An Extension of Learning Object Model Focusing on Learners' Perspective

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ABSTRACT

Instructional designer must identify specific objectives with meaningful teaching and learning strategies from learners' perspective. Underlying models of preceding researches do not have sufficient pedagogical components such as instructional strategy classification to describe our unit of learning. To solve this problem we considered additional elements with existing meta-model. The purpose of this study is to describe an extension for learning object meta-model specific to learning activities, to help instructional designers select strategy in various situations where they are working with existing assets.

INTRODUCTION

Although virtual learning environment such as Learning Management System (LMS) enriches surfaces of media for learning, some questions are raised from pedagogical perspectives. To transform teaching materials into a digital form does not mean the meaningful learning will occur. Emerging learning environment such as virtual classrooms, increases the demand to optimize features of systems with various learning tasks which are characterized as learning types. Object model will helps designers to understand associations of related elements and their attributes and to find cues for re-use of existing designers' assets such as data packages or external materials appropriate for learning objectives. The purpose of this paper is to describe an extension of part of meta-model which makes designers work effectively and efficiently with a conceptual understanding of strategies observed in learning contexts. There are several ways to view learning "object." [7] [8] We propose additional learning object model elements that extends preceding research of Koper *et al* to apply the extended object model to wider learning contexts such as collaborative learning. We described an extension of learning activity to be able to express educational settings such as lessons with various strategies.

METHOD

Instructional designer must identify not only generic objectives but also specific objectives with meaningful strategies from learner's perspective. The purpose of this study is to describe an extension for learning object meta-model to help instructional designers to understand strategies they can observe in the learning contexts. To this purpose we adopt to extend meta-model with UML notations.

REQUIREMENTS

Requirements for the extension of the learning object model is to provide:
1. Pedagogical expressiveness: The extension must be able to express pedagogical meaning of the model elements within any learning contexts such as on-campus classroom or virtual learning environment.
2. Capability for Modeling: The extension must be able to suggest introducing other model components as model with instruction-specific attributes such as Events of Instruction [4].
We aim to link abstract model components with practical concrete model components which correspond to useful pedagogy along with instructional theories in action.

WHAT IS A LEARNING OBJECT?

There are several ways to view learning "object." According to Wiley (2000) [14], learning objects are considered as elements of a new type of computer based instruction grounded in the object-oriented paradigm of computer science. To facilitate the adoption of the learning objects approach, the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) formed in 1996 to develop and promote instructional technology standards [5]. At the same time, the Instructional Management Systems (IMS) Project was beginning developing technical standards to support the deployment of learning objects. The Learning Technology Standards Committee (LTSC) defines the term "learning objects" to describe instructional components, and provided a working definition: Learning Objects (LO) are defined here as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning. Examples of technology-supported learning include computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance learning systems, and collaborative learning environments. Examples of Learning Objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning. Wiley (2000) pointed out that during standards development some questions raised regarding the current standards' lack of ability to express instructional ability which means taking individual learning objects and compose them in a way that make instructional sense.[14] Sampson and Karagiannidis [12] pointed out that the current version of Object Metadata does not include instructional information. That is, learning objects are described rather as content objects, since their instructional "value" is not included in their description. We consider this situation rather requires us to introduce meta-model that suggests instruction-specific extensions which will help instructional designers in practice. Because the LTSC prescribes a variable named educational which is defined as "educational and pedagogic characteristics of the learning object." We agree with the importance of identifying objects' characteristics and think there is additional dimension with learning objects based on learner's viewpoint. That is delivery mode in which education is carried out. As virtual learning environment such as LMSs become popular increasing demand for hybrid learning which utilizes traditional on-campus classroom environments together with eLearning environments. Because of being able to select various strategies, we apply LO (Learning Object) concepts to broader contexts than that of digital processing domain.

LEARNING OBJECT TYPES

One of our major concerns is to differentiate types of learning objects to some extent to implement concrete design specifications for instruction. To this purpose we refer to Koper's work which consists of meta-models, and extended "learning activity" type, because of the meta-model's instructional expressiveness. We would like to describe brief review for Koper's unit of study model.

