DESIGNING INTELLIGENT LEARNING OBJECTS

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Abstract

Intelligent Learning Objects (ILOs) extend the concept of Learning Objects, whereby the learner is presented with material based on both curriculum and their performance. This paper discusses current practices in the field of Intelligent Learning Environments, as well as the design of ILOs with I-LODE V2.0, the Intelligent Learning Object Development Engine.

1. Introduction

ILOs extend the idea of Learning Objects (LOs) whereby the learner receives customized training like that found in Intelligent Learning Environments (ILEs). We examine work done in the area of ILEs, and then describe the I-LODE (Intelligent Learning Object Development Engine) platform for developing web-based ILOs. I-LODE allows the instructional designer several different strategies to adapt content of the ILO to individual learner needs, and provides for collection of performance data. The modular design of I-LODE V2.0 allows the use of intelligent agents to produce ILOs that are both flexible and extensible.

2. Intelligent Learning Environments

ILEs provide customizable content that is based on individual learner performance. This approach is the result of recognizing that learners have different skill levels and learning styles; thus, an E-learning environment should encourage multiple representations of knowledge. [9] The combination of customized content of ILEs and the interoperability of LOs provides a powerful solution to problems in distance education and professional training.

Knowledge Tree [2] provides a two-level architecture for adaptive E-learning based on distributed, reusable, intelligent learning activities. A component-based assembly of adaptive systems provides the content, as well as promoting reusability at the level of the instructor. Knowledge Tree features an *activity server* to provide the reusable content and services, much like an educational repository. A *learner server* collects information about individual learner performance from the activity servers, so that instructional material can be personally adapted to their individual needs. Knowledge Tree is an improvement over SCORM, [12] which provides for interoperability, but does not provide for customized learning environments

Shang, et. al. [13] propose a collection of intelligent agents for ILE delivery, with the learner model inferred from both a learner profile, as well as performance data collected and analyzed using a Bayesian belief network. Curriculum delivery is based on a dependency graph, with links representing the relationship between, co-requisite, related, and remedial topics. Curriculum sequencing is then a process of finding relevant topics, then selecting the best one.

Multi-agent architectures have also been proposed for the development of ILEs by Giraffa and Viccari [5], and Silveira, et. al. [14] These architectures are extensible, allowing different types of agents to perform monitoring, clarifications, and observe learners' actions and adapt the behavior of the ILE. [4] Web services are now being considered as a way to use Multi-agent architecture delivery to a large number of learners in a distributed environment. [8]

Darbhamulla and Lawhead [3] propose a general algorithm for the sequencing of material based on overall learner scores. By achieving an appropriate score on test questions embedded in the ILE, learners move on to advanced or related concepts; otherwise, learners must receive additional instruction on a pre-requisite or related concept. He, et. al. [7] propose a web-based system that bases assessment at the level of individual problems.

3. Intelligent Learning Object

ILOs have a richer set of behaviors than traditional LOs. We begin by defining the ILO structure, as created by I-LODE, as a *Frame* composed of information in the form or text/graphics/animation, followed by a question. We use the rule-of-thumb for the number of having 7+/- 2 Frames in an ILO, consistent with George Miller [11] and LOs created

by the CISCO corporation and reported by Griffeths, et. al. [6] When the learner completes instruction from the material (and questions) found in the ILO, they receive a total score on their performance. The instructor can see the total score, as well as the length of time each learners took in order to process material and answer each question.

Darbhamulla and Lawhead [3] describe an algorithm to determine the sequence of topics a learner will have presented to them, based on test score performance. Expanding upon this, I-LODE V2.0 allows the instructor to determine the type of response and material that will be presented to the learner. When the ILO is created, the instructor can select from one of three *granularity options*. If a learner misses a question, they may then receive either: (1) *complete reinstruction* on the topic; (2) *more information* on why the answer they selected was incorrect; or, (3) an acknowledgement that the answer was incorrect along with the correct answer. An additional consideration in ILO design is the number of times that a learner can receive additional information and evaluation questions. I-LODE V2.0 defines the number of times that instruction and/or reinstruction can occur as the *depth* of the ILO. I-LODE V1.0 initially supported a depth of two, but this important feature was increased to any positive number selected by the instructor at the time of ILO creation in I-LODE V2.0. A diagram of I-LODE's methodology on granularity and depth of instruction may be found in Figure 1.

