Ontology-Oriented SCJP Learning and Assessing System Design

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Abstract—In this paper, we proposed an advanced Petri Net model to manage the workflow of a web-based multiple participants in virtual University. The presented approach not only can conspicuously help the developer to comprehend the interaction relationship but also to easily construct a shared and trusted virtual world. This approach was based on the scaffolding theory and ontology. Learning activities of students and teachers are supported and understood by each other by the intelligent knowledge system. Their behaviors including the student’s self regulations and the teacher’s/virtual campus regulations are performed and built with trust development. Ontology based course content SCJPLearn can be supported in teaching activities and assessment stage. This paper can be taken as a fundamental research framework and tools to study and understand the characteristics of e-learning and to explore its optimal vocational education application.

Index Terms— Distance Learning, Course Management system, Ontology based, Petri Net, Reference Feedback, Trust Management, Virtual University,

I. INTRODUCTION

In this paper, we aim to develop a behavior supervision machine, based on Petri Net [7, 8], to properly guide students while they are in the campus. The main goal of this paper is to model the workflow of an integrated web-based multi-user environment so that the researcher can easily design such a system on the Web. Hence, in the following subsections, the definition of the integration is introduced first and followed by the proposed Petri Net model to monitor the user’s activities.

Virtual university system comprises the integration of the classroom structure to the Web. Such systems combine learning management capabilities with collaboration features to provide online analogs for common classroom learning events, e.g. lectures, discussions, and grade books (course management system). Learning Management System (LMS) [26] manages the whole development and administration of learning. Another option is the Learning Content Management System (LCMS), which manages the development of complex courses or the learning object for the needs if individual learners by assembling reusable units of education. Audio, video, animation, and other media may require specific authoring and editing tool.

While a student navigates through the virtual campus, a few items will be recorded:
- The international states visited in the Petri Net
- The type of communication tools used, including the frequency and duration
- The course units visited, including the frequency and duration
- The values of state variables
- The declarative rule fired by the action, which includes
  - Completeness of state transitions
  - The Campus Alert types of agent triggers
  - The Student Violation types of agent triggers
  - The control buttons of virtual campus navigation pushed

In addition, chat room logs and question-answer logs were recorded. A statistic summary will be generated after each session of navigation of each student (for an optional review by the student). This information can be used to find out what are the popular locations (such as which class and which discussion room), which communication channels are popular, type of triggers fired by the system, and others.

In support of the above learning types, we integrate a set of tools into a web-based system. We carefully look at user requirements from the perspective of educational professionals. We realize that, it is possible to design an integrated learning environment to support the application of the scaffolding theory [19]. Scaffolding, proposed by L. S. Vygotsky, was viewed as social constructivism. The theory suggests that students take the
In this paper, we outline the philosophical perspective and social constructivism that frame our understanding of e-learning. Ontology based for Java programming language course objects were illustrated in section 2. The section 3 outlines the activity supervision and behavior understanding modeling. The implementation consideration of the virtual university system is discussed in section 4. Finally, we will make a brief conclusion in section 5.

II. ONTOLOGY-ORIENTED APPROACHES FOR COURSE CONTENT-SCJPLEARN

Ontology is a method of conceptualization on a specific domain [3]. Protégé-3.1.1 [11] was developed by SMI (Stanford Medical informatics) for construction ontology. This software has some advantages for developers:

1. Open-source software.
2. Multiple knowledge ontology support.
3. Multiple storage formats support.
4. Multiple data types support.
5. Integrated Application GUI.
6. Plug-in service support.

Based on above features, we knew that the Protégé-3.1.1 not only have the friendly GUI for developer but also supporting multiple storage formats for database. We could use the database to construct the entities or the XML description to represent the semantic facilities. In this paper, we used Protégé-3.1.1 to develop our multimedia course object ontology. There are two main methods to construct the ontology in Protégé: Open Knowledge Base Connectivity protocol (OKBC) and Web Ontology Language (OWL).

Open Knowledge Base Connectivity protocol (OKBC) defines the knowledge ontology: class describes the domain concept; slot describes the abstraction of properties and relationships; facet is the restriction of the properties. Inheritance relationship existed between two classes. Subclass inherited super-class’s slot and their relationship.

Web Ontology Language (OWL) [12] is designed for application to process the messages that the documentation contained. This feature is very form only presenting the content for people. OWL can represent the terminologies of the specified vocabulary and the relationship between two terminologies with more clearly and definitely. In domain semantic representation, OWL provide more categorical than XML, RDF or RDF-S.

