

Adaptive and Personalized Learning System as Workshop Complement

Trisna Febriana
School of Information System
Bina Nusantara University
Jakarta, Indonesia
trisna@binus.ac.id

Roy Kurniawan
School of Information System
Bina Nusantara University
Jakarta, Indonesia
roy_kurniawan@binus.ac.id

Abstract— The purpose of this research is first to (1) to determine the system flow of the existing workshop, (2) to understand the learning style and prior knowledge of each lecturer as a recommendation base for any workshops that will be applied, (3) to design ontology as the basis for system development, (4) to design and develop the system in accordance with the user requirements, (5) to provide e-learning models that fit the needs and characteristics for each lecturer, (6) to evaluate the proposed e-learning model. In this research, theoretical studies conducted on adaptive and personalized e-learning. Additional material obtained either from books or related journals as a reference in the system development. The model developed in this study were made independently in order to design more flexible ontology. Five models developed in this study, (1) prior knowledge, (2) user models, (3) the domain model, (4) content models, (5) learning path. The final output of this study is a recommendation that our proposed model can be applied as a foundation for the next stage, which is prototype development.

Keywords—learning system; e-learning; adaptive; personalized

I. INTRODUCTION

Based on Internet World Stats 2013, total internet users in Indonesia is about 55 million people [4]. This data showed that Indonesian people are quite aware of the technological advances. This is proven by the rise of e-learning usage in various fields, both in education and in industry. Many organizations in Indonesia have implemented e-learning as a method of self-learning to develop their human resources, for example: Bank Mandiri, IBM Indonesia, CISCO, and PT.SAP Indonesia [11].

In the education field, e-learning has shifted the paradigm in learning method. Based on the survey from ASTD (American Society for Training & Development) in 2004, there were 90% of US university with 10,000 students have taken the advantage of e-learning [7]. E-learning facilitate interaction between the learner with learning materials, learners with teachers, or among learners [1]. E-learning can be used for internal training in companies as well as for teaching in schools, either using internet or intranet [3].

Universities must conduct regular workshop in order to have qualified lecturers. However, most workshops still conducted conventionally. Limited resource in conventional workshops leads to some problems and cause an ineffective learning process. To solve this issues, it is necessary to

implement an e-learning system which can help increasing the effectiveness of the workshop.

The e-learning systems that exist today were not able to ensure the transformation of learning itself. In study conducted by Forrester Group in 2000, reveals that 68% from 40 companies refuse to do the training with e-learning concept. While other studies indicate that 50-80% of participants enrolled in the e-learning system, actually never finish the training [11].

E-learning system has major advantages in terms of cost and time savings compared with conventional methods. However, the structure of materials and sequences are presented in "one size fits all" [8]. E-learning has various types and often in combination of these types. E-learning can be a pure online, does not involve face-to-face interaction between teachers and learners or combination online and face-to-face [1]

In the learning process, each learner has different prior knowledges. Explicitly, the prior knowledge can be measure through pre-tests [9]. The initial ability differences between the learners put a need of a personalized learning system. Currently, the personalized learning system is a key point in the online learning because there is no fixed learning path that appropriate for all learners [2].

Both conventional and online learning systems are often generalizing the learner's ability and learning style. In some previous studies, it was revealed that the generalization does not support learners in optimizing the study [9]. It also happens in the workshop which was held by the university to support the faculty. So the purpose of training to improve the skills of lecturers is not optimal.

To design an adaptive learning content, we should understand the needs of learners. Many researchers are adopting semantic web technologies to find new ways to design an adaptive learning system by using ontology [12]. Ontology is a theory about the meaning of an object, properties of the object, and the relations [11].

In order to enhance the effectiveness of the workshop, we need a system that can be adjusted based on the characteristics of each learner as an additional learning system. In addition, the development of each learner should considered as the adjustment by the system so the workshop objectives can be achieved.

II. METHODOLOGY

A. Research Process

Generally, this study conducted theoretical studies related to the research. This method is carried out as a basic understanding of the concept study. Theoretical studies obtained either from books or related journals as a reference in the system development.

Data collection is required for the research. Data related to existing learning system, workshop materials, learners and teachers. Data collected through literature study, observation and interviews with relevant parties.

Analysis performed after we collected all the data. This output was used to design and develop the system. System development method conducted by creating a prototype and then will be evaluated and expanded into a web-based system on the next study.

B. Designing Model

The type of e-learning developed in this study is blended learning, which combine online learning and face-to-face learning. Prior knowledge in this study used to determine learner's knowledge level before starting the study. Semantic web technologies in this study based on ontology. Ontology is an effective method to present a semantic knowledge in a particular domain [10]. This study uses protégé 4.2 as an ontology design tools.

