Master’s Dissertation on

**ITS in SCORM Framework**

*Submitted in partial fulfillment of the requirements for the degree of*

**Master of Technology**

*by*

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Approval Sheet

This thesis/dissertation/report entitled “ITS in SCORM Framework” by Subhasmita Mahalik is approved for the degree of M.Tech in Computer Science and Engineering.

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Declaration

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Abstract

Advent of Internet and World Wide Web have served as the foundation for distance learning systems. Most distance learning programs include a computer-based training (CBT) system and communications tools to produce a virtual classroom. The students taking the e-learning courses have different motivation and different back-ground. So Intelligent Tutoring System came into picture which provided real time sequencing that is updated while interacting with students. The ITS frameworks require the students information like current knowledge, performances in various quizzes to be stored in databases. But the problem was that the courses produced are time consuming and and are difficult to port to another learning environment. So there should exist a certain number of standards to define various parts of learning objects. SCORM is a sort of “standards package” widely used for this purpose. The learning content is made conformant to SCORM-2004 so that they can be ported to another similar learning environment. Also SCORM has the feature of sequencing and navigation. But to use these features the course creator should be able to manipulate the complex conceptual structures and rule sets. This becomes a barrier in the e-learning environment. So diagram-based standardized modelling language need to be used which can then be mapped to SCORM implementation.
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Chapter 1
Introduction

1.1 E-learning Standards

Distance learning is a field of delivering education using the world wide web to the students who are not physically present in a traditional classroom. In this type of learning the student is far away from the teacher and the resources. They are separated by in terms of time, distance or it can be both. Distance education is divided into two groups synchronous education and asynchronous education.

Synchronous form of education is similar to the traditional form of education with a timetable and all the participants being present in the same time domain but are remotely located. It follows a fixed timetable schedule. Educational television, video-conferencing, web-conferencing etc fall under this category. Direct-broadcast satellite, web-based VOIP and live-streaming have made this possible.

Asynchronous education system is more flexible and do not follow a fixed timetable. Student access material according to their fixed schedule. It includes web-forums, video-audio recordings, printed materials etc. But whatever form of education is used it should follow a standard to make it reusable and interoperable. So all the online-content produced should be a standard-compliant. The advantage of following a standard is that any other e-learning system can use the already produced content.

“ITS” is the acronym of Intelligent Tutoring System. It is developed using computer and is used in learning. It is advanced and developed version of CAI. But CAI contained only hard-coded links and ITS has some intelligence embedded into it. ITS makes the learning process more efficient by providing optimal path to complete a course. This optimal path through the course structure is decided depending on the student preferences, interests, knowledge, learning styles etc. So, the system collects information about the user taking the course and provides a personalized data. The student information is collected during the registration process and are stored in the database. The database is also updated while the student interacts with the course.

The issue of component interoperability of heterogeneous components is relevant to promote reuse of services and develop e-learning systems. E-learning is grouped into two core components: The Learning Management System(LMS) and The Learning Content Management System.(LCMS). LMS manages all the activities surrounding learning deployed via Web, such as user authentication, course deployment, and management of collaborative synchronous and asynchronous environments. So there should be a standard
using which the course content need to be developed.

1.2 Problem Statement

Varieties of courses are offered in an educational institute by different course providers using different tools and platforms. And also some students are less motivated than others and have different backgrounds. So the course should provide real-time sequencing that is updated while interacting with the student. Developing such courses is time consuming and cannot be imported. To solve this problem, a single standard format should be followed. Interoperability and reusability are two main features of SCORM standard. So the aim of this project is:

- To understand the SCORM standard and to design an education content management system.
- To integrate sequencing and navigation behaviour of SCORM into the content management system

1.3 Related work

Sequencing is an excellent technology most widely used in the ITS projects. The learning materials are stored in the databases and according to the students educational need the materials are provided to them. But if the sequencing has been implemented in the course then the student gains the knowledge following an optimal path. The optimal path may in terms of minimum time required to complete the course alongwith covering all the materials/course content offered by the course provider. Various approaches were explored in numerous projects. Like it can be task sequencing which manipulates the order of questions or problems provided to the user. Or it can be lesson sequencing where the bigger chunks i.e, the lessons are sequenced. Presentations, assignments and examples are mostly widely sequenced.

Two approaches that are discussed in the paper [20] are the dynamic course generation system DCG and the concept-based course maintenance system CoCoA. DCG looks like a traditional course that is structured. It uses the domain knowledge representation of the course. The learner has to give a pretest and accordingly the planner component searches for a path showing the materials that are to be read by the user. A student model is created for each learner and is updated as the student proceeds through the course. Concept-based Courseware Analysis (CoCoA) framework is made up of elementary domain knowledge. The size of the course content is not fixed. These course content make a hierarchy where the knowledge of parent concept is sum of the knowledge of the child concepts. Four kind of roles are used in CoCoA: light prerequisite, strong prerequisite, light outcome and strong outcome. Strong outcome or strong prerequisite deals with deep knowledge and the light outcome or the light prerequisite deals with the surface knowledge.

While the two approaches are different but they share some similarities too. Domain knowledge model is used to represent the knowledge that is composed of small knowledge elements. Both the approaches use a network domain model which has wider application and is much more powerfull. This model has links showing the relationship between them.
So there are several ways to represent the course sequencing in the adaptive learning environment.

