section three

3

SCORM 2004 3rd Edition Specification and Intelligent Tutoring System

- The Differences and Similarities

"**This article explains what the SCORM 2004 3rd Edition Specification** is aiming to do with e-learning as we move towards developing advanced instructional courseware. Early attempts at using the SCORM specification to develop advanced instructional courseware were limited by factors such as (1) sequencing code that is embedded inside the learning content code; (2) sequencing behaviours that are inconsistent across delivery systems; (3) sequencing models that are either proprietary or idiosyncratic; and (4) sequencing models and activities that are poorly defined. For most developers, sophisticated structuring and course intelligence (e.g. using pre-test scores to derive individual instruction paths or determining remediation requirements for individual students) had to be hard-coded into the Sharable Content Objects (SCOs) themselves. This technique limited the reusability, sharability, and interoperability of early SCORM based training. As the SCORM 2004 3rd Edition Specification moves towards the development of advanced instructional courseware, it has similarities and differences with intelligent tutoring systems. This article explains these similarities and differences and makes the forecast that the SCORM 2004 3rd Edition Specification is a better alternative to the development of intelligent tutoring systems."

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1 INTRODUCTION

The Shareable Content Object Reference Model (SCORM), published by the Advanced Distributed Learning (ADL) project of the US Department of Defence, is a de facto specification for e-learning content. It is developed by the Advanced Distributed Learning Initiative of the US Department of Defence [1]. This specification is based on the concepts of reusability, accessibility, interoperability and durability, or RAID in short. Since its setup in 1997, the ADL Project has released several versions of this specification. The first version, SCORM 1.0, is actually a proof of concept which was released in 2000. Subsequently, they improved on it and released the SCORM 1.1 version. However, this is a "trial balloon" and is not fully functional. The first "real" release was SCORM 1.2. This "real" release came with a real conformance test suite which can be used to check the conformance of both the content and the system.

Unfortunately, SCORM 1.2 lacks the sequencing component. So, in 2004, SCORM 2004 (or formerly known as SCORM 1.3) specification was released. This version includes the ability to specify adaptive sequencing of activities that use the content objects (called Sharable Content Objects, or SCOs). It also includes the ability to share and use information about the success status for multiple learning objectives or competencies across content objects and across courses for the same learner.

The 3rd Edition of the SCORM 2004 Specification was released in late 2006. This was made in response to enhancements and updates to the specifications and standards work. With this latest edition, the SCORM 2004 specification moves towards the development of advanced instructional courseware by providing sequencing and navigation paths. (Please see Figure 1.)

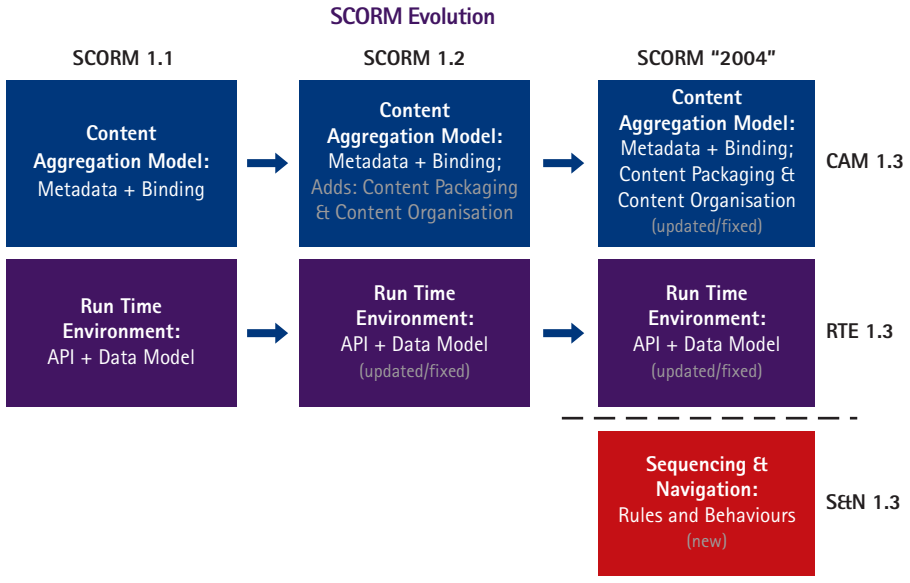

Figure 1: The different SCORM versions [2]

At the same time, with the growing popularity of e-Learning, people realise that students learn best in a tutored learning environment. This means that students who receive one-on-one instruction perform two standard deviations better than students who receive traditional classroom instruction [3].

