Towards Quality Learning Objects by Integrating Accessibility and Instructional Design

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Declaration

I hereby certify that this dissertation which I now submit for assessment by the School of Computing, Dublin Institute of Technology on the programme of study leading to the award of **M.Sc in Computing (Information Technology)** is entirely my own work and has not been submitted for assessment for any academic purpose other than in particular fulfilment for the stated above.

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Abstract

E-learning content is more sophisticated than ever at present. The concept of Learning Objects are gaining acceptance in the industry whereby any content classified as e-learning should be able to be interchangeably used among different systems. As a concept, it aims to reduce cost and complexity and also to eliminate duplicate efforts.

The main challenges to this approach are that learning object creation is a function of three disparate fields. Adherence to instructional design theories, e-learning standards and accessibility guidelines determine the quality of a learning object.

This dissertation aims to study all these factors and provide a checklist that can act as a framework for creating learning objects.

Keywords: Learning Objects, Instructional Design, Behaviourism, Constructivism, Cognitivism, Learning Standards, Accessibility, Section 508, WCAG, Learning Object Metadata (LOM), Learning Object Repository (LOR), Learning Management System (LMS).

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1. Introduction

1.1 Background

E-learning has evolved significantly since the first instances of applications of educational software with minimal interactivity. The earliest versions were essentially page turners, where the learner's interaction with the application was mostly limited to clicking the 'Next' button on the screen to move on to the next screen. This was not very different from reading a book sequentially. With the newer versions, the level of sophistication and interactivity in e-learning courseware has grown in leaps and bounds (Koohang, 2004). This has been made possible by simultaneous advances in the power of computers, a wider choice of course delivery mediums and an explosion of technologies and tools customised to the specific needs and challenges involved in developing learning objects. However, with growth has come the pressure to balance the varying demands by stakeholders involved in the field.

A Learning Object (LO) is a term that encompasses a variety of electronic media and items that aid learners. Hence, e-learning has been taken out of the strict boundaries of traditional learning developers who develop targeted courseware for specific learning outcomes. The new wave of thinking behind Learning Objects encourages the use of anything that would enable a learner to achieve the necessary proficiency in a given discipline (Polsani, 2003).

But it is clear that effective learning solutions incorporate three important factors – a sound instructional strategy, conformance to e-learning technology standards and an inclusive design for making it accessible to people with physical disabilities. This project is an exploration of each of these factors and an attempt to propose a framework for the creation of an ideal learning object.

1.2 Project Description

There are three dimensions that learning content developers must consider to ensure delivery of high quality learning objects:

Instructional Design - The theories that underpin cognitive psychology and guide the development of content tailored for specific needs. Instructional designers are trained in learner psychology, learning theories and taxonomies, and courseware development processes. They are mostly involved in the design stage and create the strategies for each project.

E-Learning Standards - The standards defined by various bodies that ensure reuse granularity and interchangeable use within courseware. Although learning standards were defined by various industries depending on their specific needs, there has been a concerted move towards one or two common standards for e-learning courseware as a whole. Presently, the SCORM standard seems to be the favoured by most

development communities. Standards compliance is also necessary for deploying learning content on central servers called Learning Management Systems (LMS).

Accessibility Requirements - Most modern e-learning content is web-based for ease of delivery and access. This also means that additional effort has to be taken to ensure that the learning needs of people with disabilities are considered while generating such content. There is some ambiguity in this domain because accessibility guidelines are clearly defined for general web-based content but not specifically for web-based e-learning content. The rule of thumb when it comes to accessibility has been to adhere to the World Wide Web (W3C) accessibility guidelines. More often than not, this is motivated by fear of legal action for non-compliance rather than any analysis of learning needs of people with disabilities. Often, a strict implementation of W3C guidelines would result in the weakening of the pedagogical effectiveness of the e-learning courseware. It is the Holy Grail of e-learning to strike the perfect balance between the two.

In the recent past, when e-learning development was a niche domain each of these factors listed above were the domain of specialists in the given area. Therefore, an instructional designer was not under the added pressure of thinking about accessibility while designing instructional strategies. Similarly, e-learning technology professionals were more worried about the implementation details rather than instructional design. However, with a move towards Learning Objects there is a greater dependence and interplay between each of these roles.

