

Framework for Personalized Learning System Using Ontology

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Abstract: The advancement in the computer and internet technology makes e-Learning implementation in educational institutions is easy. All the educational institutions uses e-Learning to enhance the teaching learning process. This study proposes personalized e-Learning System framework using ontology by creating personalized ontology user models. This model learns the knowledge level of the learners in the e-Learning environment and strengthens the instructional design to make the content personalized. To measure the effectiveness of ontology based instructional design for introduction to Java programming, an experimental model has been constructed. This was accomplished by comparing the traditional method of teaching (instructor and textbook) and Java tutor to the students in the faculty of computer applications of BSA University in Chennai. A group of students were taught Java programming concepts using ontology based instructional design and a second group was taught the same concepts in parallel by traditional methods of teaching. Both groups were coordinated for similar background knowledge of the topics being taught. Post testing revealed that the Java tutor group achieved significantly higher scores than the group taught using the traditional method. Furthermore, the Java tutor group showed that the retention of specific topic of knowledge was better than the traditional method group.

Key words: Personalized learning, ontology, user models, instructional design, knowledge

INTRODUCTION

Developing Novel Teaching Model to teach programming paper in the e-Learning environment is highly encouraged at all the time for those of educators who teach in them. However, it is much more desirable for developing innovative teaching methods for large group due to increased enrolment every year. Teaching programming paper for larger group is a very challenging task for educators due to many constrains imposed on such classes. The objective of this study is to create a learner centered environment and promote active learning among all students in the programming by creating personalized ontology user models. This model learns the knowledge level of the learners in the e-Learning environment and strengthens the instructional design to make the content personalized. The software industries are needed skilled programmers to do coding for complex problems. To fill up the gap, this study proposes a framework to teach programming based on their knowledge level using ontology.

The success of an instructor is to provide necessary optimum content to the students is a key for successful learning. For a larger group, instructor should be able to teach more effectively if he knows what are the difficulties faced by students. The proposed innovative teaching

method uses a teaching and learning strategy by creating personalized ontology model for each category of learners like novice, intermediate and expert learners. The personalized ontology allow educator to rapidly adjust course contents and to make teaching learning activities more efficient and more closely tuned to students' needs. Personalized service is important on the internet, especially in web-based learning. Generally, most personalized systems consider learner preferences, interests and browsing behaviors in providing personalized services. However, learner ability usually is neglected as an important factor in implementing personalization mechanisms. Besides, too many hyperlink structures in web-based learning systems place a large information burden on learners. Consequently, in web-based learning, disorientation (losing in hyperspace), cognitive overload, lack of an adaptive mechanism and information overload are the main research issues (2005).

To develop the personalized e-Learning System, the domain ontology plays a crucial role. The ontological structures can be used for organizing, processing and visualizing subject domain knowledge, marking the topic and coverage of learning objects and for building learner models in e-Learning Systems. The domain ontology can be used for concept-based domain specific information retrieval, visualization and navigation that help learners to

get oriented within a subject domain and build up their own understanding and conceptual association.

The notion of ontology is becoming very useful in various fields such as intelligent information extraction and retrieval, semantic web, electronic commerce and knowledge management. Although, there is not a universal consensus on the precise definition of ontology, it is generally accepted that ontology is a formal specification of conceptualization. Ontology can take the simple form of a taxonomy of concepts (i.e., light weight ontology) or the more comprehensive representation of comprising a taxonomy as well as the axioms and constraints which characterize some prominent features of the real-world (i.e., heavy weight ontology). Domain ontology is one kind of ontology which is used to represent the knowledge for a particular type of application domain. Ontology is a formal knowledge representation method to facilitate human and computer interactions and it can be expressed by using formal semantic markup languages such as RDF and OWL. Acquiring useful information from the user to know the knowledge level of the learner in the e-Learning environment is a challenging task. Various techniques are available to represent the knowledge structures of the user. This study proposes a novel method to generate ontological user models to provide dynamic content to learners in the e-Learning environment.

LITERATURE REVIEW

Nowadays, there will be great demand for personalized learning systems where learning materials are created and provided to the learners based on their need because one size doesn't fit all.

Jayanthi and Jayakumar (2012) proposed a Novel Page Ranking algorithm for a personalized web search. Since, information on the web is growing exponentially and traditional search engines provide results mainly based on the users query. Though the context of the query varies, the returned result seems to be same for all users. The users in the web are expected to search for the relevant results which is an added overhead to the users. The methodology computes the user interest score over the search results. The proposed method consider both the user interest score and Term Frequency and Inverse Document Frequency (TF-IDF) for re-ranking and provide personalized results.