With the SCORM 2004 3rd Edition Specification, courseware developers can now use the Simple Sequencing mechanism to design courseware with complex branching to provide individualised instruction to target the learning needs of individual students. Simple Sequencing has provided courseware developers with the tools necessary to design complex instructional systems such as those found in Intelligent Tutoring Systems (ITS).

The purpose of this article is to highlight some similarities and differences between the ITS and SCORM 2004.

2 INTELLIGENT TUTORING SYSTEM

Intelligent tutoring systems (ITS) or intelligent computer-aided instruction (ICAI) has been pursued for more than three decades by researchers in education, psychology, and artificial intelligence. We now have prototype and operational ITSs which provide practice-based instruction to support corporate training, K-12 and college education, and military training.

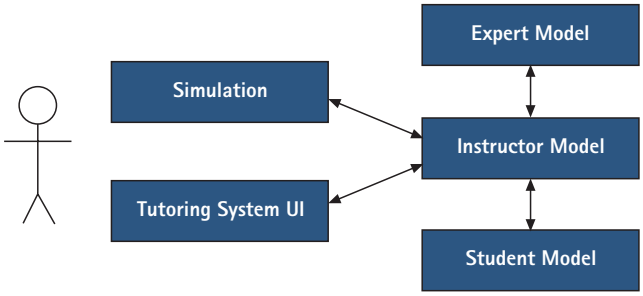

Figure 2: Components of an Intelligent Tutoring System [3]

Figure 2 shows the main components of an ITS. The *"expert model"* represents subject matter expertise and provides the ITS with knowledge of what it is teaching. The *"student model"* represents what the user does and does not know, and the *"instructor model"* enables the ITS to know how to teach, by encoding instructional strategies, used via the tutoring system *user interface* (UI). ITSs offer multiple pathways through the learning content, allowing for *remediation*, *repetition*, or *skipping ahead* based on user performance. These learning paths are provided for in the SCORM 2004 Sequencing and Navigation specification.

Research has indicated that ITS-taught students generally learn faster and translate the learning into improved performance better than their classroom-trained participants. At the Carnegie Mellon University (CMU), researchers developed an ITS called the LISP Tutor in the mid-1980s to teach the LISP programming language to college students. Another ITS, known as Sherlock, was developed in the early 1990s to train Air Force personnel on jet aircraft troubleshooting procedures [3].

ITS is most often used for narrowly defined areas of technical training and even language learning. For example, ITS can be used to deal with discrete areas of knowledge like grammar, vocabulary development, comprehension checking and specific cultural knowledge. Many ITS programmes have been built using a Cognitive Tutor Authoring Tool (CTAT) developed in the CMU. Another example is the REAP project which is a reading tutorial system. This system keeps track of students' vocabulary learning lists and individually tailors instructional materials for the vocabulary the student is working to learn [4].

With the SCORM 2004 specification gaining international acceptance and also the fact that educators and students see the benefits of customised learning, it is timely that we examine both the ITS and the SCORM 2004 options.

3 THE SIMILARITIES OF ITS AND SCORM 2004

Both the ITS and SCORM 2004 deal with the mastery of the subject matter content. The goal of ITS is to model the human tutoring interaction in a manner that can be implemented in a machine training system. Just as the ITS has the expert model, the instructor model and the student model, SCORM 2004 allows sequencing paths that can be based on knowledge-paced, competency, remediation or just a linear path.

In SCORM 2004, the flexible programming of courseware is all done by changing the codes in the imsmanifest.xml file. For example, Figure 3 gives a sample XML snippet which is used to illustrate how to completely exclude a child activity from rollup:

```
<item identifier="ITEM-A1EAD3EB-9A4A-A158-032C-7A9E7B7520EB" isvisible="true"
identifierref="RES-ADD49C24-4195-E941-3C3D-50F9DB4E8254">
  <title>Activity1</title>
  <imsss:sequencing>
    <imsss:rollupRules rollupObjectiveSatisfied="false"
rollupProgressCompletion="false" />
  </imsss:sequencing>
</item>
```

Figure 3: XML Listing in imsmanifest.xml file

Pre-testing is a common method used in both ITS and SCORM 2004 to determine the sequencing path the learner should take. However, unlike the ITS, SCORM 2004 has a very well defined data model with elements that capture the scores, e.g. *cmi.score.raw*, *cmi.score.min*, *cmi.score.max*. In the ITS, this is done in their Novice Model. The Novice Model is the current amount of semantic network successfully traversed at any given time, and is distributed across the Activity State Model and the Tracking Model.

