e-learning is often neglected [13]. However, learner could have varieties of interests, choices, learning styles and expertise level which cannot be treated in a uniform way. So, a decision system to support learner is very much essential in digital learning environment [27].

Authors in their previous paper argues that by employing Expert System (ES) technologies and tools in e-learning environment, one can make the system more attractive and interactive for learner which can help to build a learner centric platform in this domain [12] since ES is a technology that works according to human expertise [33], can solve problems and can give advice in a specialized domain area [28] [29]. ES can understand learner better and can think better way to make decision [18], can use as human decision maker in e-learning environment [5], manage knowledge to solve problems [26], use as business decision maker [19] and to make interactive e-learning platform [17]. Because of its performance, many decision support systems named as Expert System [10] [31]. ES integrating with other emerging technology like fuzzy logic can handle any linguistic knowledge [14] and can evaluate actual expertise level of a learner [27] which is very important in analyze problems, give guidance and generally aids the decision-making process [4]. ES rules are used in e-learning environment as a program advising, automated scheduling of classes, plagiarism detection and many other related applications [9]. The goal of this study is to establish a learner centric Decision Support System (DSS) with interface facilitating communication and cooperation at any time or place. This paper proposes an architecture that integrates ES rules to take decision, explaining the system's reasoning and to plan their learning path at every steps of learning for each new and regular learner. It starts with the importance of DSS in E-learning environment that follows how the proposed system works. Section IV and V gives the architecture with their internal functions and working principle. Section VI gives the role of ES in different stages of the whole learning procedure. The paper concluded by discussing the future prospects of this research.

II. WHY DSS IN E-LEARNING

A DSS is a computer-based information system and an umbrella term used to describe any computer application that enhances the user's ability to make decisions [25], serve the management, operations, and planning levels of a system and help to make decisions, which may be rapidly changing and not easily specified in advance [8], an interactive information system that provides information, models and data manipulation tools to help in making decisions in semi-structured and unstructured situations [22], and as human decision maker in simulation model [23]. It can improve personal efficiency, increase organizational control [32], facilitates interpersonal communication in promotion of learning or training, creates a competitive advantage over competition and helps automate managerial processes [30]. So, a user-friendly DSS can solve the searching path problem of learner in E-learning environment also. Dr. Cooper suggested a package in this connection with more user-friendly interface in his paper on decision support systems [34]. DSS can aid human cognitive deficiencies by integrating various sources of information, providing intelligent access to relevant knowledge, and aiding the process of structuring decisions. They can also support choice among well-defined alternatives and build on formal approaches [7]. Decision EXpert (DEX) is a decision making software package that integrates multi-attribute decision techniques with ES [2].

III. HOW LEARNER CENTRIC DSS

How to make the decision procedure learner centric is the main aim of this research. Because, learner may forget and mislay their actual learning content position where they left last, which and how much have completed with what outcome and how many have left to work, what was the last evaluation remarks, their feedback, total time covered in the last learning topic, and number of time visited to the same topic. These all will be possible if the system will somehow keep records of each and every browsing of the learner from which the system will take decision, can provide information and give feedback to the learner. So, to act as a DSS, the system should know the learner learning interest, their background skills and their preferences, manners of accessing learning resources, learner's habit and behaviors during the learning process [15]. If the system presents detailed status of the learner from the previous recorded history as and when the learner logs on to the learning system, the learner will get feedback of every access at a time which will help a learner to assess themselves. The learner need not to keep track of their own, no need to think and search for their required topic themselves. System will provide and will show the exact path of learning. This is the concept behind the proposed architecture that can solve the searching path problem of learner in E-learning environment.

IV. THE PROPOSED ARCHITECTURE

The proposed system has one user friendly interface to communicate with learner. Expert System Rules are the core of the system to analyze and to take decision. Learner's background information and previous learning history are stored in different data files that work as domain knowledge for the system. With the help of Web Services and stored Databases, the system works as a DSS where a learner can operate according to their required pace and preferences. In this proposed system the interface is assisted by the ES and provides alert notice about their learning behavior as and when required. ES rules are used here as an analyzer, problem solver and as a decision maker. Component works in this system are:

1. Web services
- To operate the whole system online.
- To find comparable information.

2. Knowledge bases
- To store user profile
- To store pre requisites
- Database updater to update learner information.

3. User Interface
- To interact with user at learning time
- To display information as and when required
- To manage the entire learning procedure

4. Expert system rules
- To work on background knowledge
- To take decisions for learner.
- To give conclusion
- To show the actual path of learning.

