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Developing adaptive hypermedia system based on learning design level B with rules for adaptive learning activities

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Abstract. For recently years the research of adaptation of computer education has been an important topic. Although Adaptive Educational Hypermedia Systems (AEHS) are different disciplines with IMS Learning Design (IMS LD), they have the same goal is to create the best possible environment for a learner to perform his/her learning activities in. How IMS LD addresses many requirements for computer based adaptation and personalized e-Learning is one of the main concerns for researcher in this field. This paper represents an approach to learning design for adaptive learning system for adaptation of learning activities. Constructing set of rules for learning activities adaptation represented in first order logic, and mapping them into IMS LD specification. In addition, an adaptive course of computer science domain in online context is implemented using IMS LD design.

Keywords: Adaptive rules, Adaptive Hypermedia.

1. Introduction

In adaptive educational hypermedia, there are a variety of research works about questions on how to adapt curricula and learning content to individuals and groups of learners has been done. There are methods and techniques has been promoted and implemented for adaptive hypermedia system [1]. In most adaptive educational hypermedia applications a learner model is the basis for the adaptation. This adaptation process based on each learner individually, to his/her knowledge, needs, preferences, learning styles, etc., conforming to learner-centered education [2]. Our researches [3-5] also had been developed adaptive educational hypermedia application that focused on generate content adaptation for learners. However, such approaches have tended to be highly specific in their implementation, hampering comparison and extension of results in the field, How IMS LD addresses many requirements for computer based adaptation and personalized e-Learning is one of the main concerns for researcher in this field. From the proposed specifications, the IMS LD has emerged as the de facto standard for the representation of any learning design that can be based on a wide range of pedagogical techniques [6]. Daniel Burgos et

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all. state that describe a group of features in the Levels B and C of the specification that make possible diverse types of adaptation such as Learning flow based, content based, interactive problem solving support, adaptive user grouping, adaptive evaluation and changes in runtime [2]. Within LD, there are at least four areas where a unit of learning could be tailored to individual learners based on their learning characteristics: i) to change the environment for different learners — providing different resources, or the same resources in a different order. ii) to change the method for different learners. iii) to slot different learners into different roles, or provide support from different roles for different learners. iv) to change the activities given to different learners [7].

This paper represents an approach to learning design for adaptive learning system; it focuses on design adaptive rules for learning activities. These rules are represented in first order logic. Mapping adaptation rules to IMS LD specification level B. Additionally, an adaptive course of computer science domain in online context is implemented using IMS LD design. The rest of paper is structured as follows: In the next section, overview LMS LD specification as well as structure of it is described. How to design and mapping adaptive learning activities with learning design with a set of rules is represented first order logic, describe in section 3. Next, our implementation with adaptive course generation system to generate adaptive course for each learner's based on learner's knowledge and learner's learning goals represents in section 4. Finally, conclusion and future work is pointed out.

2. Learning Design Specification Overview

IMS LD specification [8] drawn up by the IMS/LDWG work group, is an integration of the EML developed by the Open University of Netherlands, describes the structure and educational processes based on a pedagogic meta-model, using units of learning called Learning Design [10]. It describes a method that is made up of a number of activities carried out by both learner and staff in order to achieve some learning objectives.

A Unit of Learning (UOL) refers to a complete, self-contained unit of education or training, such as a course, a module, a lesson, etc. It includes a manifest file in which contains: metadata, learning design for organization, learning resources and physical files contain actual content in various file type such as html, media, activity description, etc. The learning-design element, as well as having a title, learning-objectives, prerequisites and metadata elements, also includes a components and a method element. This has the two main and largest structures in LD. The component includes the three components originally identified as the main elements of the language: i) roles which indicate role of who participants in learning process such as: teacher, student, tutor, etc. ii) Activities which tell what the role should do with any items included in the environment iii) environments which hold references to the resources and services used by activities. The Method holds the workflow or 'learning flow' for the learning design, and contains three main nested elements: i) play: as in a theatrical play, consists of acts even though it can be contains only one act, ii) act: run in sequence, with one starting when the previous act has finished, and the play ends with the completion of the last act. An act includes one or more role-parts iii) role-part: A role-part

simply has two reference links; one refers to a role and the other to the activity that the role is to perform in the act [9].