Despotovic-Zrakic *et al.* (2012) described an approach to provide adaptivity in e-Education courses using group personalization approach. The system enhances Moodle LMS by developing a method for creating adaptive courses and to compare its effectiveness with non-adaptive education approach.

Turani and Al-Shrouf (2011) proposed a conceptual framework for an e-Learning System that could be used to prepare the students for their end semester exam. The preparation process consists of two main activities that will be conducted in a distant learning environment: completing interactive learning activities based on subject materials and conducting a set online sample tests. The architecture employs intelligent software agents to facilitate the personalization of learning objects to be presented to each student. The system has been deployed using the web services platform, allowing access through personal computers, mobile devices and PDAs. The main objective of the system is to provide learners with more flexibility and to reduce their preparation time for the end semester exam by allowing them to navigate through materials and exam based on their academic profile from various access points. The architecture has been fully implemented by the Applied Science University in Jordan to be used by their graduating students in their preparation for setting the educational testing services exam. It will replace the current traditional way where students need to set in certain dates to conduct educational testing services tutorial sessions and paper-based exams.

Cocea and Weidelzahl (2011) analyzed online learning content delivery systems using educational data mining techniques. To identify relevant attributes for disengagement prediction by means of log-file analysis on HTML-Tutor, a web-based learning environment. The system investigated the extendibility to other systems by studying the relevance of these attributes for predicting disengagement in a different e-Learning System. Two validation studies were conducted indicating that the previously identified attributes are pertinent for disengagement prediction and two new meta-attributes derived from log-data observations improve prediction and may potentially be used for automatic log-file annotation.

Chen *et al.* (2011) design ontology in the mobile phone domain for the construction of knowledge base and presents a new method for knowledge assessment in which quizzing questions are drawn using the mobile phone ontology-based knowledge base to assess the sufficiency of professional knowledge of mobile phone salespersons. An automated learning service is then provided to offer users personalized learning contents subject to their knowledge deficiencies.

Robin and Uma (2011) designed and developed Ontology Suite for Software Risk Planning, Software Risk Tracking and Software Risk Control. Ontology as a conceptual courseware structure may work as a mind tool for effective teaching and as a visual navigation interface to the learning objects. Knowledge visualization is

defined as the use of visual representations to transfer knowledge between at least two persons. This study presents the design, development and visualization of ontologies for Software Risk Planning, Software Risk Tracking and Software Risk Controlling. The system develops ontologies using protege tool, an effective ontology editor and it is represented by the formal knowledge representational language OWL. In order to increase the richness of the knowledge available in the ontologies, its semantic representation is presented using ontology document generator. Finally, the ontologies are effectively visualised using OntoViz. The ontologies represent the domain knowledge Software Risk Planning, Software Risk Tracking and Software Risk Controlling, respectively and is developed with the intention to use it as a knowledge base for effective knowledge representation, knowledge management and e-Learning applications. The constructed ontologies are evaluated using quantitative analysis and qualitative analysis. The developed ontologies are concept oriented ontology and ready to use for applications such as e-Learning, knowledge management.

Abdellatief *et al.* (2011) proposed a technique for quality evaluation of e-Learning from developers perspective. e-Learning is gaining more acceptance as days pass because it provides learning opportunity any time and in any place. Different people have different preferences in terms of learning style such as reading text, listing audio or video, speaking and communication. To support these different learning preferences, there is need for multiple e-Learning delivery methods and teaching techniques. Furthermore, there are many stakeholders of e-Learning Systems such as system developers, administrators, instructors, instructional designers, multimedia designers, online facilitators and independent evaluators whose views are important indicators for a complete e-Learning System evaluation but the most important views of e-Learning quality are user view, developer's view and manger's view.

Lahart *et al.* (2009) suggest that parents with high levels of self-efficacy tend to make positive decisions about active engagement in the child's education while parents with weak self-efficacy are often associated with less parental involvement. Therefore, endowing intelligent tutoring systems with the ability to adapt the level of support provided for the parent based on their self-efficacy may be of great benefit. Such a system might provide high levels of support for parents with low self-efficacy while providing lower levels of support for parents with high self-efficacy. This system explores the effect of using such an adaptive system in the home-tutoring environment.