UNIT OF STUDY META-MODEL

Koper addressed learning experiences are offered mostly in chunks, like courses. These chunks are the major delivery units for e-learning. From a design perspective, the course is the aggregate containing all the necessary features to make learning successful. The concept of 'unit of study' is the smallest unit providing learning events for learners, satisfying one or more interrelated learning objectives. In practice you see units of study in all types, sorts and sizes: a course; a study program; a workshop; a lesson could all be considered to be a unit of study.[7] Koper provided a containing framework and a model to express the semantic relationship between the different types of objects in the context of use in an educational setting.

PEDAGOGICAL META-MODEL

Pedagogical meta-model is a model which models pedagogical models. This means that pedagogical models could be described (or derived) in terms of the meta-model. There are four packages:

1. The learning model, which describes how learners learn based on commonalities (consensus) in learning theories.
2. The unit of study model, which describes how units of studies which are applicable in real practice are modelled, given the learning model and given the instruction model.
3. The domain model, which describes the type of content and the organization of that content. For example, the domain of economics, law, biology, etc.
4. Theories of learning & instruction, which describe the theories, principles and models of instruction as they are described in literature or as they are conceived in the head of practitioners. Of the four models above we concentrate on the unit of study model because of practical importance of unit. After "Modeling Units of Study from a Pedagogical Perspective" [7], Koper and Oliver presented the conceptual structure of the Learning Design (LD) specification.[8] that is defined as an application of a pedagogical model for a specific learning objective, target group and a specific context or knowledge domain. The learning design specifies the teaching-learning process. The core concept of LD is that a learning design can be represented by using the following core concepts: A person gets a role in the teaching-learning process, typically a learner or a staff role.

AN EXTENSION OF LEARNING ACTIVITY

The major concern for the extension of model derived from LD specification is to help instructional designer select learning strategy within his/her working environments. Figure 1 illustrates the focus of extension that derived from Koper's work.

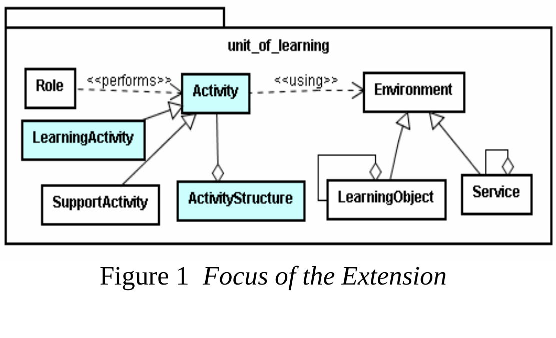

Figure 1 *Focus of the Extension*

Especially we concentrate on Learning Activity in order to utilize strategy selection with observable instances in learning contexts. Based on learning and teaching experiences and research [1][2][3][4][5], we assume the following relationships. (See TABLE 1) We apply the idea of 'power object' with learning activity. Power object is a object whose instances are subtype of another object type. [10] Preceding six relationships introduce the extension as follows (Figure 2).

TABLE 1 Relationship between components

Relationship No.	Description
1	Learning Acitivity is classified as Activity Type from learners perspective.
2	Learning Acitivity Type is generally found in Learning Context which employs Learning
3	Activiity Type is identified using Learner's Action Type.
4	Learning Acitivity is found in Learning Context.
5	Learner's Action Type is classified by Instructional Theory
6	Learning Acitivity uses Strategy

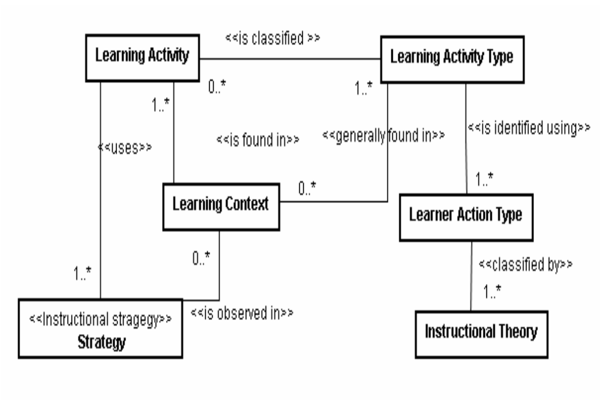

Figure 2 *Extension of Learning Activity*

Regarding the relationship No. 2 Learning Activity is generally found in Context which employs Learning Object and Strategy, we recognize Events of Instruction [4] which require specific action taken, within learning context.