IMS LD consists of three levels A, B and C [10]. These levels allow modeling UOL, focused on collaboration, adaptation, adaptability or any other pedagogical method. Every level adds to the previous one a number of extra features that provide a richer and more complex scenario. Furthermore, Level A provides method, plays, acts, roles, role-parts, learning activities, support activities and environments; Level B provides properties, conditions, calculations, monitoring services and global elements; and Level C provides notifications. Rest of this section details level B structure, which is suitable for adaptation process because Level A has only very limited support for personalization and adaptation.

2.1. Learning design level B

There are a lot of elements that level B adds to level A: i) Properties to store information from users and groups of users. ii) Global elements to set and view the information stored in properties. Properties can be read by the user himself or by others. iii) Monitor service to read the properties of other persons or yourself. iv) Conditions that work on property values to adapt or personalize a variety of elements within or outside the learning design [11].

Properties are taken as variables to store values. There are several types of properties: local, local-personal, local-role, global-personal, global. There is also a property-group that is able to compile a number of the others.

Global elements provide a communication flow between the imsmanifest.xml, where the different levels of IMS LD are set-up, and other XML files. Global elements are used to set and view property values or the values of the properties that are sequenced in property groups. The global element includes: view-property /view-property-group and set – property/set- property-group. The former property to get value of the property, the later property to set value of property at run time via automatically input control generated.

Monitoring services allows monitoring any kind of property assigned to a user or a role. When viewing or setting these properties it must be specified which property values have to be viewed or set: the property of the person himself or the properties of other persons within the same role.

Conditions are the basic mechanism to specify the dynamic behaviors in the unit of learning. Conditions are 'if – then – else rules' within the IMS manifest file to adapt or personalize the activities or resources or to calculate property values.

3. Designing adaptive learning system with learning design

3.1. What can be adapted?

Outcome of early researches find out there are two kinds of adaptation technologies as adaptive presentation and adaptive navigation support. The first technology use to customize course content to match learning characteristics specified by the user model. It includes two techniques are adaptive multimedia presentation and adaptive text presentation. The second technology attempts to guide the learner through the system by customizing the link structure or format according to a learner model. It includes some techniques such as: direct guidance, adaptive sorting of links, adaptive hiding of links, adaptive annotation of links, map adaptation [1]. Therefore, many adaptive applications in education which based on techniques have been implemented [12-14].

In respect of learning theory there are four main approaches to adaptive learning [15, 16]: i) macro-adaptive, selecting a few components that define the general guidelines for the e-Learning process, such as learning objectives or levels of detail and mainly based on learner model; ii) aptitude-treatment proposing different types of instructions and/or different types of media for different students; iii) micro-adaptive, diagnosing the student's specific learning needs during instruction, providing instructional prescriptions for these needs and monitoring the learning behavior of the student while running specific tasks and adapting the instructional design afterwards, based on quantitative information; iv) constructivist-collaborative, focused on how the student obtains knowledge while sharing knowledge and activities with others as well as consider the context, learning activities, cognitive structures of the content, and the time extension.

An initial analysis [8] describes four areas in IMS LD where some kind of adaptation could take place: environment, method, roles and activities. There are many activities in learning educational course [17]: 1) lesson delivers content in an interesting and flexible way. It consists of a number of pages. Each page normally ends with a question and a number of possible answers. 2) Assignments use to require learner need to finish one or more tasks and use to evaluate learner. 3) Forum is here that most discussion takes place Forums can be structured in different ways, and can include peer rating of each posting. Teachers can impose subscription on everyone if they want to. 4) Journal is a very important reflective activity. The teacher asks the student to reflect on a particular topic, and the student can edit and refine their answer over time. This answer is private and can only be seen by the teacher, who can offer feedback and a grade on each journal entry. 5) Questionnaire or survey provides a number of verified survey instruments that have been found useful in assessing and stimulating learning. 6) Testing to observe and evaluate whether learner pass the module/ course or not.