Chou *et al.* (2009) illustrates a novel web usage mining approach, based on the sequence mining

technique applied to e-Learner's navigation behavior to discover patterns in the navigation of e-Learning websites. They used the e-Learner's prior knowledge on which the useful intelligent systems are based. This research employs the e-Learner's prior knowledge and mines his/her interior desire on appropriate target courses or materials as a part of a personalization process to construct the overall e-Learning strategy for education.

A FRAMEWORK FOR PERSONALIZED LEARNER ONTOLOGY CONSTRUCTION

Personalized learner ontologies are a conceptualization model that formally describes and specifies user background knowledge. The users in the e-Learning environment need different content for the same topic. For example, object oriented programming is a course for under graduate and post graduate science and engineering students. Even high school students are also having this course in their curriculum. How to provide personalize content. The solution is by obtaining personalized learner ontology. Each users in the e-learning environment have a personal concept model for their information needs. A user's concept model may change according to different information needs. In this study, a model constructing personalized learner ontologies for users' concept models is introduced.

Personalized learner ontologies provide a conceptual knowledge structure of user in the particular domain. This research has taken Java domain to construct learner knowledge models in Java using ontology, effective tool for knowledge representation and modelling. Each learner will have different knowledge structure on each topic based on their knowledge level. In order to identify learner's knowledge on each topic, a personalized domain ontology model has been created by the users with the support of instructor or domain knowledge base. Figure 1 shows the framework for personalized domain ontology construction to identify the knowledge level of the learner.

Algorithm for identifying the knowledge level of the learner:

- Step 1: create a learner profile and stored in the local instance repository.
- Step 2: instructor teaches the concepts to the learner.
- Step 3: to know the knowledge level of the learner on the concept taught by the instructor, learner has to draw ontology for the concepts using ontology learning environment.
- Step 4: instructor constructs the personalized ontology by knowing the user background knowledge and user concept knowledge discovery.
- Step 5: instructor mines the ontology and identified the knowledge level of the learner.
- Step 6: instructor stores the knowledge level of the learner in the local instance repository.
- Step 7: instructor revises the content and provided to learners based on the knowledge level.

Framework for personalized learner ontology learning:

Teaching programming requires skill and most of the learners facing problem to learn. This study proposes a novel approach to teach programming. This approach improves the teaching and learning process. This innovative method uses adaptive technique to trace learner performance during and after teaching. Based on

the ontology developed by the learner, the instructor is able to quickly adjust the course contents to suit the needs of learners. Personalized ontologies are developed for user concept model. The learner develops ontology for concept say “inheritance”.

The learner uses ontology learning environment to develop ontology on inheritance via user interaction. A tool called Ontology Learning Environment (OLE) is developed to assist users with such interaction. For each concept of user interesting/understood terms and not understood terms. Not understood terms needs strong content or proper explanation. The domain knowledge base guides the user to identify positive and negative subjects. In the research, researchers have used protege tool to develop ontology.

The personalized ontology has been constructed using local instance repository and concept knowledge obtained from OLE. The user knowledge level has been obtained on mining the ontology of the learner. The ontology has been revised on each user interaction. Based on the ontology of the learner concept model for a topic, the content will be provided. This tool will predict the type of learner, i.e., novice, intermediate and expert user. Based on the prediction, the content will be provided. Figure 2 shows the portion of Java domain ontology.

