Instructional Strategies and Limitations of the SCORM 2004 Specification

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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. The authors show that it is advantageous to provide different learning paths which can be grouped into 5 main ones. However, the SCORM 2004 specification does have some limitations. The paper discusses some of these limitations and gives examples of domain areas where this approach works well.

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

Introduction

The current use of the web technology to deliver e-learning courses especially for open and distance education programmes is generally a very passive exercise of uploading many static documents to a learning management system and giving instructions to students. The end result is that many students end up having to print many documents. Such a delivery mode does not take advantage of the potential that web technology and e-learning standards offer innovative ways in making the course materials responsive to the learning abilities of the student.

Students everywhere, especially the mature ones in open and distance education universities, are getting more demanding. For a particular subject matter area, different students have different initial competency levels. Some have much expert knowledge; others have very little or no knowledge at all. Yet there are other students who need to be guided closely in their learning. Learning materials must be designed and developed to cater to these different types of learners. E-learning materials that have been designed and developed for one type of students may not appeal to other types .

Universities are also facing much competition in getting quality students. Professors know that one way to attract quality students is to improve the teaching quality. This means better quality course materials. Unlike the conventional classroom-based universities, open and distance education universities need to depend much more on the quality of the course materials as their students do not have much contact time with their professors. Yet, at the same time, developing quality course materials is time consuming and expensive. Hence, the demand is there to reuse content as much as is possible rather

than having to design and develop the course materials every time the course is run. This is where the international e-learning specification known as SCORM [1] comes in.

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. 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.

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 renamed as SCORM 2004. SCORM 2004 comes with the addition of Simple Sequencing capabilities [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). 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").

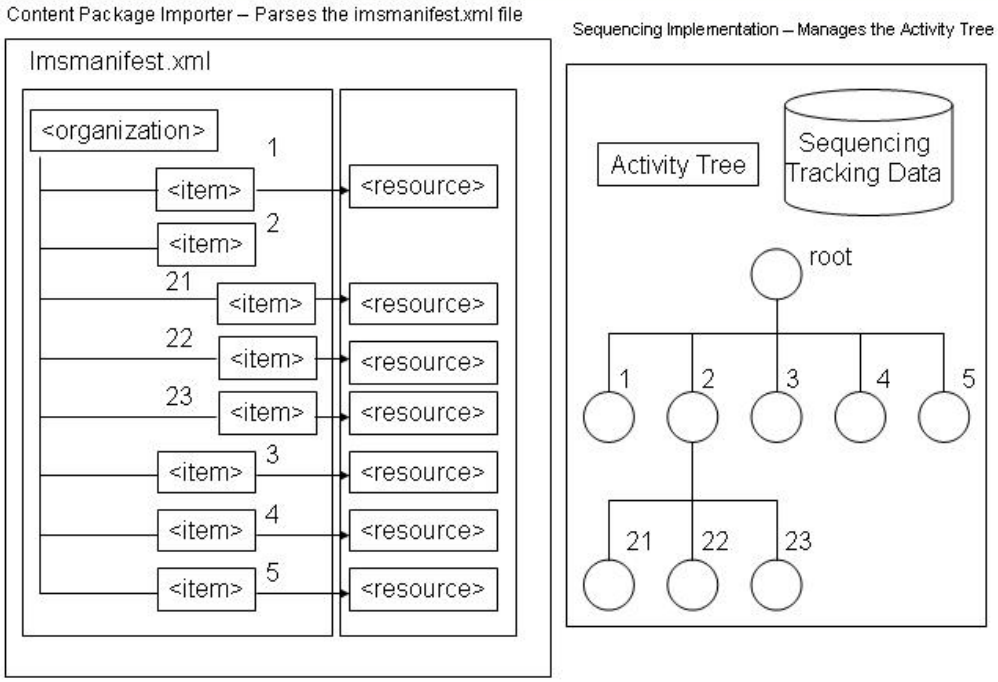

Figure 1 – Relationship between a Content Organization and an Activity Tree [4]

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 toward 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' traversal 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 [4] and RELOAD [3]) which can be used to design and develop such SCOs quickly.

