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Personalized Online Learning with Ontological Approach

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Abstract

Learning is a cognitive activity which is different from one learner to another. Most online learning system does not participate in learner's individual aspect; ignoring the difference of specific need or personalization to the occurred cognitive experience. This research highlights the ontological approach in personalized online learning. A developed learner-role-model, which later be integrated with ontology, thus enables personalization system to guide the learner's learning process. The developed model monitors the learner's progress, in which it renews the learner's achieved knowledge and, at once, determines the next knowledge to be learned by the learner.

Keywords: *online learning, personalization, ontology, web semantic.*

1. Introduction

Personalization is the next step of the development of online learning system. Learners may be classified into certain cognitive types [1], which may vary the level of efficiency and successfulness of online learning system towards various learners. As an example of the various cognitive aspects is noticeable by solving the counting of 428 multiplied by 5 can be completed by 428 divided by 2 and then the result multiplied by 10. It is easier than directly multiplying it. This research formulates the problem related to the personalization of online learning system. An approach is aimed to the developed system based on the learner model with ontology. The system responds differently, according to the learner's character and performance and the learning substance mastered by the learner. Another important aspect is the use of Sharable Content Object Reference Model (SCORM) [2] as a standard of referred format for content development (the display of the learning object) and to do a learner model.

The development of online learning system follows the learning methodology or pedagogy which constantly evolved according to the theory of distant learning (distant learning theory) by Moore [3] using the characterization of Keegan [4]. SCORM [2] consists of several technical specifications and the manual to develop learning object. SCORM is made by the initiative of Advanced Distributed Learning (ADL) for the need of Department of Defense (DoD) in the framework of web learning. SCORM functions as a facility to unite various needs and aims of different groups or organizations that work on the online learning.

Specification of SCORM is divided into two parts: Content Aggregation Model, and Run-time Environment. Content Aggregation Model provides specification to develop the content based on the manual of learning object-making such as accessibility, interoperability, reusability, durability. Run-time Environment applies the mechanism of communication between Learning Management System (LMS) and learning object. SCORM is the main standard to develop online learning content and a valuable asset to LMS.

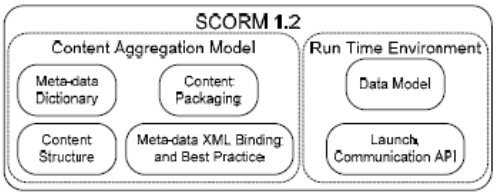

Fig. 1 SCORM 1.2 component

The constructed system combines the personalization with the standard of SCORM 1.2. The sample of stand-alone application to help online learning based on SCORM is eXe that stands for eLearning xHTML editor.

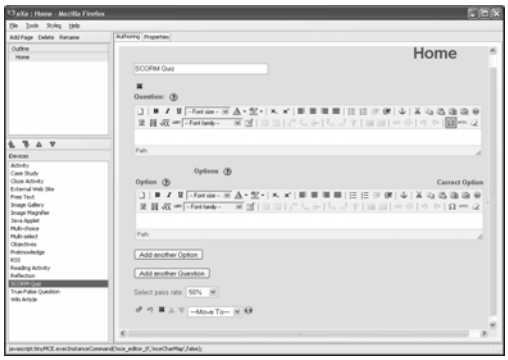

Fig. 2 eLearning xHTML editor

2. Research Method

The approach applied in this research method is based on the shaping of a learner model, which is developed from various scope of area such as: authoring system; user model is included by the use of semantic web, adaptive teaching system-web based, and intelligent tutoring system. Learner model defines what is noticeable related to the learner that is done by the system. This model, which is periodically shaped by system, uses data sources from learner, learner-learner interaction, lecturer or the administrator system. From the shaped learner model, a test is applicable to the different system doer i.e. the learner, teacher or content developer.

3. Model Design

The model developed is called Learner Model. Learner model consists of two kinds of data; fixed and update. Fixed data is unmodified during the interaction between learner and the system. It means the data is fixed or obtained at the beginning. Update data is the output resulted from the learning progress during the interaction with system. Fixed data refers to fixed model, and the other kind of data refers to update model.

