Relevance Feedback and Content Aged in Course Management System

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Abstract

User’s Reference Feedback and trust information is needed for both learners and teachers in virtual university system. In this paper, we presented 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. Learning activities of students and teachers are supervised and understood by each others by the intelligent control system. Their behaviors including the student’s self regulations and the teacher’s/virtual campus regulations are performed and built with trust development. Problems of providing the multi-user interaction on the Web and the solutions proposed by the Petri Net model are fully elaborated here. This paper can be used as a basic/fundamental research framework and tools to study and understand the characteristics of e-learning and to explore its optimal educational application.

Keywords: Reference Feedback, Trust Management, Virtual University, Petri Net.

1 Introduction

In this paper, we aim to develop a behavior supervision machine, based on Petri Net, 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) 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.

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 [2]. Scaffolding, proposed by L. S. Vygotsky, was viewed as social constructivism. The theory suggests that students take the leading role in the learning process. Instructors provide necessary materials and support. And, students construct their own understanding and take the major responsibility. Between the real level of development and the potential level of development, there exists a zone of proximal development. This zone can be regarded as an area where scaffolds are needed to promote learning. Scaffolds to be provided include vertical and horizontal levels as a temporary support in the zone of proximal development.
Scaffolding is essential for cognitive development. It also plays an important role in the process of social negotiation. There are three properties of the scaffold:

- The scaffold is a temporary support for the learner to ensure the success of a learning activity.
- The scaffold is extensible (i.e., to be used in other knowledge domains) and can be offered through interactions between the learner and the learning environment.
- The scaffold should be removed in time after the learner is able to accomplish the learning task independently.

The scaffolding theory indicates three key concepts. Firstly, in the zone of proximal development, the relationship between the scaffolds providers and the receivers are reciprocal. That means that the instructor and learners should negotiate a mutual beneficial interactive process. Secondly, the responsibility is transferred from the instructor to the learner during the learning process. Depending on the learning performance, the instructor gradually gives more control of the learning activities to the learner for the attainment of the ultimate goal of self-regulation. Finally, interaction is essential to facilitate learners to organize their own knowledge. Hence the use of language or discourse is crucial to promote reflection and higher-order thinking.

As shown in Figure 2, the Scaffolding-by-Design Model [2] describes a process of mainly social interactions, as state in vygotsky’s work. Further it builds on aspects of cognitive apprenticeship, which is chosen as a pedagogy to support student learning. As a model for learner support, one of the aims of this model is that the learner learns to self-regulate. Some suggestion for learning to self-regulate were found that are applied in this model. One of the means to learn to self-regulate can be the application of Scaffolding. The two main components that define Scaffolding, support of the learner and fading, are emphasized in the Scaffolding-by-Design Model. In this paper, we based on this model then propose an activities supervision and behavior understanding model for Virtual University System. Our approaches can let the learner, instructor period to check reports and manually adapts their course/curriculum by re-configure the weight, progress and tests.

![Figure 2: The Scaffolding-by-Design Model](image)

In this paper, we outline the philosophical perspective and social constructivism that frame our understanding of e-learning. The section 2 outlines the activity supervision and behavior understanding modeling. The implementation consideration of the virtual university system is discussed in section 3. Finally, we will make a brief conclusion in section 4.

## 2 Advanced Petri Net Model

We defined learning behavior based on the characteristics of the Petri net. As a graphical tool of Petri net, the following are basic properties of a Petri net and the description of learning objects: Definition 2.1: A learning behavior Petri net is a 8-tuple, \( PN = (P, T, A, K, Sw, Dt, F, ID) \) 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,
- \( T_t \xrightarrow{w} t(i+1) = range\ \{0, 1\} \) is the weight of trust rate and reliable factor from transition ti to (i+1) in its sequence of transitions,
- \( A \subseteq (P \times T) \cup (T \times P) \) is a set of arcs,
- \( K = \{\alpha, \beta, \ldots, \zeta\} \in \text{String} \) is a set of Keyword,
- \( Sw = \{0, 1, 2, \ldots\} \) is a set of significance weight within learning objects,
- \( Dt: P \rightarrow \{0, 1, 2, \ldots\} \) is the duration of time tags,
- \( Fs : P \rightarrow \{0, 1, 2, \ldots\} \) is the frequency of the learning objects to be stayed,
- \( ID: P \rightarrow \{0, 1, 2, \ldots\} \) is the identifier of a learning object,
- \( P \cap T = \emptyset \) 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 interactions on the semantic web. FuzzyTrust, EigenTrust algorithm computes a global trust/reputation value in peer-to-peer network.