3.2. Rules for adaptation

In this section, we describe rules for adaptive learning activities of our model Adaptive Course Generation System (ACGS) [3, 4] in First Order Logic (FOL) which is a symbolic reasoning in which each sentence, or statement, is composed of a subject and a predicate [18] with extended rules for adaptive learning activities. Adaptation process is based on learner's knowledge. The course had hierarchically structured, it includes some chapters, each chapter has some sections, and subsections. Each section/subsection consist one or more concepts and activities, and test-items. Kind of activities are various for each chapter and type of the course.

Nicola Henze et.all. [19] described adaptive functionality by some components that are: i) document space for underlying hypermedia system, ii) observations – the runtime information which is required, iii) user model for representing learner' characteristics. This research also model an AEHS is Quadruple (DOCS, UM, OBS, AC) based on first order logic with DOCS: Document Space belonging to the hypermedia system, UM: Learner Model describes and infers information, learning's goal, skill, preferences etc. about learner, OBS: Observation about user interactions with AEHS, and AC: Adaptation Component rules for adaptive functionality.

3.2.1. Document Space

Document Space of ACGS consists of documents, test-items, concepts, and activities.

For each document, there can be more than one concept. Activity has some role or type of activities, one or more concepts involve with one or more activities:

$D_1,\ldots,D_n, C_1, \ldots, C_m, A_1, \ldots, A_k, TI_1, \ldots, TI_s$ (with D_i represent document, C_j for concept, A_k for activity and TI_i for test-item).

Now we describe more detail relationship among element of document space follows:

1. Part-of: partOf (D_i,Dj):Dj is the set of documents which are sub-document of D_i, for certain $D_i \neq D_j$

2. Successor: successor (D_i, D_j):D_j is the next document of D_i in the consequence for certain D_i and one $D_i \neq D_j$

3. No sub-document: nosub(D_i):D_i has not any sub- document for certain D_i

4. Prerequisite: preq(D_i, C_j):C_j that is necessary for learning D_i for certain D_i, C_j

5. Prerequisite: preq(TI_i, C_j):C_j that is necessary for finishing TI_i for certain TI_i, C_j

6. Prerequisite: preq(A_i, C_j) :C_j that is necessary for executing Ai for certain A_i, C_j

7. Require: req(D_i, C_j):C_j should be learn in D_i for certain D_i, Cj

8. Require: req(TI_i,C_j):C_j should be learn thoough TIi for certain TI_i, C_j

9. Require: req(A_i, C_j):C_j should be learn thoough Ai for certain A_i, C_j

10. Role: role(A_i, lecture):A_i is lecture for certain A_i

11. Role: role(A_i, assignment) :A_i is asssignment for certain A_i

12. Role: role(A_i, forum):A_i is activity to paarticipant forum for certain A_i

13. Role: role(A_i, journal):A_i is activity to paarticipant journals for certain A_i

14. Role: role(A_i, survey):A_i is activity to paarticipant survey for certain A_i

15. Pass: passed(C_j, value):A numerical value indicating a number of activities such as lecture/assignment that learner passed for certain C_j

16. Pass: passed(D_j, value):A numerical value indicating a number of concepts that learner learned for certain D_j

17. Enroll: enrolled(C_j, value):A numerical value indicating a number of activities such as forum, journal, survey that learner enrolled for certain Cj

3.2.2 Observations

Based on knowledge of learner, we distinguish between different knowledge levels of learner acquire about a domain concept Ci. These levels are: none if a learner has not learned a concept at all, beginner if learner only read lecture but not take any activities or not pass, intermediate if a learner read more about the lecture and pass some activities, advanced if a learner read more about the lecture, and pass all of activities related to the concept, and expert if the learner has performed tests and activities related to the concept successfully. There are some observation rules for ACGS:

obs(Dj, Ui, Visited): A learner can visited a document Dj for certain Dj, Ui

obs(Aj, Ui, Passed): A learner can passed an activity Aj for certain Aj, Ui

obs(Aj, Ui, Enrolled): A learner can enrolled an activity Aj for certain Aj, Ui

obs(TIj, Ui, Worked): A learner can worked an test-item TIj for certain TIj, Ui

obs(TIj, Ui, Solved): A learner can solved an test-item TIj for certain TIj, Ui

obs(Cj, Ui, Beginer): A learner is beginner about concept for certain Cj, Ui

obs(Cj, Ui,, Intermediate):A learner is intermediate about concept for certain Cj, Ui

obs(Cj, Ui, Advanced):A learner is advanced about concept for certain Cj, Ui

obs(Cj, Ui, Expert):A learner is expert about concept for certain Cj, Ui

obs(Cj, Ui, Learned):A learner learned about concept for certain Cj, Ui

obs(Dj, Ui, Learned):A learner learned about document for certain Dj, Ui

3.2.3 User model

In order to classify learner base on his/her knowledge, some rules described:

A learner U_i is beginner if learner is not read any a page about this concept or only read a page about that.