OWL adds many lexicons to describe the properties and classes: among others, relations between classes, cardinality, equality, richer typing of properties, characteristics of properties, and enumerated classes. On the other hand, OWL designed three extensible sub-languages for special purposes communities of implementer and users [13]:

1. OWL Lite: It is the syntactically simplest sub-language and supports those developers needing classification hierarchy and simple constrain.
2. OWL DL: It is based on Description Logics and is therefore amenable to automated reasoning. It is therefore possible to automatically compute the classification hierarchy and check for inconsistencies in an ontology that conforms to OWL-DL.

3. OWL Full: is meant for users who want maximum expressiveness and the syntactic freedom of RDF with no computational guarantees. OWL Full allows an ontology to augment the meaning of the pre-defined (RDF or OWL) vocabulary. It is unlikely that any reasoning software will be able to support complete reasoning for every feature of OWL Full.

The choice between OWL Lite and OWL DL depends on the extent to which users require the more-expressive constructs provided by OWL DL. The choice between OWL DL and OWL Full mainly depends on the extent to which users require the meta-modeling facilities of RDF Schema. We took the OWL DL as our meta sub-language. Figure 3 shows the protégé-3.1.1 development user interface for classes design. There are three main regions in class tab: Classes, Annotation, Properties and Restrictions. Figure 3 illustrates the properties setting tab. There are four parts for configuration: Property, Triples, Domain, and Range. We designed SCJPLearn ontology for Java programming language course content. The SCJPLearn ontology was constructed by OWL editor and then to support the Java classes understanding and accessing.

Figure 2: protégé-3.1.1- SCJPLearn classe user interface

Figure 3: protégé-3.1.1-Property user interface

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Figure 4: Classes_and_Objects Ontology in Java Programming Language

Figure 5: first level Classes_and_Objects Ontology

Figure 4 illustrated the SCJPLearn ontology’s Classes_and_Objects for Java programming language. The figure 5 is the first level SCJPLearn ontology. The first level related OWL is shown in figure 6.

Figure 5: first level OWL Classes_and_Objects Ontology

The corresponding second level Nested_Class ontology and OWL was illustrated in figure 6 and figure 7.
III. ADVANCED PETRI NET MODEL

We defined learning behavior based on the characteristics of the Petri net. As a graphical tool of Petri net, the followings are basic properties of a Petri net and the description of learning objects: Definition 3.1: A learning behavior Petri net is a 8-tuple, \( PN = (P, T, A, K, \Gamma, \Xi, \Psi, \Delta) \) where:
- \( P = \{P_1, P_2, \ldots, P_m\} \) is a finite set of places,
- \( T = \{T_1, T_2, \ldots, T_i\} \) is a finite set and a sequence of transitions,
- \( A \subseteq (P \times T) \cup (T \times P) \) is a set of arcs,
- \( K = \{\alpha, \beta, \ldots, \zeta\} \subseteq \text{String} \) is a set of Keyword,
- \( \Gamma = \{0, 1, 2, \ldots\} \) is a set of significance weight within learning objects,
- \( \Delta : P \rightarrow \{0, 1, 2, \ldots\} \) is the duration of time tags,
- \( \Psi : P \rightarrow \{0, 1, 2, \ldots\} \) is the frequency of the learning objects to be stayed,
- \( \Xi : P \rightarrow \{0, 1, 2, \ldots\} \) is the identifier of a learning object,
- and \( \Theta \subseteq P \cap T = \emptyset \) and \( P \cup T \neq \emptyset \).

The generic components of Petri net include a finite set of places and a finite set of transitions. Petri net is a finite bipartite graph. Its places are linked with transitions in turn are connected to the output places. For a given place, there are input and output transitions defined.

In [3], they proposed swift trust for virtual learning communities. Their analysis showed online faculty role changed in cognitive, affective, and managerial activities. In distributing environment, content awareness is also needed to trust. They studied a formal approach and revised a theory of trust, that contained techniques for modeling trust changes and theory changes, a method for computing the new trust state from the old one and its change, and a method to get the theory change corresponding to a given trust change. They addressed the trust is very essential to source and high quality factor from transition \( ti \) to \( t(i+1) \) in its edge of transitions, so the total trust rate from transition \( ti \) to transition \( tj \) is calculated as:

\[
T (t_i \rightarrow t_j)w = \sum_{n=1}^{Ti} T_{iw} \cdot S_i
\]

(1)

Where \( Si \) is the local trust confidence score of user’s rated from transition \( Ti \) by \( Ti+1 \), range= \([0, 1]\).