While a significant amount of research work has gone into each of these fields individually, a holistic look at these three dimensions solely within the context of e-Learning development will be an interesting challenge. It would of particular interest to explore research that straddles all three factors. The author feels there is potential to propose a new framework for learning development that encompasses all three.

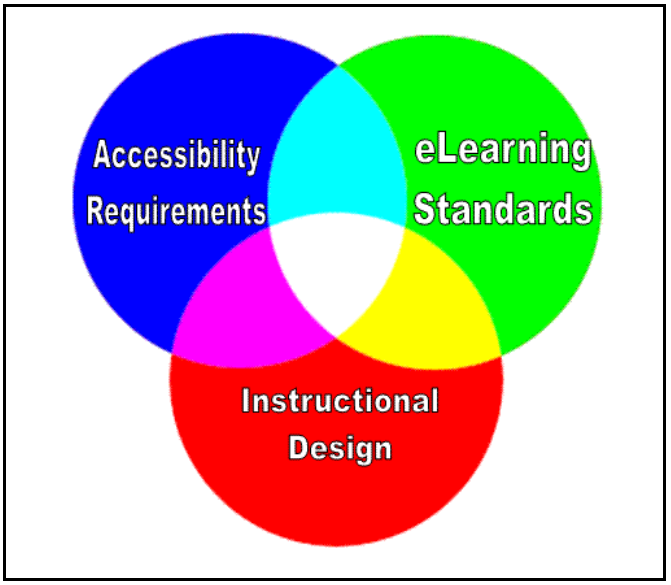


Figure 1: Three Dimensions of Quality Learning Object Design

1.3 Research Methods

It is important in any project to ascertain prior art or the work that has been done in field already. As e-learning has been accepted as a branch of study which is included as part of computer science and educational psychology, there was ample opportunity to review published literature in those disciplines. This part of the research consisted of desk-based research such as review of academic papers, journals, magazines, conference proceedings and authoritative documents from the Internet. It was helpful in understanding the history of the discipline and the evolution of e-learning techniques and the factors affecting it.

To ascertain current trends in the field, two questionnaires were designed. The target audience was practicing e-learning professionals within the learning development team of multi-national IT corporation. The first questionnaire was used to gather data about instructional design trends. The other one was used to identify information about e-learning standards and accessibility guidelines. The objective of the exercise was to gather qualitative data and ideally a direct interview in an exploratory manner would have been preferred for this. However, due to the geographical dispersal of the sample crowd across multiple countries, the questionnaires were deployed online.

The trial version of an e-learning tool was evaluated to understand real world implementation of subjects discussed. A checklist that can act as a framework for Learning Object development is designed as a direct result of research.

1.4 Project Aims and Objectives

The aim of the project is to develop a framework that enables the creation of quality Learning Objects by integrating instructional design, e-learning technologies and accessibility requirements.

The objectives for the exercise are:

- In-depth immersion and understanding of current research in the field of educational psychology, instructional design, and learning courseware development processes.

- A study of e-learning standards and the standards body behind each of the standards. This is helpful in understanding the motivation behind creation of different standards and the reason a select few are in favour currently.

- An analysis of the accessibility guidelines followed by the World Wide Web Consortium (W3C) and a study of the difficulties in adapting these guidelines to create web-based e-learning content.

- Investigation of an e-learning authoring tool to understand the content generated. The various aspects to understanding this content are the levels of instructional design possible, compliance to e-learning standards and compliance to accessibility guidelines.

- Exploration and background work that leads to a framework for creating learning objects that gives importance to the 3 factors discussed above.

1.5 Intellectual Challenge

The intellectual challenge posed by this project lies in the fact that all the present iterations of learning objects seem to satisfy any one or two of the factors discussed above (Kelly *et al.*, 2004). Therefore, from an overall quality perspective it is sometimes found lacking. There are inherent difficulties in trying to synthesise a framework that aims to satisfy such disparate requirements. A learning object that rates highly on accessibility might score low on instructional design. On the other hand, a learning object designed with a high level of focus on instructional theories and pedagogy might not comply with accessibility guidelines. When both these requirements are satisfied, it might be found lacking in the e-learning standards department. To distil all three into a form that satisfies a significant amount, if not all, of the requirements would pose a challenge.