But the DCG based education is class based i.e, the student has to take the test at the same time and have to study the same material same as if he is in a virtual class. Bootstrapping the DCG method is expensive. So it is mainly for homogenous students. CoCoA approach does the indexing on the course materials. Larger the proportion of indexed material, the more problems are provided by the system. So, CoCoA method is quite good for the situations in which the course materials are very large in number. So it also decreases the bootstrapping cost.

1.4 Organization of the Thesis

This explains about the educational standard called SCORM and the intelligent tutoring system. We have integrated the SCORM standard into the ITS to make the system reusable and interoperable. We have designed a content management framework having student and teacher interface. The thesis is organized as follows: We first introduce the SCORM standard, its features, the different APIs. Then the next section explains about the intelligent tutoring system. The major modules like the pedagogical module, the student module, the domain module and the UI is described in this section. Then at the end we compare the similarity between the different modules of SCORM and the ITS. And map the ITS events that trigger the SCORM functions to be called. The last section is the conclusion and the future work.
Chapter 2

Study of SCORM

2.1 Introduction

Advent in the field of information technologies, electronics and computer systems has made the accessibility of the wide range of applications easier. The issue of component interoperability of heterogeneous components is relevant to promote reuse of services and develop e-learning systems. E-learning is grouped into two core components: The Learning Management System (LMS) and The Learning Content Management System (LCMS). LMS manages all the activities surrounding learning deployed via Web, such as user authentication, course deployment, and management of collaborative synchronous and asynchronous environments.[1]

LMS also interacts with the run-time environment and traces the student learning process while the e-learning course is offered.

The server component implements the RTE by J2EE technology, while the client component needs a Web browser supporting ECMA script and Java applets to enable the communication between didactic contents and an e-learning platform.

The Middleware Machine node is composed of five software components. The Front End component presents the appropriate features and contents to the students and teachers using the components on the Middleware Machine node. The front end uses Tracer Component to trace the learning process and a Content Sequencer to show the suitable knowledge content. The instructional designer uses Deliverer component to deploy e-learning activities or a whole course. The Content Deliverer component allows the instructional designer to deploy single e-learning activities or whole courses. The Collaborative Environment Manager component is used to manage the cooperation among students and teachers. The RTE Machine node contains the software components to manage and deploy linear and adaptive didactic contents as well as to trace learning processes. The Synchronous Collaborative Manager component on the Service Machine Node provides means to handle and use synchronous and asynchronous collaborative environments.

There were lot more courses and lot more course providers. The big problem was that the course providers could not share the courses. All the courses were different. They did not communicate. Then came the brilliant idea that there should be standard. Then they invented SCORM.

Now the question is What is SCORM. Before we talk about SCORM lets think a moment about communication. When we communicate, we begin with many assumption
without even realizing it. Imagine you are a teacher in the classroom. One of the most important part of your job is to communicate. But what if the students do not speak English and you didn’t speak their language. Nobody would understand you. In order to understand each other we must have basic assumptions on how to communicate. And that’s what SCORM is: A basic set of assumptions that allows courses and LMS to communicate. Now getting back to our basic question: What is SCORM?? SCORM is the best and popular standard for building online content. If you want to build or buy an online course to share with learners it got to be SCORM course. The word SCORM is an acronym. It stands for Sharable Content Object Reference Model. When a course is sharable you have lot more freedom on how to use that course in the organisation. You can take it from one system to another without changing it. Lessons in SCORM are called objects. It’s like sections in a textbook. You can have any number of sections. You can set moves for those lessons. For example you can make sure that the learner have to understand one lesson before going to another. To sum up the SCORM course is a collection of lessons, packaged with instructions that are understood by online learning management systems called LMSs. A SCORM course is like a good teacher. They both have an lesson plan and track the progress of the learners. They both know who you are and call you by name. They both track your progress and record when you study and when you leave. Both the teacher and the SCORM course record your score.

The SCORM specification, developed by Advanced Distributed Learning, is a set of rules that learning management systems (LMS) and learning content follow in order to be compatible with each other. SCORM allows the content to be uploaded, launched and tracked by the Learning management Systems (LMSs).[5]
2.2 Anatomy of a SCORM package

- **Asset**: Assets are electronic representations of images, text, sounds, media, assessment objects, HTML pages and other data. Assets do not communicate with LMSs. Assets are the smallest resuable items. They can be deployed, arranged, purposed, or used many times in many different contexts and applications.

- **SCO**: Unit in which the E-learning contents are delivered are known as SCOs. They are package that are **self-contained, independent, transportable** and have lowest level of granularity that LMSs tracks[1]. SCOs should be small in size so that they can be reused. SCOs are files made up of Javascript, HTML, or different types of Client side technologies( like Macromedia Flash). SCOs should be platform independent and transportable.

- **Aggregation**: An aggregation is a collection of related activities. An aggregation may contain SCOs or other aggregations. In this Guide, an aggregation is defined as a parent and its children. An aggregation is not a physical file; it is a structure within a SCORM manifest where sequencing rules are applied to a collection of related SCOs or aggregations.

- **Organization**: Content package also contains organization where SCOs are arranged into a tree structure. Sequencing behaviors are then assigned to the SCOs. It is a tree structure outlining the whole course content. The organizations are delivered as a single content package. Organization are also referred to as the root aggregation in this document.

