

Instructional Strategies and Limitations of the SCORM 2004 Specification

Mr. Lim Kin Chew

Senior Lecturer and Research Fellow, SIM University, Singapore

kclim@unisim.edu.sg

Abstract: This paper explains the different instructional strategies that can be used to design and develop learning content with different learning paths. With this specification, the instructional designer can enable the tracking of learner's learning, the sequencing and navigation mechanisms. These mechanisms can be developed so that learners with different abilities can be provided with different learning paths. However, the SCORM 2004 specification does have some limitations. The paper discusses some of these limitations and gives two examples in which researchers are trying to overcome these limitations.

Keywords: Sequencing, navigation, instructional strategies, adaptive learning, SCORM 2004 3rd Edition

Introduction

Different people learn differently. In a classroom environment, the teacher can customize his or her teaching to cater to the learning pace of his or her students. But how do you do that in web-based e-learning? In the days of computer-based training, we have many proprietary software systems that allow the instructional designers and developers to incorporate different learning paths for different learners. It is not easy with web-based e-learning. Fortunately, we now have the SCORM 2004 Specification which allows the instructional designers and developers to plan and provide different learning paths for the same content.

1. The SCORM 2004 3rd Edition Specification

SCORM is an acronym for Sharable Content Object Reference Model. SCORM is developed by the Advanced Distributed Learning (ADL) Initiative of the US Department of Defence [1]. The purpose of SCORM is to standardize e-learning such that any SCORM conformant content developed by any course developer, on any authoring system, can be delivered to any learner, over the Internet, on any SCORM conformant learning management system (LMS).

Since its first release in 2000, SCORM has evolved and improved significantly. It started with SCORM 1.0, then SCORM 1.1, SCORM 1.2 and in 2004, SCORM 1.3 or subsequently renamed as SCORM 2004. Perhaps the most useful improvement to SCORM is the addition of Simple Sequencing capabilities in SCORM 2004 [2].

With Simple Sequencing being incorporated into the SCORM 2004 3rd Edition Specification, developers can now design courseware with complex branching to provide individualized instructions to target the learning needs of individual students [3].

2. SCORM Sequencing

The sequencing feature in SCORM 2004 comes from the Simple Sequencing Specification of IMS (IMS Global Learning Consortium) [4]. This feature allows for the creation of content with a non-linear path, such as courseware with complex branching options. The content model is mirrored by the Content Organization spelled out in the manifest file (named as “imsmanifest.xml”).

This manifest file is the central document of a SCORM content package. Since a SCORM content package is designed to be used within an LMS, the Content Organization in the manifest file is parsed by the LMS and becomes the "Activity Tree" for that content.

Each item in the Activity Tree corresponds to a learning activity (such as a question or a series of questions). Sequencing rules can be attached to each activity, i.e., to indicate what happens given different responses to activities. Activities can be associated with one or more Learning Objectives. Depending on responses to learning activities, learning objects may be satisfied or not, leading to different branching options.

In any learning environment, there is a "**student model**", which spells out what the learner knows and progress made towards achieving the learning goals. In SCORM 2004, this is represented by the *Activity State* and *Tracking Models* (spelled out in the manifest file). These allow the students' traversals of the learning content to be followed, recorded, and assessed. SCORM 2004 has the Sequencing Definition Model (which is an instructional model) which defines the order in which content is presented, how pre-tests and post-tests are used for sequencing, as well as providing remediation options. This Sequencing Definition Model is designated in the structure of the manifest file. The sequencing model in SCORM 2004 provides for considerable flexibility in how content is presented and how the system interacts with the user. Fundamentally, the model is one of **content mastery**, established by the learning objectives, and assessed through questions (learning activities). In this sense, computer technology skills such as programming knowledge or object-oriented design comprehension lend themselves quite well to being developed into SCORM-compatible lessons. Such lessons could be set up to provide choices to learners on how to work with the materials; for example, the options to chose a **guided flow** in which a learning path is pre-determined or an **exploratory mode** in which the user is provided more choices. This would move in the direction of an **adaptive learning** environment.

One of the goals of SCORM is that SCORM-compatible content be portable to different learning systems and be able to be combined in different ways depending on the needs of the user. For this reason, SCORM learning objects (called SCOs for Sharable Content Object) are designed to be small units, or “chunks”, with flexibility to be used in different contexts. However, the granularity of SCOs is something that cannot be defined strictly. It depends on the project nature and its projected use. Fortunately, by now there are some software tools (e.g. eXe [5] and RELOAD [6]) which can be used to design and develop such SCOs quickly.