The average trust rate is calculated as:

\[
\text{avg.} T (t_i \rightarrow t_j)w = \frac{\sum_{n=1}^{Ti} T_{iw} \cdot S_i}{N}
\]

(2)

where \( N \) denotes the number of edges in path between \( Ti \) to \( Tj \).

User’ Relevance Feedback Analysis:

Degree = \((1 + Q') \cdot A_F\). \((3)\)

\( Q' \) is the updated user’s relevance feedback value (By Rocchio’s formula as illustrated in formula (4) \([4][5]\). Where, \( Q \) is the origin query value, \( DR' \) is the sample of positive feedback with the number \( NR \cdot DN' \) are the sample of negative feedback with the number \( NN, \alpha, \beta, \gamma \) are the selected constants.

\[
Q' = Q + \beta \left( \frac{1}{N_F} \sum_{i \in \Omega} D_i \right) - \gamma \left( \frac{1}{N_N} \sum_{i \in \Omega} D_i \right) \]

\((4)\)

\( A_F \) is the Aged Factor for course units, considering the course unit aged issue. The aged factor is derivated from formula (5).

\[
A_F = \frac{\text{Long\_Period} - \text{Short\_Period}}{\text{Long\_Period}} \] \((5)\)

where the Long_Period and Short_Period are the course unit renovation configuration.

By retrieval we mean the virtual university system can satisfy the storage and retrieval requirements of a very large number of atomic learning objects (by learning tasks) where a learning progress can have a storage requirement of several hundred gigabytes. Therefore, this is very difficult to query in virtual university system by using content-based image/video retrieval techniques. In our approach, we defined the attributes “keyword” to achieve user demand. Keyword attributed can be extracted from the title or teacher’s specified of the teaching materials. Queries are expressed in terms of high-level declarative constructs that allow users to qualify what they want to retrieve from the virtual university system. The retrieval definition is defined as follow.

Definition 3.2: The retrieving operation, \( \rho_k(PN'\{P_1, P_2, \ldots, P_m\}, PN\{P_1, P_2, \ldots, P_n\}) \) extracts from \( PN'\{P_1, P_2, \ldots, P_n\} \) all the keyword \( k \) of the virtual university place \( P' \) that are similar to \( PN'\{P_1, P_2, \ldots, P_m\} \) with respect to the similarities threshold keywords.

Let the set of keyword \( k_1 \in P_1, k_2 \in P_2, \ldots, k_m \in P_m, \) where \( P_i \in PN'\), and \( k_1 \in P_1, k_2 \in P_2, \ldots, k_n \in P_n \) where \( P_i \in P_N \).

\( \rho_k(PN'\{k_1, k_2, \ldots, k_m\}, PN\{k_1', k_2', \ldots, k'n\}) = \)
Definition 3.3: The abstracting operation, $\alpha_{Sw}$ ($PN\{P_1, P_2, ..., P_n\}$) compares all the virtual university place $P_i$ with $Sw$.

Let the set of Significance weight $Sw_1 \in P_1, Sw_2 \in P_2, ..., Sw_n \in P_n$, where $P_i \in PN$.

$\alpha_{Sw}$ ($PN\{Sw_1, Sw_2, ..., Sw_n\}$) = $PN\{Sw_1, Sw_2, ..., Sw_n\}$

Where the $Sw$ of $P_i$ in $PN\{P_1, P_2, ..., P_n\}$ is equal to or greater than $Sw$.

In assessing participation operation, there are two additional time factors in our model: duration time and frequency time. Firstly, we defined the attributes “duration” to achieve user demand. The purpose of the duration factor is one of the critical characteristics in learning environment. It records how long with the place (learning object) to be stayed. The remained processes are same as the duration assessing participation operation.

Definition 3.4.a: The frequency assessing participation operation, $\gamma_c$ ($PN\{P_1, P_2, ..., P_n\}$) sums all the virtual university place $P_i$ with specific learner had been visited ($\exists Lx$).

Let the set of duration time $Dt_1 \in \{(P_1 \in Lx)\}, Dt_2 \in \{(P_2 \in Lx)\}, ..., Dtn \in \{(P_n \in Lx)\}$, where $P_i \in PN$.