- **Curriculum or Course**: While a curriculum or course is outside the scope of SCORM, SCORM-conformant content can be part of a curriculum or course that
is managed by your LMS. A curriculum consisting of multiple independent components. It consists of some SCORM organizations and a combination of other learning experiences (such as, collaboration sessions, labs, lectures). A curriculum includes lessons, courses and assessments using a variety of instructional strategies and delivery media.

- **Content Package**: Content Package[1] contains a manifest file that is placed on the root of the content package folder and it contains more than one SCO. Manifest file is used to find and import the SCOs into the LMS. Some authoring tools will create the entire content package after you load your SCOs and assets into the tool. The ADL version of the RELOAD is an example of such a tool. RELOAD provides a graphical interface for creating a content package and managing sequencing and other values contained in the manifest file.

The SCOs which are to be uploaded in the LMSs are first packaged in PIF(Package Interchange Folder) and are then deployed in the server. The PIFs are like ZIP files.

The LMS utilizes the content of the manifest file and loads the course content i.e, the SCOs accordingly. **Components of Content Package**

Two principal parts of a SCORM content package is:

1. The XML manifest file that describes
   - The SCOs or assets that are included in the package
   - Organization i.e, the content structure diagram created
   - The sequencing rules
   - Metadata for the SCOs, aggregations, and also the package

2. The resources that is all the SCOs and asset files

- **Manifest**: An Extensible Markup Language (XML) file organizes the content package. This XML file is the manifest file. The manifest is a detailed set of instructions, structured in a manner specified by SCORM, that organizes your content package and tells the LMS when, how, and what content to deliver to your learners.[9]

The manifest file is always named imsmanifest.xml and it always appears at the top level of a content package (zip file), regardless of the structure of the rest of the package.

The basic structure of a manifest file contains:

**Metadata node**: The metadata section is where additional informative data about the course is placed. At its simplest and most common form, it only contains the schema and schemaVersion elements:

```xml
<metadata>
  <schema>ADLSCORM</schema>
  <schemaversion>20044thEdition</schemaversion>
</metadata>
```

**Organization node**: The organization consists of multiple activities (SCO or aggregation) represented by item elements. This structured representation of the
content is typically called the "Activity Tree." Inside the organization and item is where all the sequencing is defined.

\[ \text{organizationsdefault} = \text{"ORG - SAMPLE"} \]

\[ \text{organizationidentifier} = \text{"ORG - SAMPLE"} \]

\[ \text{adlseq} : \text{objectivesGlobalToSystem} = \text{"false"} \]

\[ \text{itemidentifier} = \text{"AGGREGATION1"} \]

\[ \text{title} > \text{SampleAggregation} < /title > \]

\[ \text{itemidentifier} = \text{"SCO1"} \text{identifierref} = \text{"RES1"} \]

\[ \text{title} > \text{SampleSCO} < /title > \]

\[ \text{itemidentifier} = \text{"SCO2"} \text{identifierref} = \text{"RES2"} \]

\[ \text{title} > \text{AnotherSampleSCO} < /title > \]

\[ \text{/item} \]

\[ \text{/organization} \]

\[ \text{/organizations} \]

**Resource node:** SCORM content typically consists of web-delivered assets. These assets may be HTML, images, Flash objects, audio, video, etc. The resource section of the manifest file lists all of the resources. A resource is a grouping of related assets. There are two types of resources: SCO resources and asset resources. If a set of assets is shared by multiple SCOs, then an asset resource listing may be created to remove repetition of assets in the manifest file. The asset resource is referenced using the dependency element.

\[ \text{organizations} \]

\[ \text{organization} \]

\[ \text{title} > \text{ExampleCourse} < /title > \]

\[ \text{itemidentifier} = \text{"EXAMPLE-SCO"} \text{identifierref} = \text{"SCO-RESOURCE"} \]

\[ \text{title} > \text{ExampleSCO} < /title > \]

\[ \text{/item} \]

\[ \text{/organization} \]

\[ \text{/organizations} \]

\[ \text{resources} \]

\[ \text{resourceidentifier} = \text{"SCO - RESOURCE"} \text{adlcp} : \text{scormType} = \text{"sco"} \text{type} = \text{"webcontent"} \]

\[ \text{href} = \text{"load.html"} \]

\[ \text{filehref} = \text{"load.html"} \]

\[ \text{filehref} = \text{"example.jpg"} \]

\[ \text{filehref} = \text{"example.swf"} \]

\[ \text{filehref} = \text{"example.mp3"} \]

\[ \text{dependencyidentifierref} = \text{"LESSONCOMMON"} \]

\[ \text{/resource} \]

\[ \text{resourceidentifier} = \text{"LESSON - COMMON"} \text{adlcp} : \text{scormType} = \text{"asset"} \]

\[ \text{type} = \text{"webcontent"} \]

\[ \text{filehref} = \text{"common/apiwrapper.js"} \]

\[ \text{filehref} = \text{"common/common.js"} \]
2.3 API Wrapper

It is a file will locate the SCORM API instance and contains all the functions required for the content to communicate with the LMS. These functions are standard JavaScript functions and may be used just like any other JavaScript functions in a web page. To be conformant, a SCO must make, at a minimum, two calls. The first, doInitialize(), must be called to initiate communication between the LMS and the SCO. The second, doTerminate(), must be called at some point before the SCO exits. [9]