1.6 Thesis Roadmap

Chapter two introduces the concept of Learning Objects, the definition, debate surrounding them, Learning Object Metadata (LOM) and Learning Object Repositories (LOR) and challenges encountered while trying to reuse Learning Objects. It also explores centralised servers called Learning Management Systems (LMS) on which learning content is deployed.

Chapter three is a detailed look at instructional design theories and processes, e-learning standards and standards bodies, and accessibility constraints with associated difficulties in implementing them - which are the three primary factors identified as crucial to the creation of Learning Objects.

Chapter four discusses the design of two questionnaires and the rationale for each question included in those. The selection of the audience to be queried and the skills and experience levels of the sample crowd are also explained in this chapter.

Chapter five is dedicated to the qualitative and quantitative analysis of the survey data. Qualitative responses are evaluated with the help of 'gist analysis' – a technique where salient phrases and the general themes are identified. Quantitative responses are evaluated with statistical tools built into the online survey hosting system.

Chapter six explores the trial version of three popular e-learning tools to understand how it implements standards and accessibility. IBM Simulation Producer, Adobe Captivate and RWD uPerform were compared and their features studied.

Chapter seven presents a checklist that can act as a framework for Learning Object design. The check list is an amalgamation of the most desirable features of a learning object. The chapter also provides the conclusions drawn by the author and points out possible future works in this area.

2. Learning Objects

2.1 Introduction

This chapter discusses Learning Objects. Sections are dedicated sequentially to discuss its definition, debate surrounding them, its architecture, challenges in their reuse and Learning Object Metadata (LOM) and Learning Object Repositories (LOR) It also discusses Learning Management Systems (LMS).

2.2 Definition of Learning Objects

The term Learning Object was first popularized by Wayne Hodgins in 1994 when he named the CEdMA (Computer Education Management Association) working group "Learning Architectures, APIs and Learning Objects"(Polsani, 2003). However, the exact meaning of the phrase Learning Object is still under debate (Polsani, 2003; McGreal, 2004). Some of the definitions that are provided include:

"[A Learning Object is] 'any digital resource that can be reused to support learning.' This definition includes anything that can be delivered across the network on demand, be it large or small. Examples of smaller reusable digital resources include digital images or photos, live data feeds (like stock tickers), live or pre-recorded video or audio snippets, small bits of text, animations, and smaller web-delivered applications, like a Java calculator. Examples of larger reusable digital resources include entire web pages that combine text, images and other media or applications to deliver complete experiences, such as a complete instructional event" (Wiley, 2002)

"*For this standard (Draft Standard for Learning Object Metadata v6.1), a Learning Object is defined as any entity, digital or non-digital, that may be used for learning, education or training*" (IEEE, 2001)

"*[A Learning Object] is defined as the smallest independent structural experience that contains an objective, a learning activity and an assessment*." (L'Allier, 1997)

Michael Shaw offers two modified interpretations of Learning Objects:

A contextual learning object (CLO): *"a chunk of instruction or a supporting mechanism that has been originally designed to have specific meaning and purpose to an intended learner, so that meaningful knowledge and/or learning can be derived from it, applied, linked to other knowledge, or simply retained."* (Shaw, 2003)

A mutated learning object (MLO): "a learning object that has been re-purposed and/or re-engineered changed or simply re-used in some way different from its original intended design - to one with a different implicit or explicit purpose, and/or outcome, and/or learner, while retaining an acceptable level of (educational) validity or use." (Shaw, 2003)

2.3 Debate around Learning Objects

As expected, the plethora of definitions on offer has created some confusion for a neutral observer. Wiley is recognised as a well-known authority on Learning Objects (LO) and Instructional Design. However, even his definition has been criticised as too broad and over-arching (Polsani, 2003). Polsani argues that all digital resources like images, photos, videos and audio should not be classified as learning objects unless they meet some basic criteria. When the term was initially used, the idea was that Learning Objects would be analogous to the objects created in the context of Object Oriented Programming (OOP). Therefore, some of the qualities that a resource has to exhibit to qualify as a learning object are modularity, separation of content and context, and reusability. That being the case, it becomes apparent that Wiley's definition of Learning Objects might include resources that would not strictly fit into the description.