$\forall C_j \forall U_i$

$(\exists D_k$ obs $(D_k, U_i,$ Visited$) \wedge$ req $(D_k, C_j)) \vee (\forall D_k \neg obs(D_k, U_i,$ Visited$) \Rightarrow$ p_obs$(C_j, U_i,$ Beginner)

With p_obs is notation for processing observation.

A learner U_i is intermediate if learner read about a concept C_j on two different documents and passed some activities of the course.

$\forall C_j \forall U_i$

$\exists D_k \exists D_l \neg (D_k = D_l) \wedge$ obs$(D_k, U_i,$ Visited$) \wedge$ obs$(D_l, U_i,$ Visited$) \wedge \forall A_k$ req$(A_k, C_j) \exists A_i \exists A_j \neg (A_i = A_j)$ obs$(A_i, U_i,$ Passed$) \wedge$ obs$(A_j, U_i,$ Passed$) \Rightarrow$ p_obs$(C_j, U_i,$ Intermediate)

A learner U_i is advanced if learner read more about documents involved concept C_j, passed all of activities related this concept and passed at least one test belonging to a concept.

$\forall C_j \forall U_i$

$\exists D_k \exists D_l \neg (D_k = D_l) \wedge$ obs$(D_k, U_i,$ Visted$) \wedge$ obs$(D_l, U_i,$ Visted$) \wedge \forall A_k$ req$(A_k, C_j) \wedge$obs $(A_k, U_i,$ Passed$) \wedge \exists TI_l$req$(TI_l, C_j) \wedge$ obs$(TI_l, U_i,$ Solved$) \Rightarrow$ p_obs$(C_j, U_i,$ Advanced)

A learner U_i is expert if learner read all about documents involved concept C_j and passed all of activities and passed all of test item related this concept.

$\forall C_j \forall U_i$

$\forall D_k$ req$(D_k, C_j) \wedge$ obs$(D_k, U_i,$ Visited$) \wedge \forall A_k$ req$(A_k, C_j) \wedge$obs$(A_k, U_i,$ Passed$) \wedge \forall TI_l$ req (TI_l, C_j) obs $(TI_l, U_i,$ Solved$) \Rightarrow$ p_obs$(C_j, U_i,$ Expert)

A concept has been learned by learner when learner read about all documents belonging to concept, passed and enrolled a number of activities, and solved some test-item related concept.

$\forall$Cj$\forall$Ui

$\forall$Dk$\forall$Dl req(Dk, Cj) $\wedge$ req (Dk, Cj) $\wedge$obs(Dk, Ui, Visited) $\wedge$ obs(Dl, Ui, Visited) $\wedge$ passed(Cj, Value) $\geq \partial \wedge$ enrolled(Cj, Value) $\geq \theta \wedge \exists$TIl req(TIl, Cj) obs (TIl, Ui, Solved) $\Rightarrow$ p_obs(Cj, Ui, Learned)

With ∂, θ symbol is threshold that decided by teacher or course designer.

A document has been learned by the learner when learner learned a number of concepts belonging to the document.

$\forall$Ak$\forall$Cj $\forall$Dj$\forall$Ui

$\forall$Ak req(Ak, Cj) $\wedge$req(Cj, Dl) $\wedge$ passed (Dj, Value) $\geq \partial \Rightarrow$ p_obs(Dj, Ui, Learned)

3.2.4. Adaptation Component

In this paper we only focus on adaptation component for learning activities with adaptive activity annotation. About adaptive content generation, we presented in [5]. For adaptive activity annotation, we use different notes at each activity to indicate a learner had enrolled or passed activity and give advice to the learner which activity that he/she needs to do.

A "Omited" note links to activity represents that a learner has expert knowledge all of the concepts belonging to a document, so learner can not take activity.