2.4 Understanding the SCORM API

SCORM APIs are developed using ActiveX controls, Java applets and javascript. The APIs serve as a communication channel between LMSs and SCOs. Data are then passed through this channel. The SCOs finds the APIs and contacts and then starts communicating with the LMS. The SCO can be launched either in a new browser window or frame within a page. The SCO uses these steps to find out the target window where the content need to be opened: First, it searches for API_1484_11 (or API) in the parent window (if framed) or the window that opened it (if a new window). If it does not find the API, the SCO expands its search by looking in the parent of the window that opened it, the parent of its parent, and so on according to the specification. If it finds the API then the methods to start communication with the LMSs are invoked and data are transferred. And if it does not find the API then user is given the alert message about the communication fail.

2.5 Data Transfer

The SCORM specification has set of methods for making the communication between SCO and LMS easier. These methods are simply javascript codes. These methods are accessed as objectname.methodname(arguments)[1]. The objectname is same as the APIname, methodname is the name of the method intended to be used. The SCO begins the communication with LMS using these standards[8].

2.6 API methods

- **Initialize** It is the first method called to begin the communication. When this method is called successfully then it returns the value true, else false. Only after successful completion of this method the other methods can be invoked.

- **Terminate** It is the last method called to end the communication. When this method is called successfully then it returns the value true, else false. After successful completion of this method no other methods can be invoked.
Figure 2.3: API Adapter State Transition

- **Commit** This method is invoked to save the data sent to the LMS via the setValue method. Terminate method implicitly invokes this method too. If this method is not invoked then the learner's data does not get saved. When successfully completed it returns true else false.

- **GetValue** This method is used to get values from the LMS. It is invoked with the data element whose value is required as argument. When successful it returns the value of the data element requested.

- **SetValue** This method is used to pass data from SCO to be stored in the LMS. But in order to save the data Commit method need to be called. The SCO must invoke this method with the name of the data element which needs to be updated, and the value. It returns true when successful else returns false.

- **GetDiagnostic** It is for LMS specific use. Returns a diagnostic text description based on the parameter that is passed as an argument. When completed successfully, the diagnostic information text will be returned.

So the getValue and setValue are used to send and retrieve the values to and from the LMS. learner_name, learner_id, score, completion status are some of the common data elements whose values are communicated to the LMS. Some methods are executed during the onLoad of the body tag. It initializes the communication. At that time value of learner_name, learner_id are the mainly retrieved from the LMS. The SCO may attempt to load previous data such as score in a quiz, learner responses may be required to proceed further through the course, progress status, to continue further through the course. At the end of the session the result data are sent by using the setValue and are saved by Commit and then terminate is invoked to close the connection.

### 2.7 CMI Data Model

This section explains storing and retrieving data about learner performance from and to the Learning Management System (LMS). Understanding the types of data that can be
communicated via the SCORM data model enables you to discuss with your instructional system designer (ISD) what information you can retrieve from or store in the LMS. The data model is used whenever you need to store or retrieve data related to the learners session in the LMS. For example, you might want to retrieve the following information from the LMS[9]:

- Score
- Total time spent in a SCO
- Time spent in a single session of a SCO
- Completion status
- Responses to assessment items
- Interactions within a SCO
- Pass/fail status

The cmi data model is accessed through JavaScript calls in the content. In the API wrapper files we are using in this document, there are two calls that are used when working with these elements: doSetValue and doGetValue. Values of the cmi data model are simple strings and numbers.

```javascript
//get the learner's name
var name = doGetValue("cmi.learner_name");

//set the score for the SCO
var score = ".85";
doSetValue("cmi.score.scaled", score);

//mark the SCO as passed
doSetValue("cmi.success_status", "passed");

//lookup the bookmark of a SCO
var bookmark = doGetValue("cmi.location");

//store the current state data of the SCO to be used after resuming.
//savethisdata refersto a string stored in the LMS thatupon
//resumptionofthecoursewillbe fetched and used to initialize the
//content
doSetValue("cmi.suspend_data", savethisdata);
```

### 2.8 Inter-SCO Data Storage

Prior to SCORM 2004 4th Edition, SCOs had no visibility or access into information tracked by other SCOs or even different attempts on a given SCO. With 4th Edition, ADL has provided the adl.data data model element to allow for the sharing of sets of data across SCOs through a collection of data stores. [10]

Data stores are associated with a SCO using the `adlcp:data` extension element in the Manifest File. The data stored in adl.store may be shared across content packages as well. An attribute `adlseq:sharedDataGlobalToSystem` in the `organization` element of
the manifest controls if this data is accessible outside the scope of the content package. The default value is true, so be sure to set the value to false if you wish to restrict access.

bfStatus and Scoring

Both a SCO and an aggregation have a primary objective. This primary objective is an object holding status values related to the progress and success of the learner’s interaction with the activity. The following information is stored in the primary objective:

- Success status
- Completion status
- Score (scaled, raw, min, max)
- Progress measure

When you need to track a numeric score in a SCO, the score object of the primary objective is used. The score is calculated by the content. For example, to set the score to 85%, the following JavaScript code is used in the content:

```javascript
doSetValue("cmi.score.scaled",".85");
```