C. Prior Knowledge

Learners will learn and remember the lesson when the learning process is associated with prior knowledge [9]. At this stage a pre-test will be conducted before starting study which can be saved as a reference to provide recommendations course that should be taken by learners. Mid-test will be conducted at the end of every Learning Object (LO) to determine the next LO. Then finally, a post-test will be conducted to evaluate the results of learning. Designing prior knowledge will refer to research by Santoso, et al 2008 [9].

D. Ontology

We used personalized and adaptive learning system as an approach in this study by sharing some separate model. Thus it can build a flexible and independent model.

To support personalization, ontology design conducted in this study including: user models, domain models, content models and learning path. Ontology user models, domain models and content models will refer to the study conducted by Yarandi., Et.al in 2013 [12], while ontology learning path will refer to the research by Jovanovic 2009 [5].

1. User model

User model tailored to the needs of personalize learning for learners to support the workshop. This ontology is describing learning style of each learner.

At this stage, personalization will be applied for each learner based on their learning style. Adapting from

Yarandi., Et.al, (2008) [12], refers to the learning style theory Felder & Silverman, 1988 which was revised in 2002. This model is used to determine a person's learning style. To determine their learning style, learners will be given a questionnaire to establish the dominant learning style of each learner and the results can be connected easily to the e-learning system [12].

There are four dimension in this model [12] : (1) active-reflective; (2) visual-verbal; (3) sensing / intuitive; (4) sequential / global.

2. Domain Model

This model contains classes and properties to describe the topics in a course [12]. System will define hierarchy of the topics. It will sort the topics that will be taken by learner in accordance with the results of pre-tests that have been determined before. Learner will be given recommendations of the subtopics that correlate with their choices.

3. Content Model

In this stage we will apply the levels of learning content. The first level consists of several classroom learning. The second level is a Learning Object (LO). The last level is a Content Object (CO) where in this class include some metadata to describe the LO.

4. Learning Path Model

This stage determines some aspects of learning design, defines the direction of learning course, defines the relationship and the level of difficulty. The difficulty level of each LO will be compared with learner's knowledge so the it can be adjusted.

III. RESULTS AND DISCUSSION

A. System Running

Based on observations and interviews, we found some facts about the existing learning method:

1. Organizers of the workshop will distribute invitations workshop via email with the schedules and quotas of participants to the faculty candidates.
2. Learners who invited are allowed to choose to accept or reject the workshop.
3. Learners who accept the invitation are required to register by sending an email registration.
4. Learners who obtain a seat in a workshop can attend the conventional learning process with the time and place specified. Then they will get a certificate stating that the candidates have followed the workshop.
5. Learners who do not accept the invitation will get the same invitation
6. However, if the workshop is only once, then the learner who do not accept the invitation will not get a chance to be invited to the next workshop.

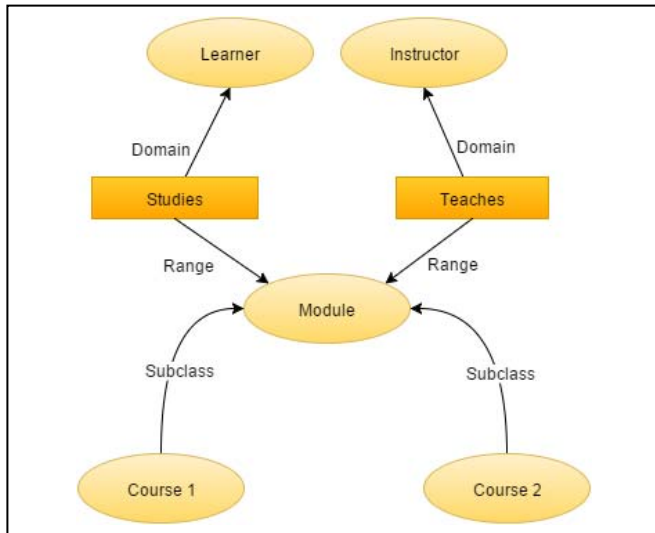


Fig. 1. Ontology E-learning.

B. Problems Encountered

Based on observations and interviews with some learners and users we got several issues:

1. Lecturers will be offered some workshops either from the faculty or human capital development;
2. Offered workshops are often not in accordance with the learner's field of science.
3. The workshops were conducted conventionally, so learners have difficulty in adjusting the schedule.
4. The workshop still using the one size fits all. The workshop generalizes ability of the lecturer.
5. After attending a workshop many learners forgotten the material.
6. No evaluation about workshop effectiveness

The design of ontology-based e-learning prototype is used to determine the learning style and level of content. An overview of ontology in e-learning is shown in Figure 1.

This ontology consists of classes: (1) Learner is lecturer who participated in workshops which has a "studies" property; (2) Instructor who determine the content and difficulty level of the workshop which has a "teaches" property; (3) Module consisting of subclass Course1, Course2, and Course-N, where the module contains learning materials of the courses.