The trust weigh of each path is calculated using following definition.

Definition 2.1.1:

\[ T(t_i \rightarrow t_{i+1})w = range\ \{0, 1\} \]

\[ (1) \]
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:

$$\text{avg. } T(t_i \rightarrow t_j) = \sum_{i=1}^{N} Tiw_i \cdot Si$$

Where $N$ denotes the number of edges in path between $Ti$ to $Tj$.

User’s Relevance Feedback Analysis:

Degree = $(1 + Q’) \cdot AF$;

$Q’$ 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, $Dq’$ is the sample of positive feedback with the number $N_r \cdot Dn’$ are the sample of negative feedback with the number $N_n$, $\alpha$, $\beta$, $\gamma$ are the selected constants.

$$Q’ = \alpha Q + \beta \left( \frac{1}{N_r} \sum_{i \in Dq'} D_i \right) - \gamma \left( \frac{1}{N_n} \sum_{i \in Dn'} D_i \right)$$

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

$$AF = \frac{\text{Long} \_ \text{Period} - \text{Short} \_ \text{Period}}{\text{Long} \_ \text{Period}} \qquad (5)$$

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 attributes “keyword” to achieve user demand. The purpose of the duration factor is one the critical characteristic in learning environment. It records how long with the place (learning object) to be stayed and the total time by the learner took.

Definition 2.4.a: The duration assessing participation operation, $\alpha Sw (\text{PN} \{ P1, P2, ..., Pn \})$ sums all the virtual university place $Pi$ with $Sw$.

Let the set of Significance weight $Sw 1 \in P 1, Sw 2 \in P 2, ... , Swn \in Pn$, where $Pi \in PN$.

$$\alpha Sw (\text{PN} \{ Sw1, Sw2, ..., Swm \}) = \text{PN} \{ Sw1, Sw2, ..., Swm \} \rightarrow \alpha Sw (\text{PN} \{ P1, P2, ..., Pn \}) = \text{PN} \{ P’1, P’2, ..., P’m \}$$

where the $Sw$ of $P’i$ in $\text{PN} \{ P’1, P’2, ..., P’m \}$ 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 the critical characteristic in learning environment. It records how long with the place (learning object) to be stayed and the total time by the learner took.

Definition 2.3: The abstracting operation, $\alpha Sw (\text{PN} \{ P1, P2, ..., Pn \})$ sums all the virtual university place $Pi$ with specific learner had been visited ($Lx$).

Let the set of duration time $Dt1 \in \forall(P 1 \ni Lx), Dt2 \in \forall(P 2 \ni Lx), ... , Dtn \in \forall(Pn \ni Lx)$, where $Pi \in PN$.

Process:

FOR $i=1$ to $i<n$ DO

IF (P \ni Lx) THEN $Dt= Dt+ Di$ END IF

Return $Dt$

End Process

Let the set of duration time $Dt1 \rightarrow \gamma c (\text{PN} \{ P1, P2, ..., Pn \}) = \text{PN} \{ P1, P2, ..., Pm \}$ where the $P’i$ in $\text{PN} \{ P1, P2, ..., Pn \}$ is satisfied in $Lx$.

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.
3. Establishing the Virtual University

We used The Petri Net model to establish the common activities in Virtual University. It includes the following five stages:

The Registration stage: this stage is the first step to apply for admission to a school. For the web-based virtual university, the user should be able to log into the virtual university system and then follow the registration subsystem guidance.

The Curriculum stage: this stage is the selecting courses step for learner. The curriculum subsystem should provide and record the user chooses. The Virtual University may provide the courses that contain on-line courses, off-line courses, and the curriculum and courses catalog of courses (Transition Tc2 for selecting the courses).

The Authoring stage: this stage is the course design step for the teacher. The authoring subsystem should provide the course creating and editing function module.

The Examination stage: this stage is the one of the important evaluation/examination function for the learner or education training. The examination subsystem should provide the various examination styles, such as questionnaire, question-and-answer drill or the collaboration examination.

The Assessment stage: this stage is important index for learner’s leaning achievements. 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.

The Petri Net model of these five stages are then elaborated as follows.

3.1 Registration Stage

In this stage, the client site accesses the HTML or 3D VRML files from the server site. As shown in Figure 3, user uses the web browser to access the main page of the Virtual University System, Transition Tr1, to load the login page. When the login page is replied from the server, user should input the personal identification information into the desired fields respectively (Transition Tr2).