The other elements of cmi.score are used to provide additional context only. These include cmi.score.min, cmi.score.max, cmi.score.raw. The min and max values may be used to define a range and the raw element should be a number within the range of min and max. A score in and of itself does not have any impact on the course. It should be combined with the Success Status and Sequencing. The Success Status represents if an activity is passed or failed. This can be set directly, using the data model API:

```javascript
doSetValue("cmi.success_status","passed");
```

### 2.9 Sequencing and Navigation

- **Sequencing:** Sequencing is optional. If the content designer want to provide the freedom to the learner about the choice of the sequence of the materials, then no sequencing needs to be specified[5]. SCORM sequencing depends on activity tree, Sequencing Definition Model and Sequencing Behaviors. How do you specify sequencing? According to some of the designers their content should follow a specific sequence otherwise it won’t be that effective. SCORM 2004 allows to specify sequencing behavior in the content package. But if a learner already have concept about the content provided then he should be given the freedom to choose the materials according to his choice. So, there should be both guided and unguided flow about the course content. So the free choice should not be disabled.

- **Navigation:** It provides a “Continue” button in each page of the content package. This helps in navigating from one SCO to another. Navigation assumes existence of UI for triggering this event. LMS translates the navigation event to corresponding navigation request and provide the next learning material. When Commit is called the data are saved in the LMS and activity tree status is updated. Since navigation signal is just a request it can be denied based upon the status at the activity tree and sequencing rules.
2.9.1 Activity Tree

Activity tree (AT) describe the structure of learning activity. The content organization is translated into activity tree. AT contain the corresponding sequencing information for the interoperable application. So learners experience with the same content structure may be different.

![Image of Activity Tree]

Figure 2.4: Relationship between Content Organization and Activity Tree

2.9.2 Sequencing Definition Model

It is a set of elements to define intended behavior. These include sequencing control modes, constraint choice controls, sequencing rules, rollup rules, objective, selection controls, randomization controls, and delivery controls.

- **Constraint choice controls**: Activities can be targeted as choice only logically is addressed in constraint choice. Prevent activation disallows an attempt begin because choice request targeting on descendent of the activity

- **Limit Conditions**: Limits the number of attempts and the duration time can be spent in a single attempt

- **Rollup Rule**: Set the clusters tracking status

- **Local VS. Shared Global Objectives**: Objective progress information defined for the activity

- **Selection Controls**: Indicate when to select certain activities and limit the number of activities to be chosen

- **Randomization Controls**: Indicate when and how the ordering of the children of the activity should occur

- **Delivery Controls**: Describe actions the LMS will take prior to an attempt on an activity beginning and after the attempt ends
2.9.3 Sequencing Behavior

- **Tracking model**: Capture information gathered from a learners interaction with the content objects associated with activities.

- **Activity state model**: Manage sequencing state of each activity in the AT and the global state of AT

- **Sequencing definition model**: Describe how the various sequencing processes utilize and interpret Tracking Model information

2.10 Exiting SCOs and Courses

The concept of exiting learning content is an important one. Everything that gets launched must eventually exit. There are many variations of exiting a course, that will appear to be similar from the learner’s perspective, but the results are quite unique. There are multiple applications of the word ”exit,” so to make it clear, consider the following use cases:

1. The learner has finished a SCO and is ready for the next activity.
2. The learner needs to ”pause” in the course and return later.
3. The learner has completed all the activities in the course.

Each of these represents a way to ”exit” an activity in the course. When a SCO terminates, it is either with a normal or suspend exit state. If a SCO is exited normally, it means that this attempt on the SCO is completed and any re-entry into the SCO will initiate a new separate attempt. A suspended SCO retains state data from the prior session, and upon resumption of the content, the learner may be placed where he/she left off.

To exit normally, which typically indicates some finality (not needing to resume), the following JavaScript code in the SCO may be executed:

```javascript
doSetValue("cmi.exit","normal");
doTerminate();
```

To exit in a suspend state (the ability to resume later):

```javascript
doSetValue("cmi.exit","suspend");
doTerminate();
```

If the SCO is exited, as described above, the course session is still active. The learner will have to select a new activity or sequencing will present a new activity to him/her. The course session is not necessarily exited if the SCO exits. A course is usually exited when the learner needs to take an extended break from the course or when the course is completed.

A course is exited through the use of exitAll or suspendAll navigation requests. If a course receives either of these navigation requests, this will cause the course to close and the LMS will regain control.

There are four places that affect when and how content is exited:
2.11 ADL SCORM Overview

**Bookmarking**

Bookmarking is the common term used for allowing the learner to take a break and then return to where they left off in the content. SCORM 2004 does not use the term Bookmarking, but provides multiple ways to accomplish this. This can be done either by *Save the State Or Suspend the Content*.[5]

Two ways to save content state that can be accessed when the learner resumes. These elements are simply storage areas for text that may be used for bookmarking. No bookmarking occurs automatically.

*cmi.location* (hold 1000 characters) and *cmi.suspend_data* (hold 64000 characters) are the two options for bookmarking using Save the State.

**Prerequisites**

A very common design pattern is that of a prerequisite. This is where the availability of one activity is dependent on some external condition, typically the completion or satisfaction of a prior activity.