V. WORKING PRINCIPLE

What the proposed system does is: first respond the learner, ask questions about their contents, compare with the basic requisites and give answers. After taking all the required information, the system will now act as a decision maker and path planner for their session. For this, it will check the previous browsing history of the regular learner and will take decision accordingly. For the new learner, it takes decision from their background history and skill. The system will decide what content to present to learner and when. At the time of learning, the system will analyze their learning style, whether fast, slow, very slow or repeated learner, and give automatic notification about that. System gives alert notice time-to-time about all their constraints. This will help learner to evaluate and assess themselves and helps them to plan and process accordingly. It functions as according to the following algorithm:

step 1: Taking request for Log on to the system

step 2: Update respective databases

step 3: Taking request for the topic

step 4: Send the receiving request to the shell

step 5: Rules of the shell takes decision from the stored facts and send it back to the portal

step 6: Display possible path

step 7: Display content and record details of learning

step 8: Repeat the procedure from step 2

Algorithm 1: Internal function of the learning portal

Since the system works on online basis, we need a learning portal to operate and to implement the logic. A sample e-learning portal has been developed as an example. Learner learning history, pre requisites for each request and background were recorded against data bases. These databases are the knowledge domain for the system where ES rules are applied to get the required result. The portal functions as follows:

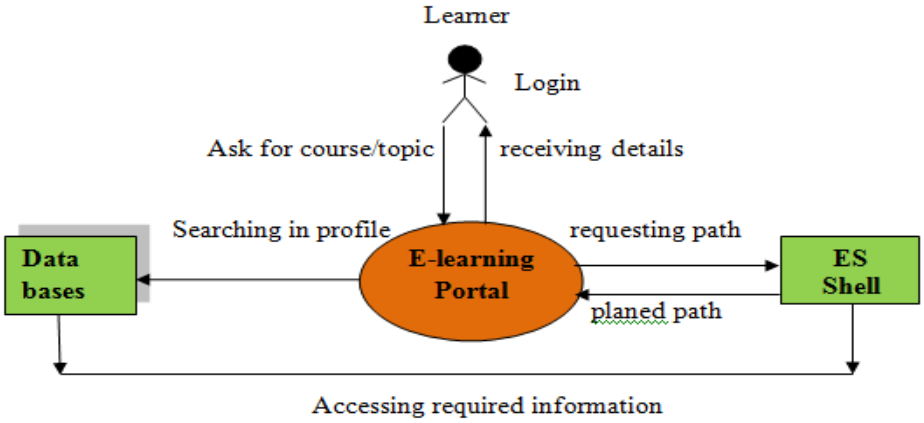

Figure 1. Block diagram of Functional Model

A prototype system has been implemented for the internal functions of each stages of the system. It is a cyclic process that gives the abstract image of the system. This portal is different in nature from the general available e-learning portal, in the sense that instead of simply managing and generating content to the learner, it takes decisions, give conclusion, solve problem, and shows actual E-learning path. It works as a guide for a learner.

With the help of web server, multiple feedback measures are recorded for feedback extracting in gap analysis process. Learner profiling stores the information from feedback extractor and analyze by the gap analyzer process. Then the result sends to the ES shell to get the actual path of learning. In this portal, the new learner always has to register themselves first. The background information supplied in this stage is stored in a separate database files for future decision making. This is the knowledge base for ES to determine rules for preliminary stage.