∀Ak∀Ui

∀Dl∀Cj req(Dl,Cj) ∧ preq(Ak, Cj) ∧ obs(Cj, Ui, Expert)⇒activity_annotation(Ak, Ui, Omited)

A "Can omit" note links to activity represents that learner has a least advanced knowledge all of the concepts belonging to a document, so learner also can not take any activities.

∀Ak∀Ui

$\forall D_l \forall C_j$ req(D_l,C_j) ∧ preq(A_k, C_j) ∧ obs(C_j, U_i, Advanced)⇒activity_annotation(A_k, U_i, Can omited)

A "Need" note links to activity represents that learner has a least intermediate knowledge all of the concepts belonging to a document, so learner need to take activity.

$\forall A_k \forall U_i$

$\forall D_l \forall C_j$ req(D_l,C_j) ∧ preq(A_k, C_j) ∧ obs(C_j, U_i, Intermediate)⇒activity_annotation(A_k, U_i, Need)

A "Must" note links to activity represents that learner has a least beginner or no knowledge all of the concepts belonging to a document, so learner must be take activity.

$\forall A_k \forall U_i$

$\forall D_l \forall C_j$ req(D_l,C_j) ∧ preq(A_k, C_j) ∧ obs(C_j, U_i, Beginner)⇒activity_annotation(A_k, U_i, Must)

A "→" icon links to activity represents that activity is must be enroll if all its prerequisites are known to learner with intermediate knowledge.

$\forall A_k \forall U_i$

$\forall D_l \forall C_j$ req(D_l,C_j) ∧ preq(A_k, C_j) ∧ obs(C_j, U_i, Intermediate) ∧ ¬obs(A_k, U_i, Enrolled)⇒ activity_annotation(A_k,U_i, "→")

A "→pass" icon links to activity describe that activity is must be enroll and passed if all its prerequisites are known to learner with beginner knowledge.

$\forall A_k \forall U_i$

$\forall D_l \forall C_j$ req(D_l,C_j) ∧ preq(A_k, C_j) ∧ obs(C_j, U_i, Beginner) ∧ (¬obs(A_k, U_i, Enrolled) ∨ ¬obs(A_k, U_i, Passed)) ⇒ activity_annotation(A_k,U_i, "→pass")

A "→ad" icon links to activity represents that activity is recommend to participate if all its prerequisites are known to learner with advanced knowledge.

$\forall A_k \forall U_i$

$\forall D_l \forall C_j$ req(D_l,C_j) ∧ preq(A_k, C_j) ∧ obs(C_j, U_i, Advanced) ∧ ¬obs(A_k, U_i, Enrolled) ⇒ activity_annotation(A_k,U_i, "→ad")

3.3. Mapping adaptation rules for learning design level B

In this section, we represent adaptation rules in adaptation component which aforementioned in learning design level B condition elements. The first rule describes in section 3.2.4, is presented in condition element as follows:

```
<conditions>
<if>
<is>
<property-ref ref= "Learner level">
<property-value>Expert</property-value>
</is>
</if>
<then>
<show>
<learning-activity ref ref= "Omitted">
</show>
</then>
```

Correlatively, three next rules for representing activity's status are easily mapping. Likewise, the rule for representing activity status such as fifth rule aforementioned:

```
<conditions>
```

```
<if>
<is>
<property-ref ref= "Learner level">
<property-value>Intermediate</property-value>
<property-ref ref= "Enrolled">
<property-value>No</property-value>
</is>
</if>
<then>
<show>
<learning-activity-ref ref= "Must be enroll">
</show>
</then>
```

4. Implementation

In this section, we present adaptive course generation system architecture which improves adaptation engine of our ACGS model [2]. Furthermore, we also outline experiments when deploying this model for adaptive hypermedia educational course for learners who are third-year students. The course subject is C/C++ Programming with syllabus based on [20]. In online course, in order to finish the course, learner not only need to know about the course content but also need to participate in course learning activities such as: assignments, forum, journal, survey, etc.