3. Instructional Strategies of SCORM Sequencing

Having covered the conceptual background, let’s examine some instructional strategies commonly adopted by SCORM Sequencing. ADL has released a number of examples and sample content to illustrate how SCORM Sequencing could be used instructionally [8].

We will use some examples from an in-house developed course titled “Introduction to SCORM” to illustrate five of the most commonly used strategies. These are referred to as “No sequencing”, “Linear”, “Knowledge Paced”, “Remediation” and “Competency Assessment”.

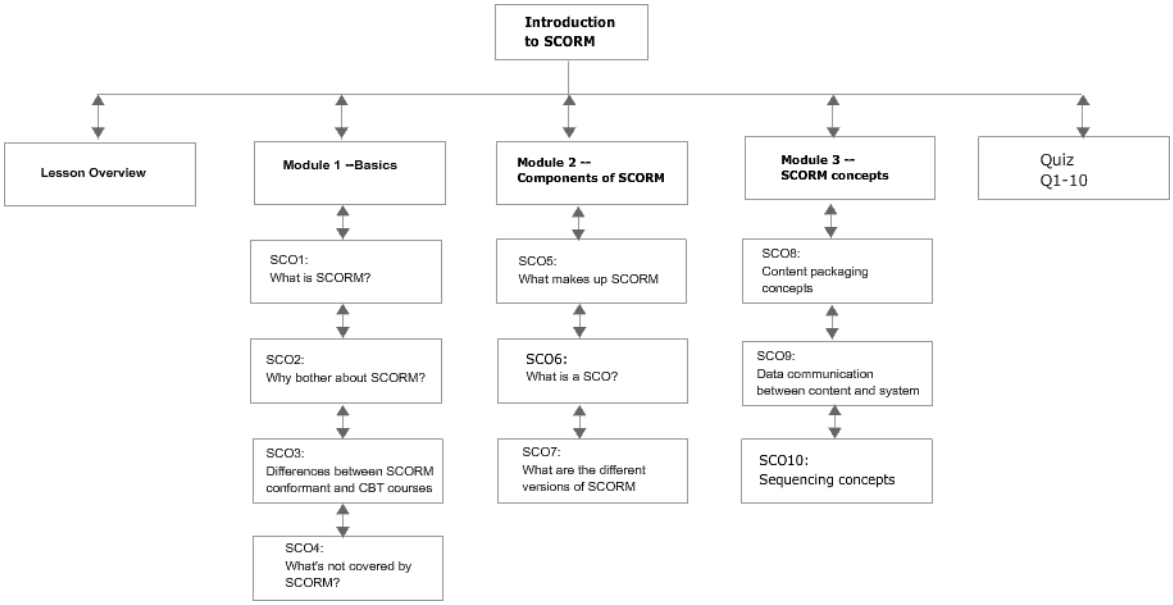

Figure 2 – Organization Structure of a course on SCORM

3.1 No Sequencing

In this instructional strategy, the learner is free to choose learning activities at will, in any order and without any restrictions on the number of attempts. No sequencing information is specified in this strategy. This learning mode might appeal to the learner who has some programming experience and who is able to learn by himself. However, beginners who need guidance will not find this mode useful.

3.2 Linear

In this mode, the learner must progress through the contents in a pre-determined order. The learner will start with the introduction first, then do all the modules and lessons in a linear order, directed by the LMS. The learner cannot proceed forward with the lessons until he has completed the current lesson. Each module is complete when he has finished all lessons in the module. The student will be presented with a comprehensive exam or quiz after he has completed all the modules. (Please see Figure 2.)