3. Instructional Strategies of SCORM Sequencing

Currently, a typical learning content conforming to the SCORM2004 Specification has a tree structure. In such a learning content, adaptive control is made available by the rules put on nodes that represent a chapter, a section and so on [7].

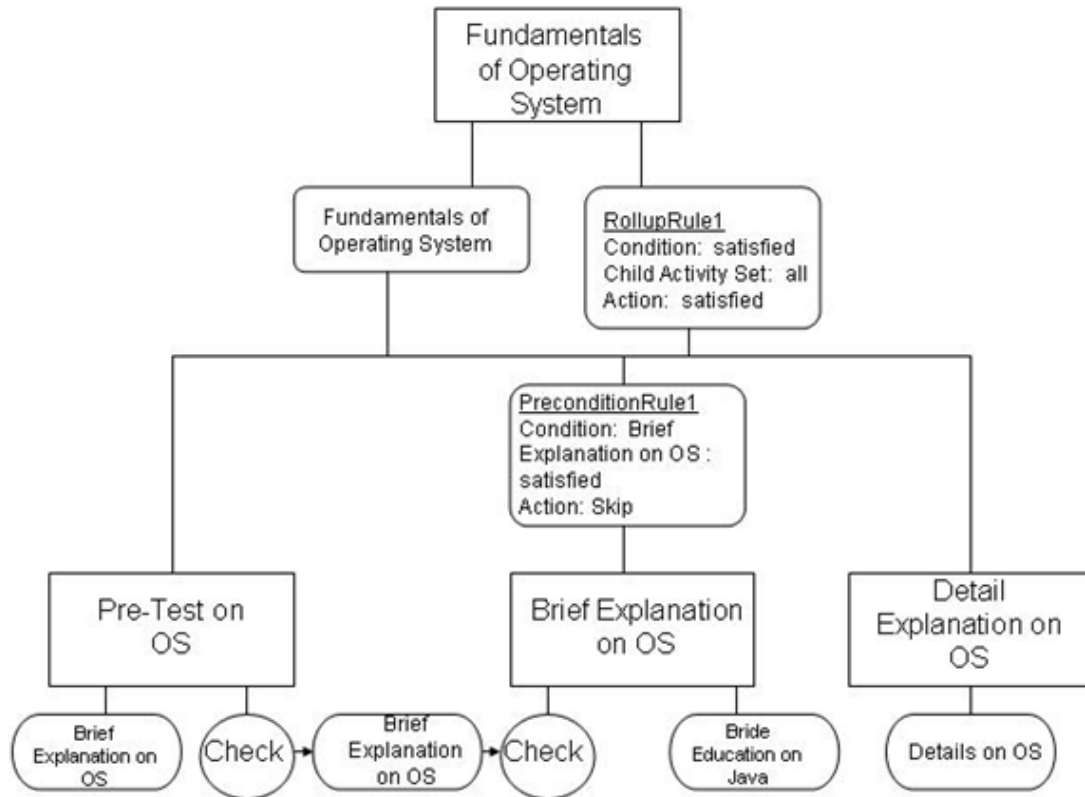


Figure 1 - An example of a typical structure of a SCORM2004- conformant learning content [7]

Figure 1 shows an example of typical structure of SCORM2004-conformed learning contents. From Figure 1, we can see that there is a tree structure with “Fundamentals of Operating System” as its parent.

This content starts from “Pre-Test on OS”. If a learner passes the Pre-Test, he/she will proceed to “Details of OS”. If not, he/she will learn the “Brief Explanation on OS” before learning the “Detail Explanation on OS”.

This control is implemented by the sequencing rule (preConditionRule1).

When an activity is finished, the tracking data in the activity is aggregated to its parent activity. For instance, “Fundamentals of OS” aggregates the tracked data from all of the “Pre-Test on OS”, “Brief Explanation on OS” and “Detail Explanation on OS”. (That is because a parameter of RollupRule1 Child Activity Set is set to “all”). So the learning result of the entire content is recorded in “Fundamentals of OS”.