4.1. Adaptive course generation architecture

ACGS includes three modules: Learner Module, Visualization Module and Adaptation Module as depicts in figure 1. Learner Module designed to get learner's demand such as learning goals, preferences, etc. and to evaluate learner's knowledge. Learner's information is stored into learner's profile which based on learner model. Visualization Module takes adaptive course outlines for displaying them as annotated hypertext links in the website to learner. Adaptation Module asks domain concepts from Learning Object Database as well as asks learner's knowledge, and learner's learning goals to generate course structure. Only is Adaptation Module focused in this section, others module described in [3, 4].

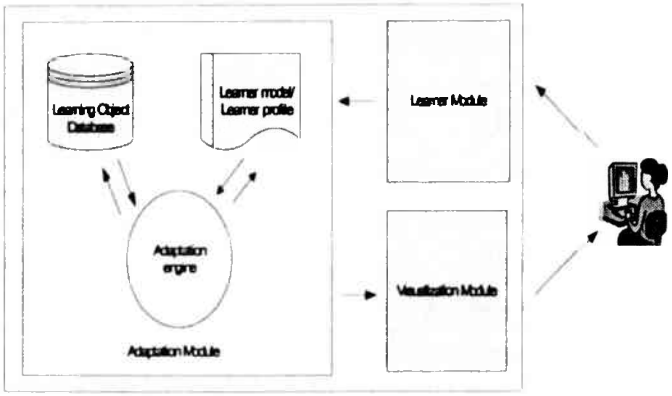

Fig. 1. ACGS Architecture.

4.2. Modeling courses

Each course consist several concepts about one domain. Each concept can include lectures as documents and activities such as assignment, questionnaire, forum, journal, etc. To finish the course, a set of learning goals is defined. The learner finishes the course when he/she acquire learning goals completely.

Based on IMS learning design, Method representing the ACGS approach has a Play made up a set of sequential Acts. Each act includes Role-Parts that relate roles with activities. For instance, C/C++ programming course includes three acts: i) C-Pre: in this act, student takes several questionnaires and test as well as choose his/her learning goals of domain concept. ii) C-P1 contains Study, Do-Activities, and Evaluate role parts, this act requires student study course material, participate learning activities, and takes assignment. iii) C-P2 includes exam, another learning activities such as forum, poll to survey learner's satisfaction about adaptive course. Method, Plays, and

excerpt of Acts of the C/C++ programming course depicted in Figure 2.