Learner model is the foundation for personalization of architecture models which are developed in online learning. There are two developed architectural model in this research; online personalization and offline personalization. Online personalization monitors the learner's interaction with the system continuously at real time. It tries to adjust the content (learning material) and the navigation channel based on the learner model. Offline personalization collect the data of learner interaction towards the system, then analyze the data to recommend content alteration to content developer.

3.1 Fixed Model

Fixed model consists of five parts, each are the unity of learner's characteristic, which are unmodified during the session of online learning. They are:

- Personal
  Consists of biographical data of the learner i.e. : name, membership, Learner Activity Unit, a list of achievement, accessibility management. They are obtainable from the registration form to enroll a learning module (of a course).
- Personality
  Describe the characteristic of learner : type of personality, concentration ability (based on the average time to accomplish learning content), and the ability to interact / cooperate in teamwork or other learners and teachers. It is obtainable through Myers-Briggs test [5]

Fig. 3 Personality test

- Cognitive
  Describe the ability to learn or comprehend, based on experience in interaction with the system. Obtainable through Ross and Witkin test [1].
- Pedagogy
  Defines the learner's characteristic or learner's behavior in learning activity that refers to learner's learning model e.g.: learning style and learning approach. They are obtainable from :
  - □ learning objective: a list of learning topic, learning material for learner to learn in learning module (of a course)
  - □ classroom evaluation: to determine whether or not the learner take the learning evaluation
  - □ control / navigation of learning module (of a course) : to determine the control type used in navigation content.
- Preference
  Preference is a group of data to customize system based on the learner's habit / like. Initially determined by system administrator. Parts of preference consists of: display format, language of content display, personalization of web-design, personalization of

command, personal notebook, voice volume, or video quality.

3.2 Update Model

Update model consists of two parts:

- Performance
  It collects data related to learner performance at present in attending learning module (of a course). The data is constantly gathered to store the recent data. It is profitable from learner interaction with the system. It consists of motivation level and self-esteem in learning, learner ability to comprehend the substance of each subject, ability in general towards learning module, level of effort in the subject, and portfolio that keep all results achieved by learner in every subject (of a course).
- Learner's knowledge
  It describes the learner knowledge towards the material and the relevant competence of the enrolled subjects, i.e. :
  - □ the domain of ontology which consists of all recommended learning material used in a subject
  - □ information message which is applicable for the learner's active collaboration
  - □ the relevant progress of material comprehension which is needed by the subject

All data in the domain of ontology are gathered from learner-system interaction.

3.3 Personalization Framework

Real time personalization (fig. 4) monitors the learner's real time-interaction continuously, adjusts the content (substance content) and the navigation channel of learner learning by using engine reasoning (logical reasoning) in doing the task. Further, real time personalization provides mechanism of adapting, decision and the modification.

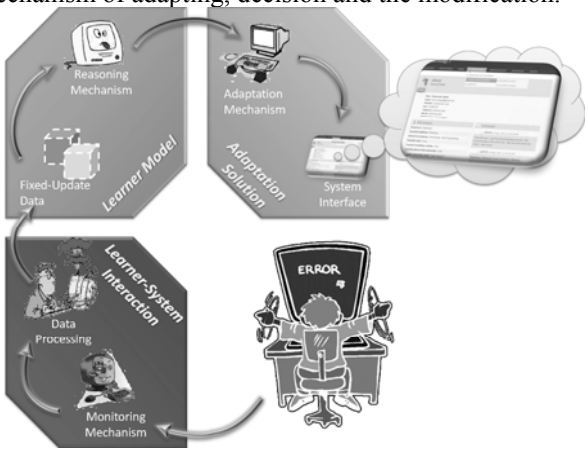

Fig. 4 real time personalization model

Non-real time personalization (fig. 5) collects the data of learner-system interaction, then analyzes it using data mining tools and recommends content change to the developer (using authoring tool).