ILOs created with I-LODE provide a number of ways to assess learner comprehension. Previous LOs have used the learner type and task type as a way to provide performance measures. [10] Performance information provided by I-LODE may be organized in terms of Bloom's Taxonomy of Educational Objectives. [1] We draw an example from the subject area of Computer Science in Figure 2. From six categories, a total of ten educational objectives are identified that can be measured with ILOs created by with I-LODE.

I-LODE is written in PHP, with a MySQL database, hosted on a server running Red Hat Linux. An example of the instructor and learner interfaces for an ILO created with I-LODE may be found at www.IntelligentLearningObjects/sample/ (available April 1, 2005).

4. Conclusions

LOs hold a bright future as we look toward the development of an interoperable and globally distributed learning environment. ILOs developed with I-LODE V2.0 will provide instructors and learners with dynamic content with reinstruction options, development of learning assessments within the framework of Bloom's Taxonomy, and response time metrics to determine problems with the material and test questions presented in the ILO.

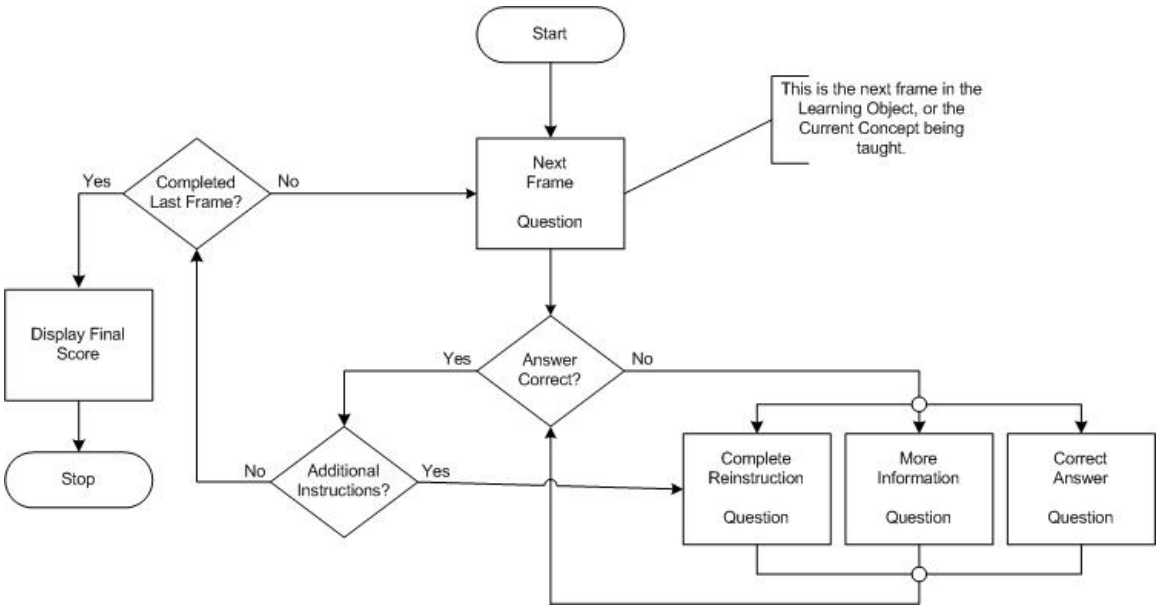

Figure 1

1.00 Knowledge
Question Type: Multiple choice, T/F, matching
1.2 Terminology
1.3 Specific Facts

2.00 Comprehension
Question Type: Fill-in the blank/short answer
2.2 Interpretation
2.3 Extrapolation

3.00 Application
Question Type: Given a scenario, select an appropriate coding solution

4.00 Analysis
Question Type: Determining code that is missing or not needed; arranging code statements
4.2 Elements
4.3 Relationships

5.00 Synthesis
Question Type: Writing algorithms/code
5.2 Given a scenario, write a set of statements that solve the problem

6.00 Evaluation
Question Type: Given code, what is the output /error that will occur upon execution
6.1 Judgment in terms of internal evidence
6.2 Judgment in terms of external data

Figure 2

5. References

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