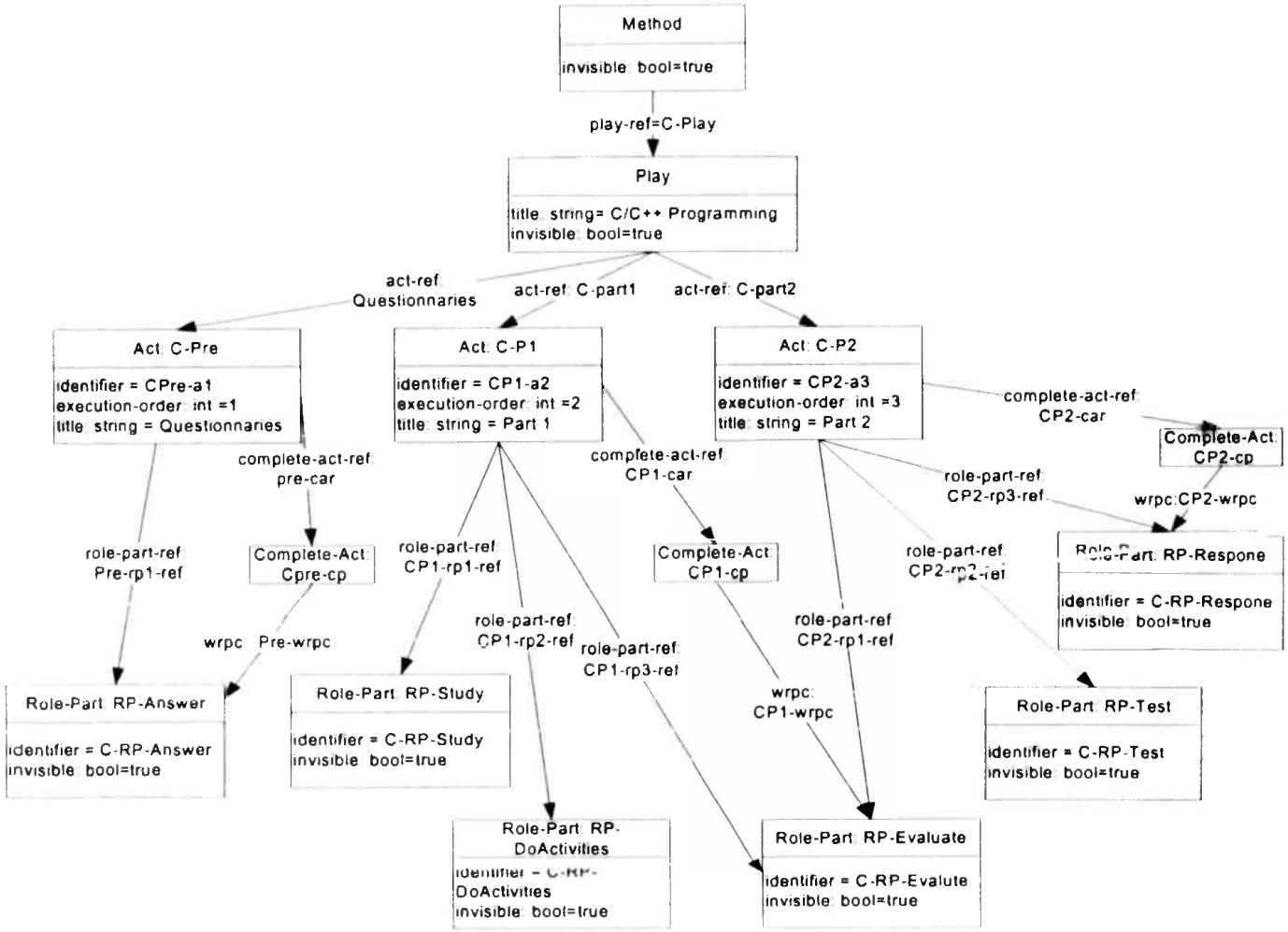

Fig. 2. An excerpt of definition of method, plays, and acts of C/C++ programming course.

Each Role-part includes Support Activity, Learning Activity and Activity Structure [8]. For example, in the Pre acts of C/C++ programming course would be to verify the student's level of knowledge in order to generate content of the course. In this case, learning activity consists of 30 questions as multi-choice form in 20 minutes for student. Interface of this activity is depicted in Figure 3.

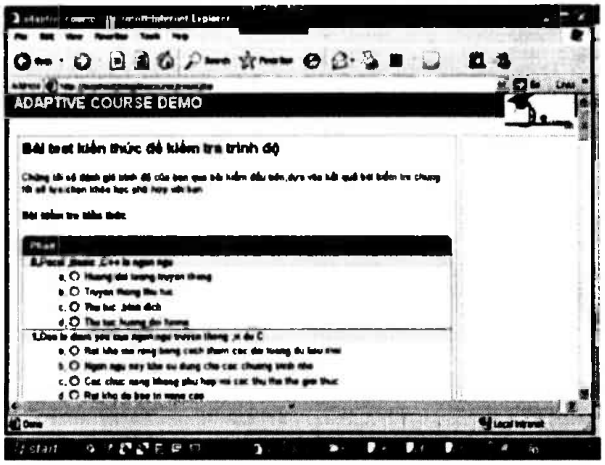

Fig. 3. Questionnaires to verify-level student's knowledge.

4.3. Adaptation engine

Adaptation process selects learning resources through phases. First of all, learning resources that stored in metadata file are selected base on learner profile and adaptation rules which aforementioned. Secondly, according to adaptive navigation technique, one ore more techniques is selected such as hiding, annotation or direct guidance in order to input for visualization module to display the course. Finally, student activities response will be updated in his/her profile which is basic for adaptation process in next run-time learning activities. Figure 4 depicts excerpt main activities of adaptive engine.