The steps to implement this are listed below and are described in detail in this section:

1. Create an aggregation (cluster) for the lessons
2. Add Rollup Rules to aggregation
3. Map aggregation’s primary objective to a shared global
4. Create Pre-Condition rule on the assessment

**Assessments**

An assessment, otherwise known as a test, is a common type of content. It is implemented as a normal SCO. However, SCORM provides some features that can assist in the tracking and reporting of the learner’s experience in the assessment. The tracking requirements for an assessment will vary based on the design. In some cases, you may only need to mark the assessment as passed or failed. In other cases, you may also need to calculate a numeric score and store this in the LMS as well. In yet other instances, you may have to capture and store in the LMS detailed information about each assessed item.

Most assessments are graded and given a result of passed or failed. This value is calculated by the programming logic in the course and the resulting value is stored in the LMS as follows:

```javascript
//cmi.success_status is either passed or failed
doSetValue("cmi.success_status", "passed");
```

Many assessments are also given a numeric score. The calculated numeric score is stored
in the LMS using the cmi.score object:
```javascript
// represents ascore of 75%
doSetValue("cmi.score.scaled","0.75");
```
The cmi.interactions data model element is an array type object consisting of many interactions. A single interaction describes a tested item. An interaction is represented by dot notation similar to other cmi data model elements. The most common elements used in the cmi.interaction object are: id, description, type, timestamp, correct_responses, learner_responses, result, latency. The interactions are a collection of information stored in arrays. The cmi data-model uses a zero-based index position (n) in the dot-notation to separate the data.

### 2.12 Benefits and Drawbacks of SCORM

**Benefits**

From a business perspective, standards are beneficial because they are essential to the growth and expansion of any technology-based industry. Whether it's 802.11 for wireless networking, HTML for the Web, or standardized track gauges for railroad transportation, standards foster efficiencies and synergies that enable markets to grow. These benefits certainly apply to e-learning standards, allowing organizations that adopt SCORM to create efficiencies, lower costs, reduce risk, and increase overall learning effectiveness and return on investment (ROI).

Before SCORM, integrating content with a delivery platform for e-Learning or training used to take days, weeks or sometimes years, unless the content was built specifically for that platform. Often the costs of modifying the content or building special adapters, along with the time to deployment, were simply prohibitive.

1. **Reuse content for faster development** Developing content once, then reusing it for multiple audiences and contexts, reduces development time
2. **Share content between systems** Moving to SCORM makes integration easier between existing and future systems, protecting your infrastructure investments and lowering your cost of ownership. SCORM learning content can be integrated with, and delivered on, past and future SCORM-compliant systems
3. **Reduce cost of content maintenance** By enabling your organization to maintain content in-house using any tool you choose regardless of system or content vendor, SCORM lowers your overall cost of content maintenance
4. **Maximize technology investments** SCORM content can be launched, operated, and tracked by any SCORM-compliant content delivery system, whether content was developed in-house or by a third party, enabling you to get the most mileage from your technology investments
5. **Avoid proprietary authoring tools** The same tools that your development team is using to create Web content can be used to develop SCORM-compliant content, eliminating the need to use or develop proprietary tools
6. Train developers faster. As SCORM adoption continues to grow, the talent pool of content developers experienced in SCORM techniques and technologies grows too. A wide selection of SCORM training materials is available to get less experienced developers up-to-speed fast.

7. Leverage best practices. Take advantage of the collective knowledge and expertise of the growing SCORM community that is continually evolving and enhancing SCORM functionality, tools, methodologies, and best practices with proven results.

**Drawbacks**

1. The standard is completely based on a Web environment (mostly browsers).

2. The standard puts a great emphasis in the client-side of the learning process.

3. The security of the API can only be guaranteed in a very limited way since it must be accessed from JavaScript and consequently can also be manipulated externally.

4. Inherently insecure.
3.1 Introduction

Computer is used in Computer-aided instruction (CAI) to teach to promote communication and language development and skills and academic skills. It includes computer tutors and computer modeling. But the problems in traditional computer aided instruction is that traditional CAI has specified set of presentation and text, canned questions and associated answers. So it lacked the ability to adapt to students. So Intelligent Computer Aided Instruction (ICAI) came into picture. ICAI has rich representation of domain. It has the ability for reasoning, user modeling and the communication of information structure.

“Intelligent Tutoring System” is a broad term used to describe the education system that contains intelligence. It is developed using computer and is used in learning. It is advanced and developed version of CAI. But CAI contained only hard-coded links and ITS has some intelligence embedded into it. ITS makes the learning process more efficient by providing optimal path to complete a course. This optimal path through the course structure is decided depending on the student preferences, interests, knowledge, learning styles etc. So, the system collects information about the user taking the course and provides a personalized data. The student information is collected during the registration process and are stored in the database. The database is also updated while the student interacts with the course.

The ITS model contains four components: the student module, the expert module, the tutoring module, and a learning environment or user interface. The student module contains information about the student knowledge, behavior, demographic data, interests, learning style, etc. The domain module is responsible for knowledge representations. The teaching module serve as a teacher. And the learning module helps in interaction with the user. There numerous number of intelligent tutoring system with varied number of intelligence level.