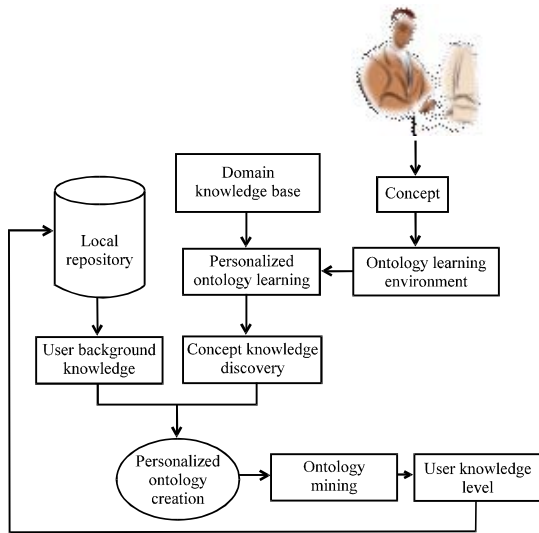


Fig. 1: Framework for personalized learner ontology construction model

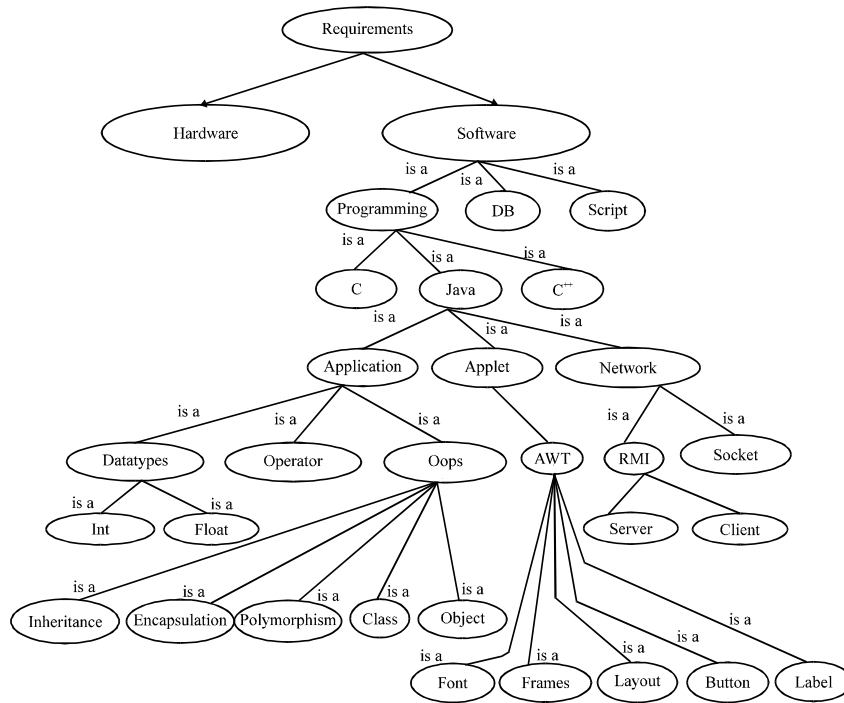


Fig. 2: A portion of Java domain ontology

IMPLEMENTATION

Figure 3 shows the home page of Java tutor. A sample of 40 students taking the course Java programming was selected to participate in this study. The student sample was divided into two groups coordinated for similar background knowledge of the Java material presented.

Group 1 (the control group): This group was taught using the conventional teaching method (lecture and textbook) and it consists of 20 students.

Group 2 (the test group): This group was taught using the conventional teaching method supplemented with the Intelligent Tutoring System Java tutor and it consists of 20 students. The independent variable is the teaching treatment.

Figure 4 shows the screen shot of ontology developed for inheritance in Java using protege tool by the learner. The learner has to develop ontology with the help of the ontology learning environment and with domain knowledge base. The domain knowledge base helps the learner to know the topics in the domain.