Object properties of this ontology consists of *learner-studies-module* and *instructor-teaches-module*.

C. Prior Knowledge

Characteristics of prior knowledge combine learning programs empirically and analytically.

This stage is designed with the concept of One-group pretest-posttest [6]. At pretest lecturers will be assessed related to the topic of the workshop, for the wrong answer will be given a value of 0 and a value of 1 for the correct answer.

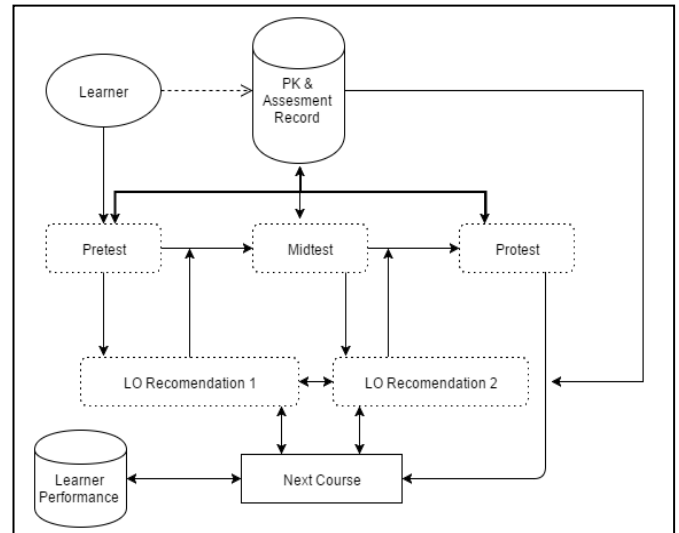


Fig. 2. Prior Knowledge.

Followed by mid-test performed on every LO, and posttest after completion of the workshop.

The results of the pretest, mid-test, and posttest will be stored on a class and used in the analysis to track the progress of learning. This prior knowledge concept was proposed with a reference to the research conducted by Santoso., et.al, 2008 [9] as shown in Figure 2.

"Learner" class described as a list of learner who participated in the workshop, which will be performed a pretest to determine appropriate learning recommendations. Once learners have completed each LO it will perform a mid-test associated with the previous material and used as a reference in determine the next LO. Then at the end of the study, a posttest will be conducted. All data will be stored as a comparison before and after the workshop, and will be used as measurement of the performance of learner after attending the workshop.

D. User Model

User model in this study was inspired by the theory of learning style models developed by Felder-Silverman. Learning styles of each learner are obtained by answering the following questions [1]:

1. What type of information is more easily perceived by learner?
 - Sensing (external) → sights, sounds, physical sensations, or
 - Intuitive (internal) → possibilities, understanding, a hunch
2. Which sense is more effective for learner to receive information from outside?
 - Visual → image, diagram, chart, demonstration, or
 - Verbal → words, sentences, sounds, conversations
3. How do learners process information?

- Active → through physical activity or discussion, or
 - Reflective → through introspection, reflection, think of themselves first
4. How do learners achieve understanding?
- Sequential → the stage step by step, or
 - Global → with a big jump, holistic, see the big picture first

Learners has different learning styles. To define the learning style of each learner, an assessment is carried out. Learner are given questions that will describe the category of learning of each learner. Learners also have preference which in this model is divided into three terms. Language as the main language of learner, convenient color for the learner in using e-learning system, and the concept as method to be used by the learner. Performance will be measured based on the topic of learning, score and the learning time. While abilities will be calculated based on the parameter score obtained by the learner during the learning process and learning time.

At this ontology, will be given a set of questions that can represent each class, so the system can automatically define learning style of each learner.

E. Domain Model

This model specified learning topics sequence. This domain contains properties that describe the topic domain and the relationships between the topics. This ontology contains two main properties, “LessonAfter” and “LessonBefore” to determine the sequence which will be presented to the workshop participants. Difficulty level is depended to the assessment.

User domain intended to obtain a recommendation level of the learner. “MultiplyingCO” is a collection of Content Object (CO) ever taken by learners, AddingCO is the CO that will be received by the learner, EquivalentKnowledge is a parameter that must be met by learner when will make learning to property hasPrerequisites, while class NextCourse is a collection of courses that are relevant to LO with property taken RequiresFor.

F. Content Model

This ontology is applied on the three levels of learning content. Course is the first level, which describes the types of topics and consists of several LO classes with “hasPart” property. The second level is LO, describe some CO classes with “HasCO” property. The last level is the Content Object (CO) describe the class of examples, definitions and references. Metadata classes are defined to represent metadata of the class course, LO and CO. This class is used to describe course, LO and CO through several properties such as name, keyword, level of difficulty and the description [20].