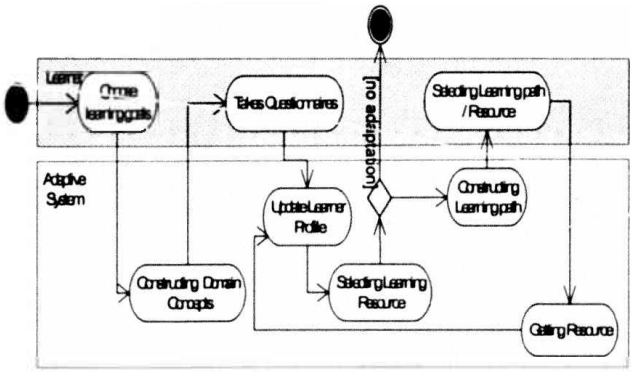

Fig. 4. An excerpt activities of adaptive engine.

4.4. Experiments and early results

We use RELOAD learning design editor tool [21] to design course overview, roles, properties, activities, etc. Figure 5 depicts interface screen shot for designing learning activities.

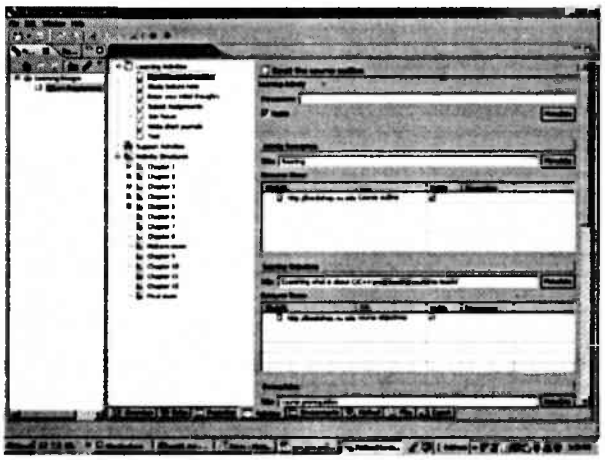

Fig. 5. Interface for design activities of RELOAD tool.

There are approximately forty students participated in the course. The survey examines several aspects such as structure, Interface, adaptive ability, and meets learner demand. Although to precisely evaluate each adaptive course is met learner demand is tough problem at this time, table 1 outlines survey outcome.

Table1. Student survey results about C/C++ programming course

Aspects	Very satisfy	Satisfy	Protest
Structure	8 (20%)	32 (80%)	0%
Interface	10 (25%)	28 (70%)	2 (5%)
Adaptation	12 (35%)	26 (60%)	2 (5%)
Meet demand	15 (38%)	21(52%)	4 (10%)

5. Conclusions and future work

This paper aims to find out the how to design adaptive learning activities rules as well as how to use IMS LD for designing an AEHS. The main contribution of this paper is a method to design AHES by using IMS LD level B. First, a set of adaptive activities rules is designed in first order logic language to adapt based on learner's knowledge and learner's learning goals. Secondly, map adaptation rules to IMS LD specification. Next, modeling the course follows IMS learning design and finally, using a tool to edit implementation. The more precisely experiment results as well as how evaluate whether selected adaptive course met learner's demand or not will find out in coming papers.

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Xây dựng hệ thống học thích nghi dựa trên thiết kế khóa học mức B sử dụng tập luật để thích nghi hoạt động học tập

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Những năm gần đây, các nghiên cứu xây dựng khóa học thích nghi trong học điện tử đang là chủ đề được quan tâm. Các hệ thống học thích nghi trong giáo dục có một số điểm khác biệt với cách thiết kế các khóa học điện tử theo chuẩn IMS (IMS LD). Tuy nhiên mục tiêu của các hệ thống này đều nhằm tạo ra môi trường học điện tử tốt nhất cho người học khi tham gia các hoạt động học tập. Làm thế nào để các thiết kế khóa học điện tử theo chuẩn IMS có thể hỗ trợ trong việc xây dựng các khóa học thích nghi theo nhu cầu người học. Bài báo này trình bày cách tiếp cận sử dụng IMS LD để xây dựng hệ thống học thích nghi các hoạt động học tập phù hợp với người học bằng cách xây dựng tập luật logic để mô tả hệ thống học thích nghi, quá trình lựa chọn các hoạt động học tập và tiến hành ánh xạ các tập luật này sang đặc tả theo chuẩn của IMS LD. Ngoài ra, bài báo trình bày thử nghiệm hệ thống xây dựng khóa học thích nghi cho một khóa học thuộc lĩnh vực máy tính.

Từ khóa: Luật thích nghi, Học thích nghi.