In the ITS, the Instructional Model is the agent that drives the tutoring of the content to the student. In SCORM 2004, the Instructional Model is primarily located in the **Activity State Model**, which relies heavily upon the **Activity Tree**, **Tracking Model**, and **Sequencing Definition Model**. The Activity Model monitors the state of the instructional world. It constantly references the navigational map in the Activity Tree, and determines the student's progress from the Tracking Model. With this requisite information at hand, the Activity Model decides and effects the course navigation in real time by invoking rules in the Sequencing Definition Model. In SCORM 2004, the Sequencing Definition Model is an information model which describes the intended sequencing behaviours. The various rules, limits, conditions and sequencing behaviours are defined for the various learning activities.

Both the ITS and SCORM 2004 are complex systems that have to be done principally by specialists rather than the subject matter experts (SMEs). However, the SMEs would need to be consulted before and during the construction of the Expert Model in an ITS or in developing the Activity Tree, Clusters and the Activity State Model in SCORM 2004. These need experienced programmers who have a handle on either the ITS or SCORM 2004 specification.

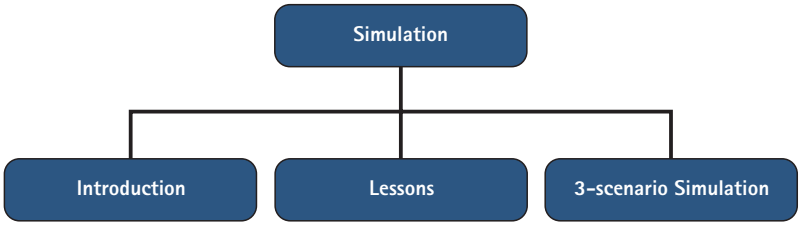

Figure 4: Example of an Activity Tree

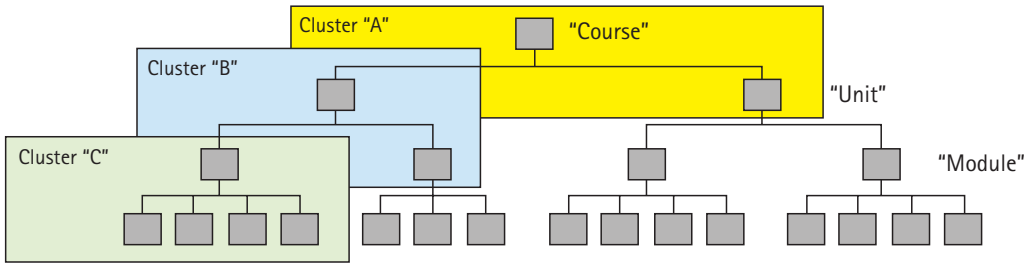

Figure 5: Example of clusters in an Activity Tree

Both the ITS and SCORM 2004 need the use of technology, e.g. for ITS, it is artificial intelligence. As such, programming languages used in artificial intelligence work, like Lisp, Prolog and C/C++ are used in ITSs. On the other hand, developers working on SCORM 2004 specification have to be comfortable with the Java programming language, JSP, JavaScript, XML, HTML, PHP, MySQL and the RELOAD editor software.

4 THE DIFFERENCES BETWEEN ITS AND SCORM 2004

Unlike the ITS, SCORM 2004 is based on the goals of reusability, accessibility, interoperability and durability (or RAID in short). So, a SCORM 2004 compliant content package can be reused (without any change) in another SCORM 2004 compliant learning management system. In the case of the ITS, the system is usually proprietary and the sequencing and navigation codes are embedded with the system. The content in a particular ITS cannot be reused nor interoperate in another ITS.