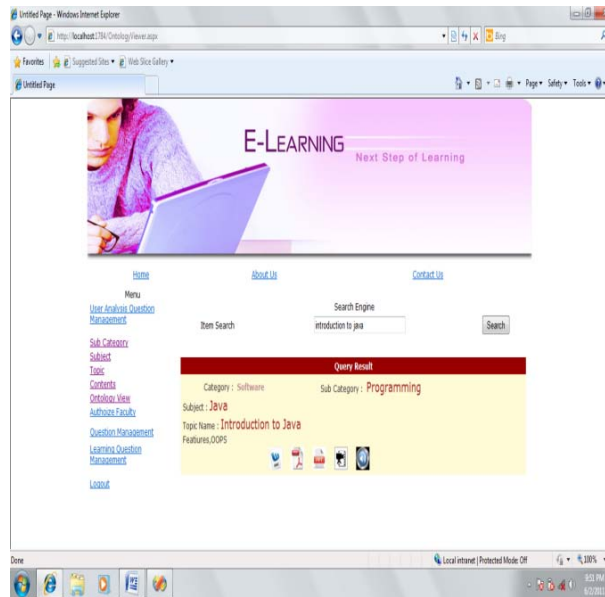


Fig. 3: Home page of the Java tutor

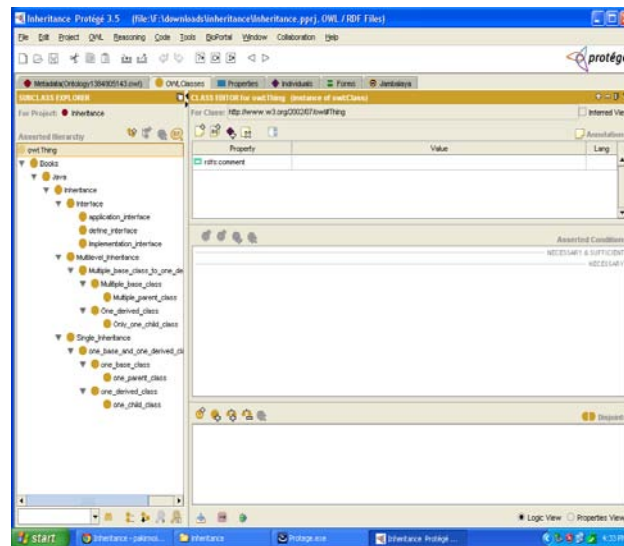


Fig. 4: Ontology for inheritance developed by the learner

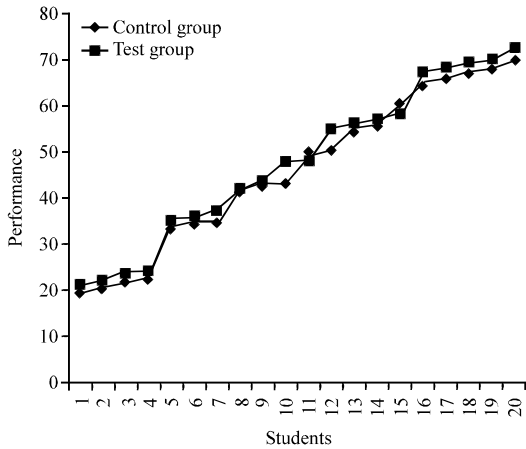


Fig. 5: Pre-test: control group vs. test group

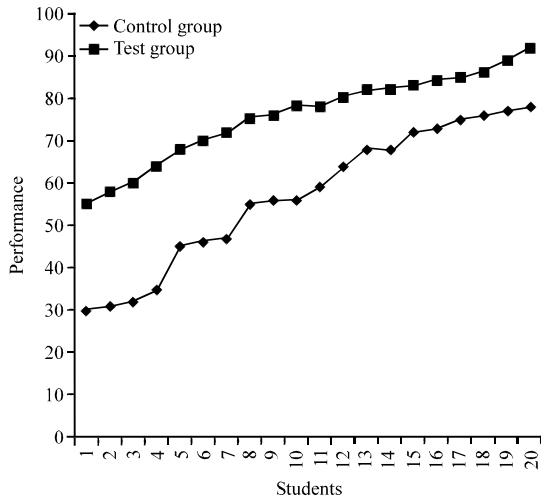


Fig. 6: Post-test: control group vs. test group

This will help the learner to analyze the domain and help to develop the knowledge and identify the problematic concepts in the domain.

Testing procedure: The testing procedure consists of two stages: a pre-test was conducted to the learners to assess the background knowledge of the subject matter to be presented. The purpose of this test was to enable us to divide the learner into two groups, a control group and a test group, both synchronized for background knowledge of the Java subject material. Figure 5 shows the performance graph of the students before providing content. A post-test was administered at the end of the 1 month training period in order to measure the student performance. The control group was taught in a traditional classroom situation. The test group was provided with the standard teaching but supplemented with the ontology

based Java tutor to analyze the knowledge level of the learner. Figure 6 shows the performance of the student after providing the content.

CONCLUSION

In this study, researchers have constructed personalized e-Learning System framework using ontology by creating personalized ontology user models. This model learns the knowledge level of the learners in the e-Learning environment and strengthens the instructional design to make the content personalized. The effectiveness of ontology based instructional design for introduction to Java programming was tested by constructing an experimental model. The model consists of two groups. The first is control group, the content is provided with the traditional method of teaching (instructor and textbook) and the second group is test group is provided with personalized Java tutor using ontology. Both groups were coordinated for similar background knowledge of the topics being taught. Post testing revealed that the Java tutor group achieved significantly higher scores than the group taught using the traditional method. Furthermore, the Java tutor group showed that the subject knowledge was better than the traditional method group. The results of this study suggested that ontology based Java tutor can be used as an effective teaching method to improve the performance the learner, to analyze the performance of the students, to identify the strength and weakness of the content, teaching methodology, to know the knowledge level, cognitive state of the student, learning style, etc. This system also removes the some of the formality of traditional learning, helped students raise their self confidence and become more effective in managing their time and to develop study habits that result in enhanced personalized learning. This system can be implemented in any learning environment.

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