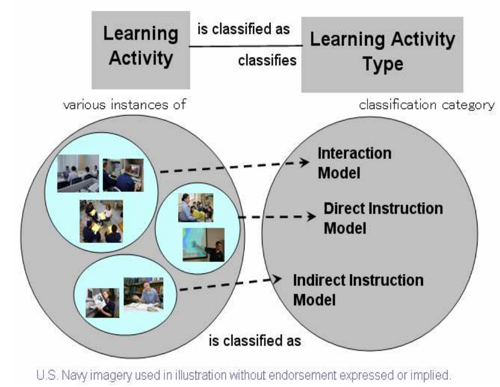

Figure 3 *Learning activity is classified by activity type*

Figure 3 depicts an image of relationship between the meta-model and model as defined instance of meta-model. The circle on the left of Figure 3 illustrates the image of learning activities. Learning activities are carried out with strategies embedded within actual procedures which represent Activity Structure in the unit of learning specification. Learning Activity is classified as Learning Activity Type which instantiates models such as "Interaction Model" or "Dick, Carey & Carey Model ." Given the analysis above we typed learning activity in five categories (see TABLE 2) The first column indicates the learning object type. The second column provides the multiplicity in UML notation that means the possible occurrences within the context of a unit of learning (0..* means: zero or more).

TABLE 2 Learning object types for extension

Learning object type	Multiplicity	Function
Activity	1..*	The prescription of the actions to be carried out by the different roles. Different subtypes: learning activity, support activity and instrumental activities.
Learning activity	1..*	Subtype of Activity. Educational procedure designed to stimulate learning by firsthand experience.
Learning Activiity Type	1..*	Type whose instances are subtype of Learning Activity. Classification system of learning activities.
Learner Action Type	1..*	Type whose instances are subtype of learner's mental or physical operations. In educational setting stands for performance type.
Strategy	1..*	Type of methods that enable learning object to manage Learning

Learning activity type as classification systems enable us to accept multiple strategies classification domains with the idea of power types.

APPLICATION

When design a unit of learning, instructional strategy is a plan for exposing learners to experiences that will help them acquire certain performances such as verbal information, establishing cognitive skills , developing intellectual skills, motor skills, or attitudes. Establishing instructional strategies help instructional designer conceptualize time-consuming works before beginning them. Instructional strategy is rooted in assumptions about what should be happen during planned learning experiences. [11] The relationship No.5 "Learner's Action Type" on TABLE 1 is classified by Instructional Theory" introduces the following referencing path. Here, we use the notation with '.' (dot) to express chain of reference as *objectName.objectName.attributeName.*

Theory. LearningActivity.LearingActivityType instantiates the following type as object:

A. Preinstructional activities
B. Content presentation
C. Learner participation
D. Assessment
E. Follow through activities

Instantiation of types above means to select specific model. In this case the preceding five components come from Dick, Carey & Carey. [3] There are various instructional models in action. We need some criteria that guide us to select model with conceptual understanding of learning contexts and activities in real world. The discussion of object characteristics such as entity, transaction and activity classifications [9] suggests existence of specific learning object taxonomy. Although there is no single general categorization applicable to all situations we can observe learning objects and identify the number of associations between types or to seek existing resources to implement prescriptions for the types. Hence we propose a strategy selection criteria with learning objects' characteristics at conceptual level. The following is an example of criterion derivation. By reviewing literatures we identified classification categories of strategies and compared with set of categories in terms of questions from instructional design considerations as follows.

- How does the model suggest learning prescriptions, abstract or concrete?
- Do the categories include interactive component explicitly?
- How are the categories associated with learner's motivation explicitly?
- How many category and subcategory does the model have?
- How many learning prescriptions do they have?

TABLE3 summarize this model selection criteria.

TABLE 3 The model selection criteria

	Model			
Characteristics	**Gagne's Nine Events**	**Dick, Carey, & Carey**	**Barkley, Cross, & Major**	**Silberman**
How does it suggest prescriptions?	**Abstract**	**Abstract**	**Concrete**	**Concrete**
Do the categories include interactive components?	**Implicit**	**Implicit**	**Implicit**	**Explicit**
How are the categories related learner's motivation?	**Implicit**	**Implicit**	**Implicit or Explicit**	**Implicit or Explicit**
Number of Categories	9	5	5	3
Subcategory	0	13	0	15
Number of Prescription	0	0	30	101

In order to define object's specification, object multiplicity matters. Multiplicity is interpreted as the answer to the question how many object types of strategy do you need to instantiate at a time ? The expected number of instance(s) guides us to select specific model as indicated in Table 4. TABLE 4 describes the conditions of selecting links to models that represent strategy categorization.