What is clear from the discussion is that a high premium is placed on the capability of Learning Objects to be reused. For this goal to be achieved, the creation and operation of Learning Objects should be processes that have minimal dependence on each other. This automatically implies that LOs cannot be designed with a strong orientation towards any particular instructional theory or methodology.

2.4 General Architecture for Learning Object Deployment

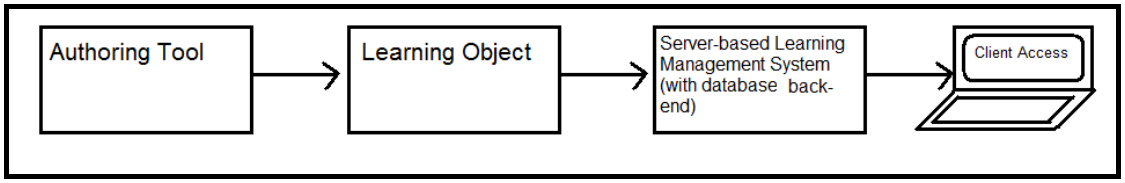


Figure 2: General LO Architecture

The author has conceptualised a general architecture for Learning Objects deployment and use from the definitions as shown above. The tools used for authoring Learning Objects could range from purpose-built e-learning tools with built in support for standards to general purpose tools that can generate a variety of web-based content including text, graphics, audio and video (Koohang, 2004). Some tool vendors who are not traditional players in the e-learning market also provide strong support for creating learning content within their tools. A notable example is Macromedia Captivate.

The Learning Object thus created is deployed on Learning Management Systems (LMS) depending on the standards to which it adheres. An LMS provides support for services like hosting the LO, enrolling and managing users, tracking scores and providing feedback to the learner. Client access, in most cases, is provided on a PC with the help of a web browser.

2.4.1 Challenges in reuse of LO

Reusability refers to prospective and future usage scenarios of Learning Objects. This entails that the specification of possible usage contexts determine the degree of reusability of the learning object, and that overall reusability may be measured as the degree of adequacy for each of the possible contexts specified (Vargo *et al*., 2003). So, despite the best intention of a developer, a Learning Object that suits a particular context or even a set of contexts could be rendered completely inadequate if there is a change to the status quo of the scenario.

Technical/operational aspect of learning object reusability deals with the problems of cataloguing, retrieving learning objects and creating a system for repository interrelation (Boskic, 2003). To some extent, these concerns are addressed by Learning Object Metadata (LOM) and Learning Object Repositories (LOR) discussed elsewhere in this chapter.

Also, with reuse comes the legal dimension of ownership. With breaking down and re-coupling of learning objects to create new ones, the ownership of new Learning Objects created continually in this manner fall into an ambiguous region. Some practitioners advocate the open source model of content sharing, but that approach might not always be palatable to all concerned stakeholders (Boskic, 2003).

2.5 Learning Object Metadata (LOM)

The success of a strategy that views Learning Objects as reusable resources rests on how effectively the true use and nature of a Learning Object can be assessed. This is also essential to rapidly identify and select a particular Learning Object from a repository. This is where Metadata, also referred to as 'data about data', plays an important role. The concept of Metadata is often explained with the help of the index card metaphor in academic literature. Just as an index card provides a visitor with information pertaining to the layout and arrangement of books in the library, Learning Object Metadata provides similar information about the characteristics of a particular Learning Object to potential users.

The current Learning Object Metadata (LOM) standards and data model are defined by the 'IEEE 1484.12.1 Standard for Learning Object Metadata' (IEEE-LOM, 2002). The standard specifies 59 metadata elements that are broadly classified into nine categories (Vargo *et al*., 2003):

1. General
2. Lifecycle
3. Meta-metadata
4. Technical
5. Educational
6. Rights
7. Relation
8. Annotation
9. Classification

Vargo *et al*. have also produced a table based on the types of Learning Objects based on the IEEE LOM standard, which has been reproduced below.