These rules in SCORM2004 realize adaptive pre-order page-turner structure easily. However, in the new paradigm of the intelligent tutoring system (ITS) (or the intelligent educational system, IES) the focus is not **control** that shows all of the contents or a part of them according the preordered structure but **decision making of the next activity** according to a learner’s status.

4. Limitations of SCORM Sequencing

Many people have regarded the SCORM specification to be very complex and too technology oriented. In fact, the four SCORM manuals (Overview, Content Aggregation Model, Sequencing and Navigation and Run-Time Environment) are highly technical and are meant more for the technical programmer rather than for the pedagogically trained instructional designer even though the ADL have stated that the specification is pedagogically neutral. In addition, even for the technically inclined programmer, one has to have knowledge of other specifications like those from the IMS (content packaging) and the AICC (for the SCO launching mechanisms, the APIs and the data model elements). Other than the complexity, there are some other limitations.

One limitation is that the SCORM 2004 3rd Edition specification is limited to the content mastery and the acquisition of skills and knowledge in a particular subject matter area. The typical domain areas that are highly applicable are engineering/computer science, mathematics/science, management and related areas, military and corporate training. The content has to be granularised properly and planned for reusability. Granularizing content is no trivial matter. The learning strategies most suitable for use are the *directed*, *self-guided* and *adaptive* learning strategies. Collaborative learning is out of scope in a SCORM 2004 learning environment [8]. The number of high level design and authoring software tools and systems is rather limited. There are very few books and instructional materials on how to design e-learning courses using the SCORM 2004 3rd Edition Specification. Instructional design courses in universities usually do not include any training on using this specification.

However, in spite of all these difficulties, there are some real applications. One of these is the courseware entitled “Octave Band Analysis (OBA)” which is part of the Bioenvironmental Engineering Advanced Measurement (BEAM) course [9]. This OBA Noise Survey Courseware comprises 2 to 3 hours of instruction and there are altogether 5 SCOs (Plug-In, Interface Instructions, Sound & Equipment Review, Noise Source Surveys and OBA Survey). The content in each SCO belongs to one of the following: conceptual, declarative and procedural.

5. Improvements to the SCORM 2004 Specification

A few researchers have proposed improvements to the SCORM 2004 Specification. One of these is from a contract proposal from Michael K. Anthony, M.S. (Galaxy Scientific Corporation) and Alan Ashworth (USAF Research Laboratory BioBehavioral Systems) [10]. They have proposed mapping the Intelligent Tutoring System (ITS) constructs to the SCORM 2004 Data Structures. Because all three critical components for ITS (Expert Knowledge Model, Novice Knowledge Model and the Instructional Model) are present in the SCORM 2004 3rd Edition sequencing capabilities, intelligent model-based instruction is possible.

In the case of researchers like Hayashi and Ikeda [7], they have developed an ontology-aware authoring tool called *iDesigner*. Their study firstly addresses the problems about how to understand others’ description of knowledge easily and how to describe their own knowledge that others can read easily. This is what they termed as making their contents more organized along the **constructive concept of instructional control knowledge in IESs**. Their other intention is to make IES designers and developers share their IES platforms. Their study aims to develop a highly scalable user-friendly IES development environment with Sequence and Navigation specification in SCORM2004 as the basis of sharing their IES platforms.

One characteristic of this authoring tool is that it has awareness for both ontology and for high scalability. The tool can convert the author’s design intention in knowledge

level to the implementation in symbol level based on an ontology for learning contents. These two authors consider that studies of intelligent educational systems (IESs) will be developed and turned into actual utilization if it is possible to build a **framework** of knowledge level description of educational control knowledge based on SCORM2004 platform as highly scalable symbol level.

6. Conclusion

Since the public release of the SCORM 2004 Specification, researchers have pointed out some limitations in this specification. They have also offered some new approaches in an attempt to overcome these limitations. This paper highlights two approaches. One approach is to map the intelligent tutoring system (ITS) constructs to the SCORM 2004 data structures. However, implementing ITS constructs requires a thorough understanding of the SCORM 2004 sequencing constructs because the ITS constructs are not clearly defined in SCORM 2004. The other approach is on the learning content design with knowledge level representation on top of SCORM 2004 platform as a symbol level architecture of IES decision-making structure. The author believes that as work on the SCORM 2004 specification improves, there will be some convergence between the ITS (or the IES) and the SCORM 2004 specification.

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