3.2 Learning Scenarios

It is the scenario where the students learning is to take place. It can be of various types like coaching environment, gaming environment, socratic teaching method, simulation based training and discovery learning. In the coaching environment the students are first offered with advices and are guided when they get misdirected. The gaming environment
combines both coaching and allows the students to discover learning. Socratic teaching makes students learn by giving questions, not answers. The students then learn by developing a probing mind by asking a lot of questions to themselves. A Simulation-based learning creates a virtual environment similar to an actual scenario and make the students work on it. It helps the student to get the feel of the real-scenario and develop fluency on the virtual environment which then can be later applied to real situation later. Another mode of learning called the discovery-based learning makes the student learn by discovering. Students analyse the existing situation, identify problem, propose solution, develop thesis, test their result and then refine their hypothesis to develop a better theory.

Research indicates that ITS-taught students faster and translate the learning into better performance than the traditional learning. For example [18], Carnegie Mellon University, researchers developed LISP Tutor (an intelligent tutoring system) in the mid-1980s for teaching computer programming skills to college students. In one controlled experiment, students who used the ITS scored 43 percent higher on the final exam than a control group that received traditional instruction. When given complex programming problems, the control group required 30 percent more time to solve these problems, compared to the ITS students.

### 3.3 Components of ITS

![Figure 3.1: Ideal ITS scenario](image)

#### 3.3.1 Domain module: Knowledge Representation

The form in which we store the knowledge is crucial to our abilities to use it. There exists no general form that is suitable for all knowledge. The main challenge in representing knowledge is to determine the type of knowledge required, and suitable representation for that knowledge, to support teaching particular subjects. There are various ways in which knowledge are represented.
• **Bayesian network**: A knowledge base consists of two types of nodes\[19\]: learned and shown. Each atomic-content is represented in the nodes. Each topic then consists of some test and some set of questions. There is dependency among the nodes.

• **Semantic network**: Nodes represent the domain knowledge and the links represent the relation between them. It supports flexible query and reasoning\[19\].

• **Hierarchical Rule Structure**: Rules are arranged in a hierarchical structure. If the condition in the parent rule is satisfied then the actions in the child is fired and action is taken.

• **Concept Map**: The Ontology stores concept and the various relationship among them. Concept map and ontology are two similar type of knowledge representation.

• Kukla et al. (2004) assume\[19\] that the knowledge structure is considered on two levels: conceptual (knowledge pieces and relations between them) and presentation (sequences of hypermedia pages called presentations). The learning scenario is a sequence of presentations and tests after each presentation.

### 3.3.2 The Pedagogical Model: Instructor model

The model where the system should decide the appropriate explanation style to be used with a certain user based on his history (user model). This model act as a the teacher in traditional classroom. Accordingly materials are provided to the students. If the student is identified as a beginner then step by step process is revealed and detailed explanation and examples are given. Else he may be asked to perform a process by himself. The identification of the student into different group is done by gathering the information about the student while registering.

### 3.3.3 The User Model: Student Model

This module is concerned with information related with the user abilities and subject understanding, it contains the history of the user. It evaluates each learner’s performance. Then the learners reasoning skill and perceptual ability is determined. The tutoring system determines the student’s misconceptions from this answer. Users strength and weaknesses are maintained in database, and accordingly the system provides the relevant and specific instruction.

### 3.3.4 User Interface

It deals with text generation in tutoring systems. Via this user interface the student interacts with the system.

### 3.4 Problem Generation

Problem generation, expert problem solving and student diagnosis can be viewed as a set of constraints on the solution. Student answers are then evaluated by checking that
all constraints are satisfied. Student are given feedback on wrong answers by telling him which constraints he failed to satisfy. When the learner proceeds the expert knowledge model is compared with the learner knowledge model and using AI, the sequence of instructions are dynamically generated by the system.

In order to develop good tutor some principles of designing should be followed. These include representation of student competence as a production set, communicating the goal structure underlying the problem solving, providing instruction in problem solving context, promoting an abstract understanding of the problem solving knowledge, minimizing working memory load, providing immediate feedback on errors, adjusting the grain size of instruction with learning, facilitating successive approximations to the target skill.

3.5 Benefits and Drawbacks of ITS

Advantages of Intelligent tutoring system because of World Wide Web is that it is globally accessible independent of distant-time, interactive, distributed, learner-controlled, convenient, environment friendly, cost-effective, non-discriminatory etc.

But there are some drawbacks of ITS too. They are it is highly costly to put the new technology. Getting teachers and students to get used to the new environment requires time. Also instructor’s effort is required to connect conventional education to ITS.
Chapter 4

Implementation

4.1 ITS in SCORM framework

In distance education system education is given to wide number of students with different educational back-ground and with different motivation. So the content provided to them should be dynamic according to the student’s learning need i.e, the course content should be personalized. To do this ITS stores the student current knowledge in the database.

Figure 4.1: Activity Tree with Clusters

But developing such an intelligent system is very time consuming and also they cannot
be imported. So SCORM standard can be used for this purpose. SCORM standard defines communication and packaging with transferrable file. SCORM use SCO(Sharable Content Object) which are the smallest reusable unit of SCORM which can be launched in SCORM conformant environment and is used for communicating with the LMS.

![Functional model of an ITS](image)

**Figure 4.2: Functional model of an ITS**

SCORM Content Aggregation Model(CAM) has three major parts: metadata, content packaging and sequencing and navigation[11]. The sequencing in SCORM is done by using activity tree. The activity tree has three major modules: sequencing structure, sequencing definition and sequencing behaviour[9]. The activity in the activity tree is called SCO in SCORM. The nodes of the activity tree are called the clusters. The parent cluster stores information about the sequencing strategies. The non-cluster children have content resources that will be delivered according to the sequencing strategies defined in the cluster.