Aggregation Level *Level 1* refers to the most granular or atomic level of aggregation, e.g. single images, segments of text, or video clips *Level 2* refers to a collection of atoms, e.g. an HTML document with some embedded images, or a lesson *Level 3* refers to a collection of level 2 objects, e.g. a set of HTML pages linked together by an index page, or a course *Level 4* refers to the largest level of granularity, e.g. a set of courses that lead to a certificate
Interactive Type *Expositive*: information flows primarily from the object to the learner for and includes text, video and audio clips, graphics, and hypertext linked documents *Active*: information flows from the object to the learner and from the learner to the object for learning-by doing including, simulations and exercises of all sorts *Mixed* : a combination of expositive and active
Resource Type Resource types could include: exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative, text, exam, experiment, problem, and self-assessment

Table 1: LO types (Vargo et al., 2003)

Wiley points out that the reusability of a learning object is inversely related to its aggregation level (Wiley, 2000). Therefore, Learning Objects classified under Level 1 and Level 2 would lend themselves to reuse more easily when compared with those of Level 3 and Level 4.

2.6 Learning Object Repository (LOR)

Learning Object Repositories serve as the gateway to Learning Objects. They are usually made of a centralized server that can contain Learning Object Metadata and the Learning Objects themselves or in some cases maintain metadata only and provides links to the Learning Objects available on the internet.

Learning Object Repositories have been studied and the popular repositories have been divided into 4 distinct categories (Vargo *et al*., 2003):

- Commercial repositories that provide a service to instructors and course developers. This includes publisher websites that list aids like PowerPoint slides, case studies and simulations.

- Vendor repositories maintained by e-learning providers to support their own development efforts.

- Corporate repositories maintained by large companies and military organizations for internal personnel training.

- Open access repositories established by academia. These are often funded by educational grants from the government and universities. Contributions to such open access repositories are made by individual educators and participating institutions.

Some literature questions if open-access repositories are necessary at all, given the availability of easy-to-use and highly effective full-text web search engines. Others counter that notion by arguing that potential users require metadata to retrieve non-text objects such as images or video, and they also require standard metadata to identify an object as designed for learning and to efficiently select the best object to meet their pedagogical need. Repositories satisfy these requirements by providing tools for entering, storing, and retrieving object metadata.

Repository	URL	Description
UT TeleCampus	http://www.telecampus.utsystem.edu/	Online education portal from University of Texas system.
Apple Learning Interchange	http://edcommunity.apple.com/ali/	A social network for educators to share content provided by Apple Inc.
The Math Forum@Drexel	http://mathforum.org/	An online forum for teaching, learning and communicating about mathematics.
MERLOT	http://www.merlot.org/merlot/index.htm	A repository of peer-reviewed learning content
SLOOP	http://www.sloopproject.eu/	A European project for promoting open sharing of Learning Objects.

Table 2: Learning Object Repositories

2.7 Learning Management System

A Learning Management System (LMS) is a centralised software tool, usually hosted on a server, which allows digital courseware to be deployed on it. Almost all LMS come with a powerful database back-end. The web-based nature of most prominent LMS allows any-time, any-place, and any-pace access to content hosted on it (Darbhamulla & Lawhead, 2004). LMS find commercial use in enterprises and corporations which need such a system to manage the learning needs of a huge number of employees spread across different locations. In some regulated industries like financial services and pharmaceuticals, compliance training needs are met by deploying courses centrally on an LMS and making it mandatory for employees to certify themselves by completing the required courses. Most buyers of LMS use authoring tools to create e-learning content which conforms to a standard - usually SCORM or one of the others (Darbhamulla & Lawhead, 2004). This content is then hosted on an LMS. So, the choice of an LMS is also dictated by the standard to which the content adheres.

Some of the features provided by modern LMS are:

- Manage users, courses, instructors, and reports.
- Manage course calendar.
- Messages and notifications about enrolment, completion and expiry dates.
- Tests, assessments and scores.