TABLE 4 Strategy Classifications Selection Rules

Conditions and Actions		Case 1	Case 2	Case 3	Case 4
Learning Object Characteristics	How many object types of strategy do you need to instantiate at a	one	one to few	few to many	
	Seek to link with existing assets				Yes
Refer to	Generalized model such as five components of learning of Dick, Carey & Carey	X	X	X	
	Specialized conceptual classification such as the Interaction Model of Eggen & Kauchak			X	X
	Concrete model that prescribes actions to be taken in detail such as 101 Active Learning Techniques	X			X

In case of programming courses, we structure introduction, presenting and construct new knowledge, and to provide opportunity of student practices. Types of learning activities have been classified by pedagogy found in literatures and knowledge of designers, and we select strategies to meet specific learning objectives. (See Figure 4) Figure 4 indicates that the learning unit has three learning objectives. Three objectives imply at least three learning objects as learning activity exist. Therefore number of activity elements is more than one. We select the Dick, Carey, & Carey model based on the criteria shown in TABLE 4.

Dick, Carey, & Carey model suggests the strategies as follows.

A. Preinstructional activities
B. Content presentation
C. Learner participation
D. Assessment
E. Follow through activities

For preinstructional activities, the instructor will carry out various tasks on the classroom environment. To activate learning content presentation, learner participation is utilized. In-class presentation works as an assessment function and enhance retention as follow through activity. TABLE 5 summarize the learning objects of Java programming course. The detailed head "type" in TABLE 5 contains subtypes of learning activity which denoted Learning Activity Type in the extension of unit of learning meta-model. The "refer to Silberman" expresses that the Session 1 implements strategy originated from the literature of Silberman *et al* named "Learning start with a question" [13] to involve and energize students from the start.

TABLE 5 Learning activities of the programming course as object composition.

Object Name	Property: name	Property: type	Property: referto
Java programming: Learning Activity	Java programming	Course work	Tutorial Chapter 2
Session 1: Strategy	Starting with questions	Collaborative	Silberman
Session 2: Strategy	Excersize 1	Direct Instruction	original
Session 3: Strategy	In-class presentation	Group Interaction	Eggen & Kauchak
Face to face classroom	Java I room no. 305	Learning Context	Syllabus 2007

Java Programming I

Java I room no. 305

Module 1

Overview
An introduction to Java language basics

Objectives
After completion of this module you should be able to:

- Describe how to create a java source code file
- Write a main method with commnadline argument
- List the elements of a Java class definition

Duration : **120min**

Activities Session 1 Research project

Session 2 Exercise

Session 3 In-class presentation

Session 1 Instruction

Procedure	Description: Action	Description: Resources
Step 1	Read textbook	Yuki, H. (2006)
Step 2	Pose ten questions each	
Step 3	Think-pair-share	
Step 4	Plan investigation	
Step 5	Implement investigation	

Figure 4 *Instruction in Java programming course*

TABLE 5 also expresses activity structure with a composition of objects seen in the leftmost column. After selection of strategies we prescribe concrete instructions. (See Figure 5)

Learning Starts with a Question
- Group size : PAIRS - Time on Task : 15-30 MINITES - Duration of Group : SINGLE OR MULTIPLE SESSION - Useful for : Stimulate students to inquire into subject matter on their own, and activate learning.
+ Distribute to students an instructional handout of your own choosing.() : void + Ask students to study the handout with a partner. () : void + Ask students to make up the document with questions next to informatino they do not understand.() : void + Request that each pair make as much as sense of the contents and identify what they not understand.() : void + Call the class again() : void

Figure 5 *The prescription of the concrete strategy*

CONCLUSION

We described an extension of learning activity type to be able to express educational settings such as unit of course. To view models based on meta-model will apply to specify a model as composite objects as aggregation and to compare existing conceptual models. Specification as aggregated objects will be able to express external resources for reference and locating existing assets for reuse at conceptual level. Models expressed in terms of generalized characteristics of categories, will serve as model selection criteria to study instructional design. Further research of this study will be guided by the following questions. How well the strategy selection criteria work with us? How can we integrate assessments of learning, as LO component?

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