3.3 Knowledge Paced

In this mode, the learner must go through and complete the introduction first. After that he may proceed to the module 1 pre-test, select another module pre-test, or select a lesson. (Please see Figure 3.) The learner may 'jump' between modules, selecting pre-tests or lessons in any order. The learner cannot select the Module post-tests. These are only encountered after the learner 'flows' through the modules lessons.

After selecting or 'flowing' into an exam (pre- or post-), the learner must attempt each question in order. While going through a module exam, the learner cannot choose to exit the module exam before completing it. If the learner passes an exam (pre- or post-), the module's learning objective has been satisfied and the module's post-test becomes disabled.

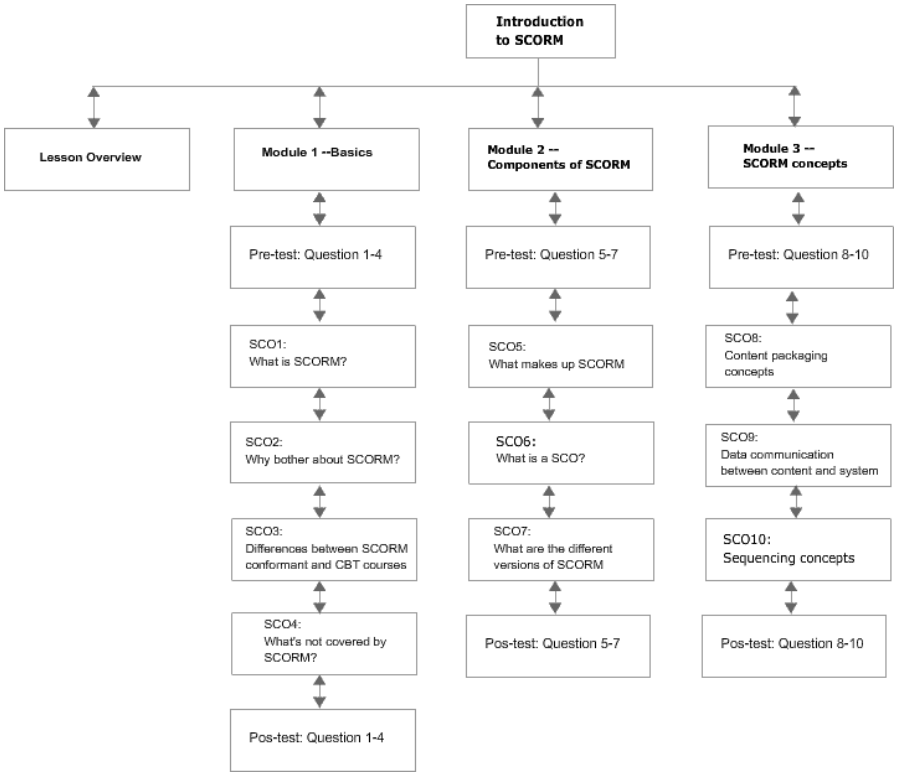

Figure 3 – Knowledge-Paced Strategy

The learner may continue to select individual lessons for the duration of the course, even after a module's objective has been satisfied. If the learner does not pass the exam, the learner is directed to that module's instructional content, and once completed, must retake the module exam (post-test). A summary of the learner's results is presented after all of the modules have been attempted. The learner is deemed to have completed the course after he reviews the course summary (i.e. *cmi.completion_status* = "completed").