The User Interface module is used for communicating with the student. The Tutor module is responsible for generating problems dynamically based upon the student performance in attempted module. Students are given problems set of problems with different difficulty level and based upon the performance of the student next problem for the particular student is decided.

When the SCORM standard is compared with the ITS framework, then it is observed
that Run-time Environment of SCORM is similar to Communication module of ITS. Tracking data model of the SCORM Sequencing and navigation is similar to the Student module of the ITS. And the expert module is the actual resources provided to the user. The expert module and student module are compared parallelly while the student proceeds through the materials. The database storing the information of the student is updated alongside and the next set of problems are generated dynamically.

As the student proceeds with the material, the student model and the expert model are compared using AI techniques, and the sequence of learning activities is dynamically generated to suit the needs of the student. Every ITS have the two major functionalities: (1) the inner loop and (2) the outer loop. Inner loop is executed while the learner works on an activity. And the outer loop is executed when a new activity is selected.

1. Until the course is complete
2. Until the module is complete, do:
   2.1. Tutor provides the appropriate materials
   2.2. Student goes through the materials
   2.3. Student takes the quiz of that module
   next level is decided.
   2.3. Tutor stores the student performance in the
3. Student ends the course and gets the final marks
Also every activity according to the SCORM SN has two important set of data associated with it. They are (1) tracking data and (2) Sequencing definition. The tracking data module of SCORM can be used to develop the student module of the ITS. The user information can be collected while the registration process itself. And these information gets updated while the student proceeds through the course. And the navigation module of SCORM is used to select the next task. So, the combination of navigation and sequencing of SCORM helps to choose the next task in the ITS.

Content Management System Framework is a web portal which provides interface to the course provider to upload the materials, subdivide them into modules, and setting quizzes using which the students category will be decided and materials will be provided accordingly. The teacher interface also have the privilege to view the student performance.

And in the student side, an interface is provided with an opening learning scenario after registering for the course. The registration process act as the tracking system of SCORM. Similar type of students are given same course content. So they are grouped into groups while registration process(figure:4.3).

**Limitation of the Framework**

It do not provide modification of the opening learning environment. It just decides the level of the next module according to the performance in the quiz.

### 4.2 Creation and Deployment of SCO

SCORM is just a standard and a SCORM object (or package) is just a collection of information. Creating one is relatively easy. Here follows the steps to create a simple SCO [8]:

1. Create a folder and two sub-folders. One of the subfolder will contain resources and the other will contain SCORM object.
2. Start the Reload editor.
3. Go to "File," select "New" and choose "ADL Scorm" to create a new SCORM object. The "Select Folder for New Content Package" window will appear.
4. Choose the resource folder as content package folder and click OK.
5. Right-click on the "Organizations" item in the main window and select "Add Organization" to add a default organization to your SCORM object. Right-click on the new organization, named by default "Organization," and select "Rename." Change its name to "Main," the conventional name for default organizations.
6. Right-click on "ScormPack," select "Import Resources" and browse to your resource folder. All the files present in this folder will be imported to your SCORM object.
7. Drag the resource files from the resource folder to the "Main" organization to add them to your object.
8. Right-click on ”MANIFEST-...” and select ”Add Metadata” to add a metadata container. This will create a ”Metadata” item. Right-click it, go to ”Add Schema” and select ”Schema Version.”

9. Go to ”File” and click ”Save” to save your SCORM object. Go to ”File” and select ”ZIP content package” to start creating a content package from your object. Give a name to your new package and select a location where to save it.

10. Test your new SCORM object by using the Reload Editor’s ”Reload Scorm Player” tool.

Once the SCO is created it can be deployed by uploading the zip file in LMS. various available LMSs are: Moodle, Atutor, Meridian, Docebo etc. In case of moodle the following steps are followed to upload a file:

1. Click on ”Turn editing on” after logging into moodle.

2. Click on ”Add an Activity or Resources” as is done while uploading other resouces. It opens a pop up window.

3. Select ”SCORM package” in the pop window that was opened in the previous step.

4. Click ”Browse” and upload your ZIP file.

5. Choose the various options according to the requirement.

6. Once the SCORM object is uploaded it can now be accessed by the students by simply clicking on the activity. It opens the object in the browser.

Otherwise, one can test the ZIPped SCORM object by using https://cloud.scorm.com/link. It provides the LMS interface for launching and testing the SCOs.
Chapter 5

Conclusion and Future Work

Studies show that ITS make the student learn with greater interests than the traditional classrooms. The performance also increases if the intelligent tutoring system is used. But making an intelligent tutoring system is a time consuming process and are not reusable. So if a standard is followed for designing such system they can be used by other course designers. SCORM compatibility feature has made it to be used widely in the e-learning standard. It has a leading effort in resuablity and interoperability. The tools that are available to make content SCORM-compliant are easy to use and friendly. But making an ITS following SCORM standard is time consuming but the reusability and interoperability feature makes the task worth.

The content management framework designed do not have the feature to modify the opening learning scenario. The learning scenario of each module is decided just after the performance in the quiz. So, if a student fails a test he is again given the same set materials of the same level. This feature will be added to the framework for better performance.
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