After finished the applying for admission confirmation procedures (Transition Tr3), learner could check the registration demands (e.g. Academic Background, payment voucher) that were filled the bill or not. After admission demands confirmation step (Transition Tr4) were done by the applicant, they could modify the personal information (Transition Tr5) or change the login password. After the above registration procedures, server will auto apply the re-login page (Transition Tr6), and then the user can be granted the legal authorization (Transition Tr7).

Figure 3: The Petri model for registration stage

Tr1: Accessing the main page of the Virtual University System
Tr2: Login page for the user
Tr3: Applying for Admission Confirmation
Tr4: Admission Demands Confirmation
Tr5: Personal Information modification
Tr6: Re-login with Granted Authorization
Tr7: Confirm and Update into Database
Pr1: Registration Subsystem View
Pr2: Registration Procedure Information
Pr3: Paying Subsystem
Pr4: Academic Background
Pr5: Registering Into Database
Pr6: Responding the registration information to the user
Pr7: Email the registration information to the user
Pr8: Registration Confirmation

3.2 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 4. 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).

Figure 4: The Petri Net model for curriculum stage
Tc1: Login with Granted Authorization
Tc2: Select Curriculum Subsystem
Tc3: Starting a Select with Curriculum Subsystem
Tc4: Tools Select Subsystem (Communication Tools)
Tc5: Curriculum Activities Record or Degree Confirmation

Pc1: Curriculum Subsystem
Pc2: Retrieval Curriculum
Pc3: Online Curriculum
Pc4: Offline Curriculum
Pc5: Syllabus Information
Pc6: Curriculum Activities Record Subsystem
Pc7: Insufficient the Curriculum criteria Record

3.3 Authoring Stage

For developers of Virtual University System, authoring tools make it possible to create and manage large numbers of independent pages and their assets. The authoring subsystem should provide the instructor to work on the site as a whole, rather than just a collection of independent pages. In Figure 5, with granted authorization (Transition Tau1), instructor could creating/updating a course page by specifying characteristics (Transition Tau2) such as where to put it on the server and what content database connection it will use. Authors are not limit to editing/creating individual pages. They can organize the entire site and link individual pages in a virtual map (Transition Tau3). Authors can make changes throughout a site without having to open and change individual pages or learning objects (Transition Tau4). In order to analysis the learner’s learning achievements (for individual learner’s progress), instructors can configure/adapt the weight for individual learning objects (Transition Tau5).

Figure 5: The Petri Net model for authoring stage
Tau1: Login with Granted Authorization
Tau2: Selecting a Course
Tau3: Course Organization Design
Tau4: Content Object Editing
Tau5: Weigh-bearing Point Configuration
Pau1: Authoring Course Subsystem
Pau2: Creating a Course
Pau3: Updating a Course
Pau4: Course for Lecture
Pau5: Course for Examination
Pau6: Course Preview

3.4 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 6, 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 Te4 for disqualification, Transition Te3 for qualification). 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.

Figure 6: The Petri Net model for Examination Stage
Te1: Login with Granted Authorization
Te2: Test Selecting
Te3: Qualified and Starting Examination
Te4: Disqualified, confirmation and Exit
Te5: Hand in the Examination
Pe1: Examination Information Retrieval
Pe2: Online Examination
Pe3: Offline Examination
Pe4: Curriculum Record Qualification
Pe5: Questionnaire
Pe6: Question-and-Answer drill or exercise
Pe7: Team Work/Collaboration Examination

3.5 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 7, 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).

Figure 7: The Petri Net model for Assessment Stage

| Tas1: Login with Granted Authorization |
| Tas2: Selecting Curriculum or course  |
| Tas3: Selecting Students for Curriculum/course Record |
| Tas4: Selecting Students for Examination Record |
| Tas5: Email the Record to Student for Notification/Remedy |
| Tas6: Email the Record to Student for Notification/Remedy |
| Tas7: Email the Record to Student for Notification/Encourage |
| Tas8: Degree Confirmation |
| Pas1: Assessment Subsystem |
| Pas2: Curriculum Record Subsystem |
| Pas3: Examination Record Subsystem |
| Pas4: Disqualification in Curriculum Attendance |
| Pas5: Qualification in Curriculum Attendance |
| Pas6: Disqualification in Examination |
| Pas7: Qualification in Examination |
| Pas8: School Report Subsystem |

5 Conclusion and Discussion

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. It is to the purpose of mapping the territory of e-learning, then providing directional choices for higher education and specific guidelines to reach worthwhile destinations. 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