3.4 Remediation

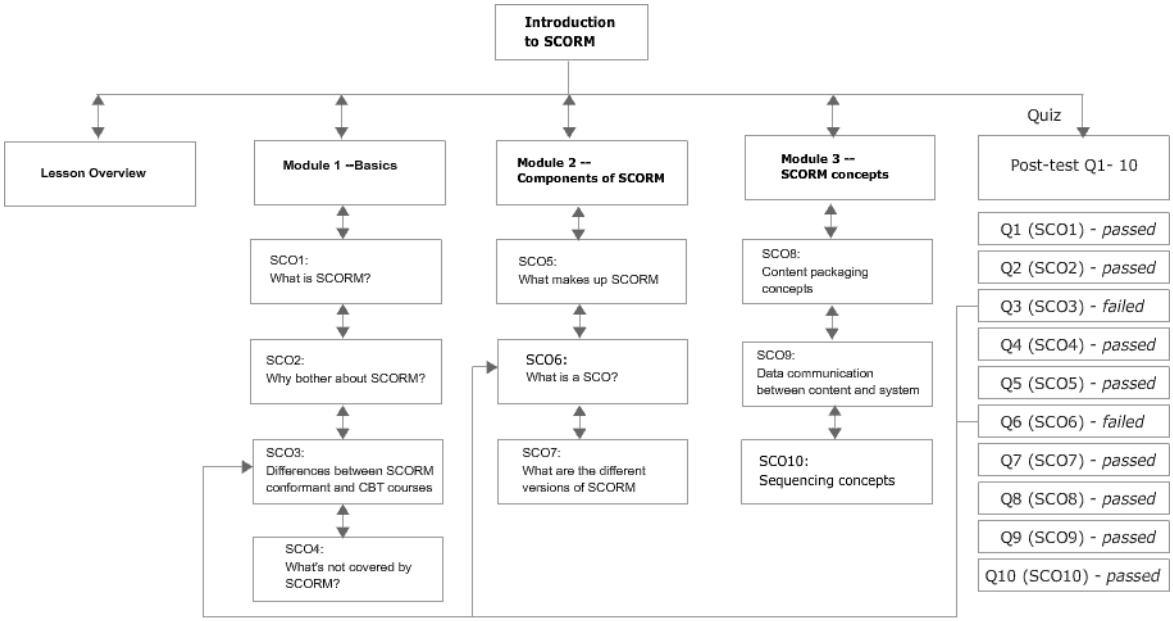

Figure 4 – Remediation Strategy

In this mode, the learner must go through and complete the introduction, and then follow a 'linear' approach. If the learner passes (i.e. meets all of the module objectives) the comprehensive exam, the course is completed. For each section of the exam (module objective) that is "not satisfied", the learner is directed to that associated Module(s) of instructional content, and once completed, must retake the Module Exam(s). (Please see Figure 4.)