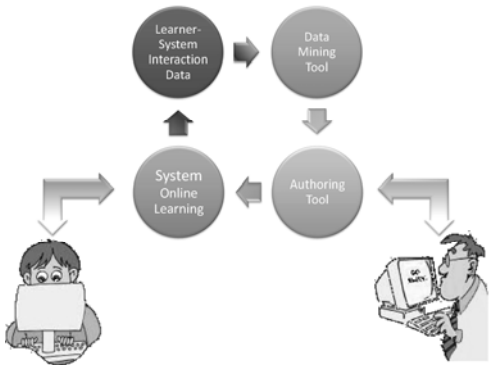

Fig. 5 non-real time personalization model

The implementation of this online learning system consists of well-made learner model, which enables the system to keep and to access learner data, in which to be analyzed to result different value as learner attributes. Values are obtainable by LMS from those attributes to be used further.

4. Ontology Utilization

The update learner model creates a reference to enroll course topics, which is used to make a decision about the content of what should be delivered to learner. The material is managed in ontology [6], which represents a knowledge domain. Basically, ontology is a formalization of topics domain of a course, which is transformed into classes. Therefore, a connection between classes and classes attributes may appear. This model uses classes to generalize relationship between classes to form a structure of taxonomy.

The subject, as it is defined in the standard of SCORM above, consists of several modules which are implemented in SCO (Shareable Content Object) or the topic of a subject. The subject must have an objective that must be achieved by learner and the process of interaction. The mentioned interaction illustrates parts of interaction between learner-system interactions, normally used to prove what has learned.

Learning material is linked to the subject, objective and interactions. Those linkages are registered during learning session, which is useful to determine learner knowledge about the learned material. It enables system to predict the learner's learning progress and to notice a comprehensive material for learners. Each subject is a part of ontology which has four parameters: Correct Answer/CA (the

amount of correct answer in a test of a subject), Incorrect Answer/IA (the amount of incorrect answer in a test of a subject), Accomplished SCO Subject/AS (the amount of accomplished course), and Unaccomplished SCO Subject/US (the amount of unaccomplished course). These parameters are obtained from interaction of learner towards system, objective, and SCO data.

Besides those four parameters, there is a condition in each subject within ontology, which has four values e.g. acknowledged (learner has acknowledged the concept / learning material, based on the experience. historical information of the learner), well-learned (learner does a test and obtains more than half of correct answer), learned (determining the learner's success in the material of learning which is indicated if half of the concept / learning material is accomplished), and non-learned / non-acknowledged (excluded from the other three materials).

During the learner's progress, the data is renewed within the domain of ontology. Therefore, the scope of learner's knowledge can be determined in general within certain area.

5. Implementation

5.1 Ontology Application

An applicable approach as an example is the subject of "Web Wireless Programming". It defines the ontology which describes all course domains. It is connected with the interaction in each topic of the subject so there is a group of learning material in ontology as it is displayed in fig. 6.

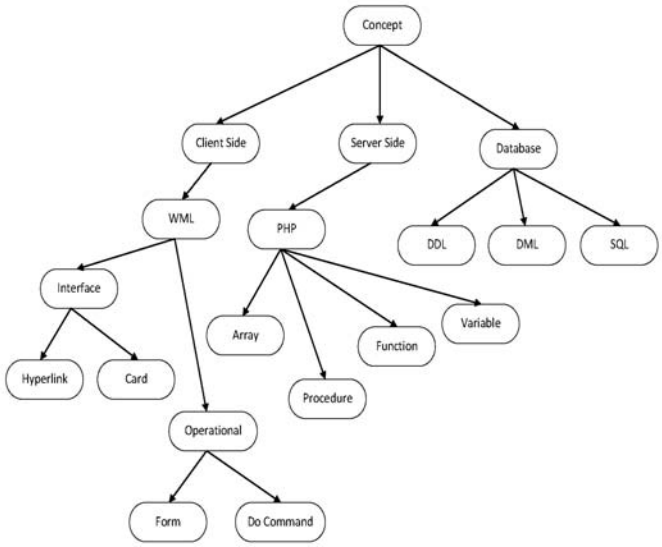

Fig. 6 Parts of ontology which describes the example of course domain

As an example, if a learner has accomplished modules in Table 1. It can be seen that some courses are related each other. When the learner has accomplished the modules, the amount of SCO (AS) of each material which is linked to the module will increase.