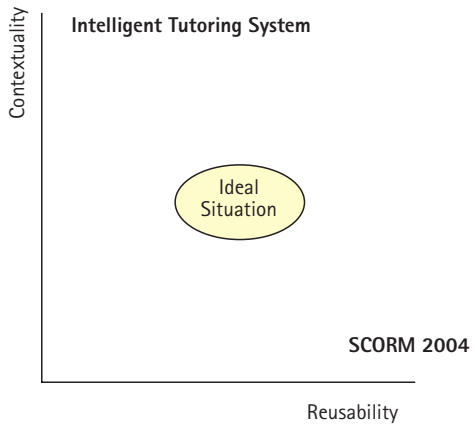

Figure 6: Contextuality versus reusability

The traditional ITS model contains four components: the domain (or expert) model, the student model, the teaching (or instructor) model, and a learning environment or user interface (Please see Figure 2). ITS projects can vary tremendously according to the relative level of intelligence of the components. For example, a project focusing on intelligence in the domain model may generate solutions to complex and novel problems so that students can always have new problems to practise on. But it might only have simple methods for teaching those problems. On the other hand a system that concentrates on multiple or novel ways to teach a particular topic might find a less sophisticated representation of that content sufficient (Please see Figure 6 above.).

Another difference is in the security area. For the ITS, security is not an issue as the programming codes are embedded in the content and the content cannot be shared with another ITS. For SCORM 2004, the situation is different. There are two security concerns related to the SCORM 2004 RTE (Run-Time Environment). The first is known as the "cross-domain scripting problem". This occurs in a client-server implementation in which the domain supporting the run-time service and providing the API (Application Program Interface) implementation is different from the domain providing the SCO. The result is a cross-domain security violation. At the moment IEEE LTSC (Learning Technology Standards Committee) has begun work on a Web service alternative [6]. The second security concern has to do with

SCOs implemented with a "transparent" media format such as HTML or XML and susceptible to a "view source" action on the browser. This is a problem in learning applications if the learner can inspect the logic used to assess learner performance. For learning applications, it might be better to make the transparent media "opaque".

Whilst there is emphasis on making the content as contextual as possible in an ITS, it is a difficult issue in the SCORM 2004 specification. In SCORM 2004, the content has to be structured in a granular form. In SCORM 2004, this granular form is known as a Sharable Content Object (SCO).

For SCORM 2004, there are templates that can be used to develop content with different sequencing and navigation paths. For example, the company, Xerceo.com [7], has provided easy-to-use templates such as allowing one to hide an activity from choice or to allow one to exit one's current parent or course.

In SCORM 2004, the logic of learning path and learner interaction are contained in a highly structured text file named the "imsmanifest.xml" or manifest file. On the other hand, in ITS, the logic of learning path and learner interactions are embedded in the compiled programme.

Yet another difference is that the SCORM data structures are abstract in nature and at times, can be confusing. For example, the Activity Tree is represented in an LMS as a Content Organisation. However, a Content Organisation can also represent a small portion of the complete Activity Tree.

5 CONCLUSION

Although there are some similarities between the Intelligent Tutoring System and the SCORM 2004 Specification, there are just as many differences between them. However, SCORM 2004 now has the capability to implement the three basic constructs of an ITS, i.e. the Expert Model, the Student Model, and the Instructional Model using a completely different approach. This approach can be summed up by the goals of the SCORM 2004 specification in encouraging reusability, accessibility, interoperability and durability of both the content and the learning system as well. With SCORM 2004 3rd Edition we are now able to allow for non-linear sequencing based upon simultaneous assessment of learning activities incorporated in the different SCOs.

6 REFERENCES

[1] SCORM 2004 3rd Edition - Overview, 16 November 2006, Advanced Distributed Learning.
- http://www.adlnet.gov.

[2] Jennifer Brooks, SCORM 2004 Overview, International PerformanceFest 2.
- http://www.s1000d.org/events/user_forum/performance_fest2/03_SCORM2004Essentials%20%20Jenifer%20Brooks.pdf.

[3] Jim Ong and Sowmya Ramachandran (February 2000). Intelligent Tutoring Systems: The What and the How.
- http://www.learningcircuits.org/2000/feb2000/ong.htm.

[4] Godwin-Jones, Robert (2007). Emerging Technologies, Tools and Trends in Self-Paced Language Instruction: Language Learning & Technology Volume 11, Number 2 (June 2007), pp. 10-17.

[5] Michael K. Anthony, M.S. and Alan Ashworth (2005). Mapping Intelligent Tutoring System (ITS) Constructs to SCORM 2004 Data Structures.
- http://www.jointadlcolab.org/downloads/research/2004/beam_its/Mapping_ITS_to_SCORM_2004.doc.

[6] IEEE LTSC (Institute of Electrical and Electronic Engineers, Learning Technology Standards Committee).
- http://ieeeltsc.org.

[7] Sequencing and Navigation Guide from Xerceo.com
- http://www.xerceo.com/snguide/.