3.5 Competency Assessment

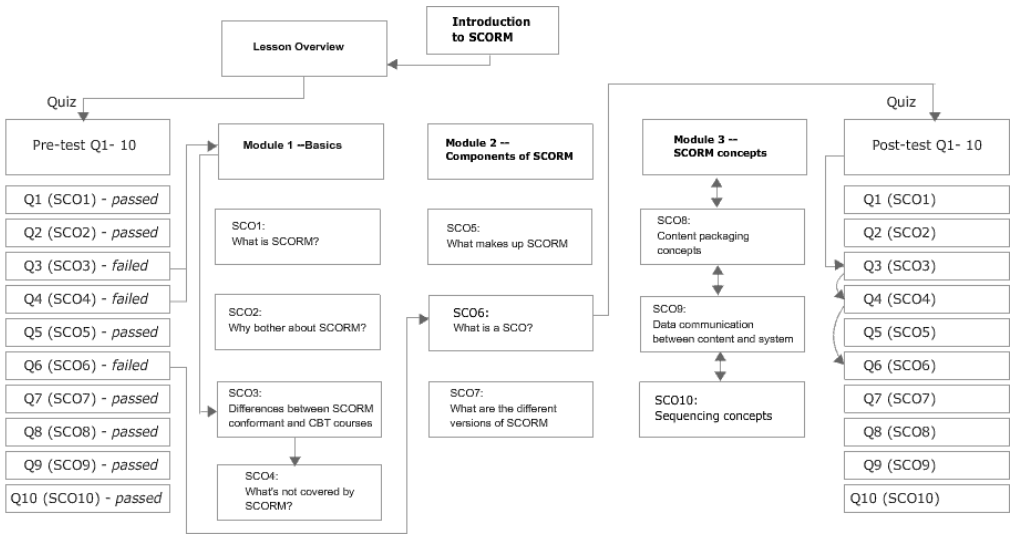

Figure 5 – Competency-based Strategy

This learning strategy is a variation of remediation. The learner is first presented with the introduction (lesson overview). He is then presented with an assessment SCO that internally evaluates the learner's mastery of each of the module objectives. The assessment SCO reports the satisfaction status of the module objectives through the SCORM Run-time Data Model (i.e. *cmi.objectives.n.success_status* = "passed" & *cmi.objectives.n.completion_status* = "completed"). The learner is presented with the instructional material (modules) related to unsatisfied objectives. After the learner has completed all the required instructional materials, an exam is presented that re-tests the objectives the learner has not satisfied. (Please see Figure 5.)

4. Application to e-Learning and e-Training Programmes

Being able to provide different instructional strategies for the same content has many implications in e-learning and e-training programmes. Firstly, as our students can choose how they want to learn the content, they will find that their understanding, comprehension and application abilities progress smoothly or according to how they want to progress. In addition, for different modules, they can choose different learning strategies.

The second advantage is that by incorporating such sequencing modes, we can preempt the questions students will ask. This will allow the tutor to have more time to attend to answering online questions on the more difficult aspects of the subject matter.

When an online course has been well planned, designed, sequenced and developed, the need for tutor-student interactions can be reduced.

The third advantage is that using the SCORM 2004 3rd Edition Specification allows the student to focus on the leaf activities in the activity tree. Consequently, the student will be able to zero in on the various leaf activities. For example, one leaf activity might be to create a user authentication controller for the website. If the student is not able to do this, he will be directed (by the LMS) to the relevant module to re-do the activities related to the user authentication.

5. Limitations of SCORM Specification

From the user perspectives, even though the SCORM specification has been around for a few years, many instructional designers and content developers still regard the SCORM specification to be overly technical and complex for adoption with ease. In fact, the authors feel the four SCORM manuals (Overview, Content Aggregation Model, Sequencing and Navigation and Run-Time Environment) 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. Other than the complexity, there are some other limitations.

By design, or possibly as a consequence of the needs of the main initiators of SCORM, many of the needs addressed by the current SCORM specification stem from content-driven learning, i.e. learning that arise from interaction between the single learner and the content – in the context of SCORM, the SCOs. As a result, to many designers, SCORM specification is only applicable to those subject matter area that are heavily content-driven (such as engineering/computer science, mathematics/science, military and corporate training) whereby the e-learning courseware often takes the form of a string of content pages (objects) put together. Here, the content has to be granularised properly and planned for reusability. Granularizing content is no trivial matter. Granted, even though this is more of a design challenge than a limitation, the problem and challenge faced by designer is very real. The learning strategies most suitable for use are the directed, self-guided and adaptive learning strategies. To many designers, SCORM doesn't address issues arise from process-driven learning, i.e. learning that arises from interaction among learners about the content (such as collaborative learning [7]). To facilitate content reuse, learners' data between SCOs are not shared and communicated. On the flip side, it poses a challenge for designers who wish to design instructional activities that require collaborative efforts on learners' part, or adopting a score board for competitive learning.

Currently, the number of high level design and authoring software tools and systems is still 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 usually do not include any training on using this specification.

6. 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) [8]. They 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.

Researchers like Hayashi and Ikeda [9] have developed an ontology-aware authoring tool called *i*Designer. This tool is able to convert the author's design intention in knowledge level to the implementation at the symbol level based the SCORM 2004 Specification.

7. Conclusion

Using the SCORM 2004 3rd Edition Specification to design and develop e-learning courses brings a step closer to adaptive learning. Where previously educational technologists were trying out Intelligent Tutoring Systems (ITSs) for narrowly defined areas of technical training, They now have the option to use the SCORM 2004 3rd Edition Specification to develop different sequencing paths for learners. 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.

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