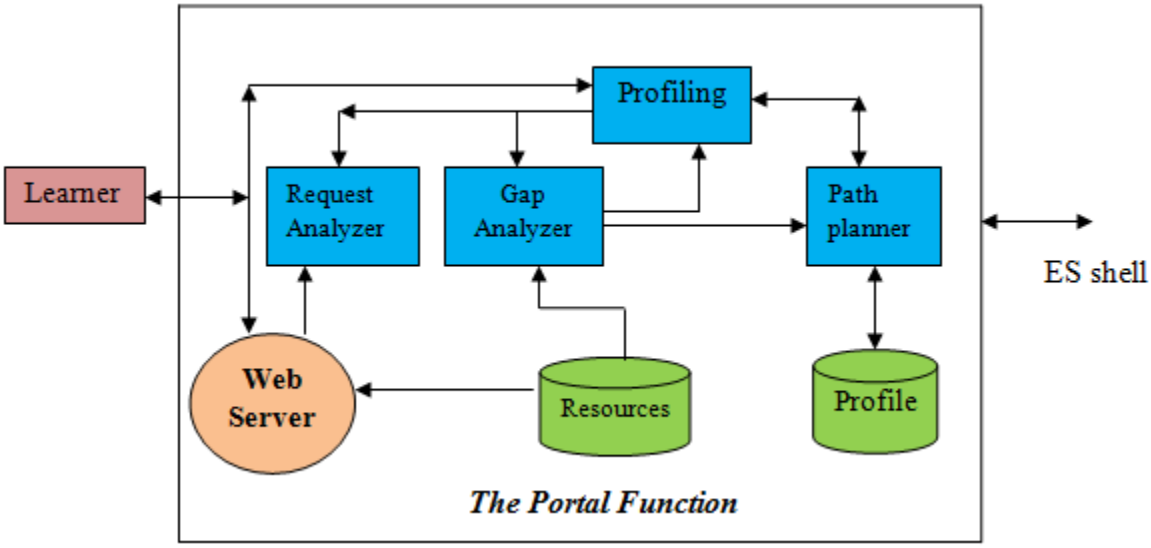

Figure 2. The Process Design

At the time of learning, the system keeps track of the learning behavior of the learner. It keeps information regarding how many times the learner accessed that same topic (no. of visits), date and time of last logon, total time spent in reading or learning the topic and total marks scored after evaluation. There is an evaluation procedure after every module to determine learner's talent which will store in a separate database so that a learner can evaluate themselves from their feedback and can understand their own category of learning. Evaluation is one of the integral parts of this proposed system.

VI. ROLE OF ES IN THE SYSTEM

After registration to the system the learner to choose the courses and to select the appropriate courses according to his/her proficiency, the system creates rules and provide to them. In this stage we restrict that the computer preliminary knowledge is must for each learner and the courses we are offering are from graduate level onwards and for simplicity again restricted to only computer science stream. The minimum age to enter to any course is restricted to18 years for a learner. With theses constraints the pseudo code of rules to choose courses are as follows where min-age is the parameter that will determine by the programmer:

```
(1)   IF    educational_qualification is "HS" and
            skill is "Computer Fundamental" and
            age >= min_age
      THEN select any graduate courses
```

```
(2)   IF    educational_qualification is "BTech_CS" OR
            educational_qualification is "BE_CS" OR
            educational_qualification is "BCA" OR
            educational_qualification is "BSc_CS" AND
            age >= min_age
      THEN select any master courses
```

Figure 3. Rules to enroll in any courses

After selecting the courses, for the new learner the role of ES is to compare learner background with that prerequisite database. If it matches with the learner background skill, then only the system gives permission to enter to the requesting module or unit. For regular learner, ES first will compare their previous learning profile with pre- requisite file and then determine their learning path. Before showing the path, the Inference Engine draws conclusion that determines:

- Whether the learner is eligible to access the requesting topic or not
- Is the learner accessed that topic before, if 'yes', for how many times
- Is the time frame exceed for that topic
- Covering Percentage of a learning module
- Evaluation Remarks

Assume that a regular learner that enrolled in a graduate course and wants to enter to a topic say "Multiplexer". In this case, ES has to determine whether to allow or not to enter to the requesting topic as well as to determine the best path, for which it has to take inferences from the previous learning and browsing history of that learner. For taking one decision, a number of rules have been generated by the system. Here showing pseudo code of one rule as an example in this context:

```
IF      subject is "Computer Organisation" and
        topic is "Multiplexer" and
        total_time_spent < max_time and
        visit_no < max_no
THEN    learner can enter to the topic Multiplexer to learn
```

Figure 4. Rule to enter to a topic

The constraints like maximum no. of visit to a topic, maximum time one learner can spent in a learning module are defined at the beginning in prerequisite data base file. In this architecture developing knowledge base is the most important part on which the overall quality of the system depends. The rules are developed in ES Shell with the help of domain knowledge and processes through inference engine. With knowledge base and Inference Engine, ES determines the path for the learner and accordingly present to the learner. The evaluation process helps the learner to plan for the next session. For the next session also the system follows the same procedure to access. So, the whole process is a cyclic process.

VII. CONCLUSION AND FUTURE PROSPECTS

E-learning services with integration of Expert System are all new emerged technology and are undergoing changes and developments. The architecture introduced in this paper is an integrated model with user friendly interactive interface that can analyze learner needs and can make decision better. This is a conceptual model developed by thinking and giving preferences of the needs of learner. The main concern is the flexibility and dynamic representation of knowledge and rules. It is an intelligent tutor by showing multiple learning paths and explaining the system's reasoning.

Developing and implementing ES rules in Java Expert System Shell (JESS) is under study. Extending the restrictions and limitations taken in the system is the further extension of this research. Opening for other courses instead of restricted to only computer courses is also the extension of this work. The whole system is made available for anyone who can remove and can extend the capabilities of our architecture as their future work.

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