Knowledge class consist of knowledge, course, LO, CO, metadata and learning topic. CO class consists of PassiveCO and InteractiveCO which is a type of delivery CO. InteractiveCO has higher level than the Passive CO, where the

content not only about explanations and giving examples, but also exercises, simulation and test of the learner’s ability.

G. Learning Path

This ontology illustrates learning path through a topic that is on the domain ontology, which is describe the relationship between domain prerequisite topics and topic difficulty level.

During the study session, a learner's knowledge level will be compared with the difficulty level domains topic that has been defined by instructors. The comparison will allow the system to help learners in providing input related to the next topic. With this ontology, learners can define their learning plan and get a course that suitable with the capabilities. Representations learning path is shown in Figure 3.

At this stage, learning style and prior knowledge will become the trigger in defining the concept of learning. Class equivalentknowledge is ability level of learners generated from collection of LO obtained by the learners. MultiplyingLO is course received before the learner get course recommendations that should be taken, while EquivalentKnowledge is a requirement that must be fulfilled by the learners in determining the course in accordance with prerequisite. CourseRecomendation is a class that contains a set of recommendations course that can be taken by learners.

H. Prototipe

In this study, a prototype has been designed to describes the workflow system. This prototype was built in order to understand the features required by the learner.

First, the learner will be asked to register by creating a username and password that will be used to access the system. After registration, the learner will go directly to the home page.

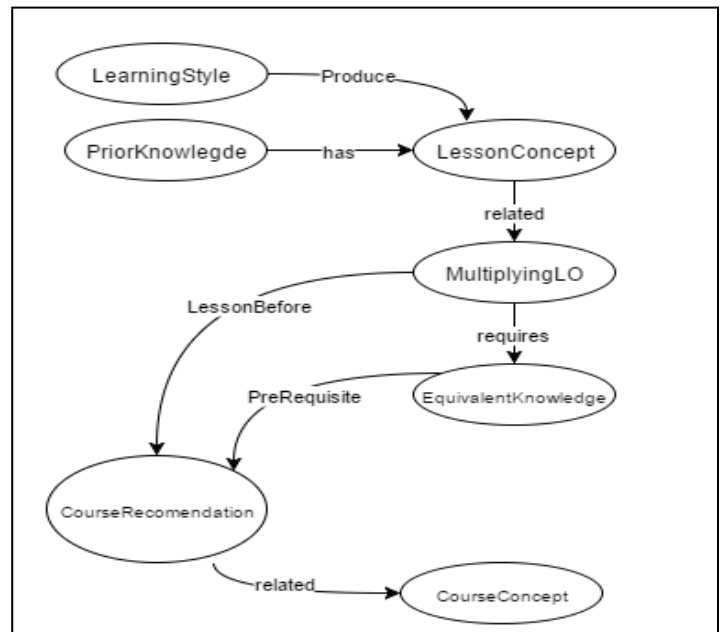


Fig. 3. Learning Path.

On home page, learner will find available courses that can be access. On the My Course menu, learner can choose the courses that are available. Before choose the course, learner will be required to conduct an assessment by answering a few questions that will triggers a preference and learning styles of learners. If the learner already answered the questions, the learner will be able to access the course. On the Forum menu, the learner can conduct discussions with other learners and instructors. On the Course Plan menu, the learner can determine the topic or lesson plan workshop desired. On the Grade menu, there is a list of assessment scores ever taken by the learner. On the E-certificate menu, learner who has completed his course will be able to print a certificate.

On the assessment page, learner will be asked to answer questions to determine the learning style. Learners will be asked to answer some questions that illustrate his preference, and allowed to answer more than one. After answering these questions, the system will directly get the results from the learning style of the learner and the learning material automatically be adjusted base on the results of assessments.

After assessing learning styles, the learner can begin to choose the basic course, but learner have to performing pretest regarding the course taken, then the learners will receive personalized course materials based on the initial capabilities and adapted to the learning style of the learner. In this page, learners will get content delivery that is personalized based on the characteristics of learners.

IV. CONCLUSIONS AND SUGGESTIONS

A. Conclusion

Nowadays, most of e-learning systems are still a 'one size fits all' system. In fact, every learner has different initial ability (prior knowledge). This issue raises a need for a self-learning system that is appropriate to the abilities of each learner. To design an adaptive learning, we should understand the methods to deliver content according to the needs of learners.

A model designed in this study is a prior knowledge, user models, domain models, content models and learning path models. Then proceed with the design of the display prototype to determine system workflow. Prototype to simulate the ontology used in this research is still in the development stage and will be evaluated in future studies.

B. Suggestion

It is better to divide the ontology development into separate content models, so that we can build a flexible and independent content models. E-learning system will provide more usability if the user is given the opportunity to reflect on the learning process in person.

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