Process:
FOR i=1 to i<=n DO
IF (PiÎLx) THEN $Dt=Dt+Di$ END IF
End FOR
Return $Dt$

End Process

$\gamma_c$ ($PN\{Dt_1, Dt_2, ..., Dtn\}$) = $PN\{Dt_1, Dt_2, ..., Dtn\}$

Secondary, we defined the attributes “frequency” to achieve “number-of-posting” as indicator for assessing participation operation. The purpose of the frequency is the other critical characteristic in learning environment. It records how many times with the place (learning object) to be stayed. The remained processes are same as the duration assessing participation operation.

Definition 3.4.b: The frequency assessing participation operation

Let the set of frequency $Fs_1 \in \{(P_1 \in Lx)\}, Fs_2 \in \{(P_2 \in Lx)\}, ..., Fs_n \in \{(P_n \in Lx)\}$, where $P_i \in PN$.

Process:
FOR i=1 to i<=n DO
IF (PiÎLx) THEN $Fs=Fs+FSi$ END IF
End FOR
Return $Fs$

End Process

$\gamma_c$ ($PN\{Fs_1, Fs_2, ..., Fs_n\}$) = $PN\{Fs_1, Fs_2, ..., Fs_n\}$
The Curriculum stage (for Student):

The curriculum subsystem should provide and record the user chooses (the curriculum and courses levels). This subsystem is important to keep the core function of Learning Management System (LMS) and the Learning Content Management System (LCMS). The Virtual University System may provide the courses that contain on-line courses, off-line courses, as well as collaborative events and online meeting.

First of all, the learner login with granted authorization (Transition Tc1) is illustrated in Figure 9. The curriculum subsystem presents a menu and catalog of courses (Transition Tc2 for selecting the curriculum, Transition Tc3 for selecting the courses). Learners can see a list of courses in which they are enrolled. Some suggested courses are based on a learner’s profiles; some analysis a learner’s progress at the level of individual objectives or the instructor manually adapts content to individual learners (Transition Tc4 for selecting the demanded tools and checking the curriculum certifications is sufficient or not). After finished and passed the above procedures, the learner’s curriculum activities records and degrees certification could be confirmed (Transition Tc5).

Examination Stage:

The examination subsystem measures the effectiveness of learning. Learner may rely on tests to gauge their learning progress in a course. Instructor can use test scores to assign subsequent learning activities or to measure the effectiveness of the distance learning. In Virtual University, tests often usually find their way onto pages created with authoring tools.

As shown in Figure 11, if the learner login with granted authorization (Transition Te1), they can choose desire course to exam. Anyway, the instructor may set some qualification for some tests. So the learners may be qualified/compares with some curriculum records (e.g. rate of attendance). After finishing that contingent qualification (Transition Te2), learners can take the tests for course or curriculum level assessments (Transition Te3).
Tests and quizzes are usually tracked as separate activities that may not as part of a specific lesson. The results reported to the learner and if specified by the test’s author, sent back to the server (Transition Te5). The instructor can check results stored on the server to see how learners are progressing in the course/curriculum.

Assessment Stage:
The assessment subsystem keeps track two learner’s learning records: curriculum and examination records. Curriculum records contain the learning activities and workflows. Learning activities could represent the histories and behaviors that could be understood some certain extent of the learning acquisition. We could evaluate and produce the reports: learners, curriculums, courses, tests, activities, and online meetings.

As shown in Figure 10, with granted authorization (Transition Tau1), instructors and course’s authors can periods check reports/results of the course or examination (Transition Tau2). If the instructor set some qualification for some tests (Transition Tau3) and if the learner was disqualified then he will not be allowed to take some test (Transition Tau5). If the instructor didn’t set any qualification for some tests or the learners was qualified (Transition Tau4) then they will get the examination results (Transition Tau6 for pass, Transition Tau5 for fail); however, the completed reports of the learner will be produced(Transition Tau8).

V. CONCLUSION
In this paper, we proposed a trust development framework and approach to the understanding of the virtual university and explain why it is proliferating throughout a rapidly evolving learning society. This is the important comprehensive and coherent framework to guide our understanding of e-learning in education and society. We also investigated the ontology based course content SCIPLearn ontology to provide the knowledge approaches. The ontology approaches are fit to the Java language class-hierarchy and the also easy to suit the assessment needs. This paper can be used as a basic/fundamental research framework and tool to study and understand the characteristics of e-learning and to explore its optimal education application.

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REFERENCES


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