Table 1: A list of certain modules and materials of related topics in learning material

Module (SCO)	Materials of Related Topics	SCO State
WML Script	Card, Hyperlink, Form, Do Command	AS
PHP Script	Variable, Array, Procedure, Function	AS
Relational Database Management System	DDL, DML, SQL	AS

After accomplishing certain course topics, a questionnaire is given to the learner to test what they have learned. Table 2 shows some questions and some course topic of related subjects. System evaluates the learner's answer as it is shown in the table. For each course topic of a subject is related to the question, the learner's answer will change the amount of correct or incorrect answer.

Table 2: A list of some questions and course topics of related subjects

Question	Materials of Related Topics	Answer
The card used in WML is used to represent page ?	WML	correct
Do Command is used to accommodate the use of Yes/No button on the Mobile Device ?	WML	incorrect
The date ("D-M-Y") is a function to display time in the form of date-month-year ?	PHP	incorrect
Implode function is used to combine array element ?	PHP	correct
mysq_query is a function to execute sql command through PHP ?	PHP; Database	correct
Aggregates can be done in SQL using the commands of SUM, AVG, MAX, MIN ?	Database	correct

In table 3 the used data is applicable to determine the state of condition for each course topic which has been mentioned before. For each course topic of a subject, the system saves four parameters and applies the stated formula to count the state of condition of a course subject (concept's state).

Table 3: The used resume data to count condition of related course topic

Topics	Parameter	State Condition
WML	TA = 1 ; FA = 1 ; AS = 1 ; US = 0	Learned
PHP	TA = 2 ; FA = 1 ; AS = 1 ; US = 0	Well Learned
Database	TA = 2 ; FA = 0 ; AS = 1 ; US = 0	Well Learned

As it is shown in table 3, "WML" is learning material which has one correct answer and one incorrect answer. Therefore, the percentage of correct answer is not more than fifty percentages and system evaluates formula, stating the state condition of learned material to fail. Since the course topic is related to a passed SCO (AS), system evaluates formula, stating a state condition of learned material to be correct. Finally, system determines the state of course topic to be learned.

Through this example, the system can comprehend that a learner's answers the question inappropriately related to the learning material which must have been understood, since the learner has completed the SCO which is related to the learning. Based on the information, the system may suggest the learner to revise the taken course module with related learning material; to combine the knowledge.

5.2 Implementation of Ontology based on JENA

Jena Java RDF API and toolkit is a Java-based framework for constructing the Semantic Web applications. This framework provides a programming environment for RDF, RDF Schema, OWL, and SPARQL and has a rule-based inference engine (rule-based inference engine). Jena also has the ability to be used as an RDF database via the layer known as Joseki [7]. In the implementation used Web Wireless Programming ontology model (fig. 6). In the ontology model is available vocabulary "Relationship" [8] that includes properties: parentOf and childOf.

Jena has ModelFactory class that can be used to make various models. Through this model will be a resource that represents each topic course materials that exist in the ontology model.

After all the resource is created, then added the statements to the resource. In Jena, the subject of each statement is always in the form of a resource, while the predicate is represented by the Property, and objects can be represented by another Resource or a literal value. To illustrate the relation on the ontology, it must be added the instance property using the addProperty() method.

Here is a snippet of code that represents the model of the Web Wireless Programming (webwireless.rdf) in Fig. 6:

```
String contentUri = "http://webwireless/";
String relationshipUri =
"http://purl.org/vocab/relationship/";
Model model = ModelFactory.createDefaultModel();
Resource clientside =
model.createResource(contentUri +"clientside");
Resource serverside =
model.createResource(contentUri +"serverside");
Resource database =
model.createResource(contentUri +"database");
Property childOf =
model.createProperty(relationshipUri,"childOf");
Property parentOf =
model.createProperty(relationshipUri,"parentOf");
// Add properties to clientside describing
relationships to other topic members
clientside.addProperty(parentOf,WML);
// Can also create statements directly . . .
Statement statement =
model.createStatement(serverside,parentOf,PHP);
// but remember to add the created statement to
the model
```

6. Conclusion

This research proposes an approach towards personalization of online learning based on the ontology and the learner model. It has been explained about the learner model in detail and how to implement it. Another important aspect is the use of ontology to map learner knowledge in learning module, therefore a good learning progress is obtainable and adjustment of learning material including learning navigation channel of certain learner.

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