The focus of an LMS is to manage learners, keeping track of their progress and performance across all types of training activities. It performs heavy-duty administrative tasks, such as reporting to HR and other ERP systems but is not generally used to create course content.

2.7.1 LMS vs. LCMS

A further development of LMS is the Learning Content Management System (LCMS). It is a multi-user environment where learning developers may create, store, reuse, manage and deliver digital learning content. The notable advantage that LCMS have over LMS is that it can be used to create courses by reusing content from different courses.

LCMS gives authors, instructional designers, and subject matter experts the means to create e-learning content more efficiently. The primary business problem an LCMS solves is to create just enough content just in time to meet the needs of individual learners or groups of learners. Rather than developing entire courses and adapting them to multiple audiences, e-learning developers create reusable content chunks and make them available to course developers throughout the organization. This eliminates duplicate development efforts and allows for the rapid assembly of customized content (Greenberg, 2002).

An LMS, however, has an advantage in that it can manage and track blended courses and curriculum assembled from online content, classroom events, virtual classroom meetings and a variety of other sources.

Brandon Hall Research, who are well known for their e-learning presence and the awards for e-learning excellence have published a comparative table of LMS and LCMS that is reproduced below.

	LMS	**LCMS**
Primary target users	Training managers, instructors, administrators	Content developers, instructional designers, project managers
Provides primary management of...	Learners	Learning content
Management of classroom, instructor-led training	Yes (but not always)	No
Performance reporting of training results	Primary focus	Secondary focus
Learner collaboration	Yes	Yes
Keeping learner profile data	Yes	No
Sharing learner data with an ERP system	Yes	No
Event scheduling	Yes	No
Competency mapping - skill gap analysis	Yes	Yes (in some cases)
Content creation capabilities	No	Yes
Organizing reusable content	No	Yes
Creation of test questions and test administration	Yes	Yes
Dynamic pre-testing and adaptive learning	No	Yes
Workflow tools to manage the content development process	No	Yes
Delivery of content by providing navigational controls and learner interface	No	Yes

Table 3: LMS and LCMS (Brandon Hall, 2007)

2.8 Conclusions

This chapter discussed Learning Objects, its definition, debate surrounding them, its architecture, challenges in their reuse and Learning Object Metadata (LOM) and Learning Object Repositories (LOR). It also discusses Learning Management Systems and how they differ from Learning Content Management Systems (LCMS).

3. E-Learning Standards, Instructional Design, and Accessibility Requirements

3.1. Introduction

This chapter is a detailed look at e-learning standards, instructional design, and accessibility constraints which are the three primary factors identified as crucial to the creation of Learning Objects.

First the primary e-learning standards and standard bodies are discussed. The positives and negatives of their work are identified from literature.

Next, the discipline of instructional design is explored. A detailed study of the philosophies, theories and models in the field is carried out.

Finally, the chapter discusses accessibility legislation and guidelines and how it affects the development of e-learning content.

3.2 e-Learning Standards

With any system that proposes interchangeable use, a set of standards need to be established to preserve the system. This is also essential to ensure that the boundaries and framework for operation are clearly defined. National and international committees, consortia and other organizations have been busy developing standards and specifications for e-learning technologies at least since the late 1990's (Friesen, 2005). Some of the organisations actively involved are the Advanced Distributed Learning (ADL), AICC (Aviation Industry Computer-Based Training Committee), IMS Global E Learning Consortium, the IEEE Learning Technologies Standards Committee (LTSC), and the ISO Subcommittee on "Information Technology for Learning Education and Training."

This is a definite indication of maturity of the e-learning sector. Digital technologies have been employed in e-learning well before the establishment of these standards. But these disparate efforts were driven by the individual organisation's needs rather than any need for inter-operability or re-use. Most of the development efforts were carried out on an ad-hoc basis and often at great expense. Standards in e-learning seek to address these shortcomings by ensuring interoperability and re-use of the content and the systems.

3.2.1 The ADL SCORM Standard

One of the most prominent standards for web-based e-learning is Sharable Content Object Reference Model (SCORM). SCORM is being developed by the Advanced Distributed Learning initiative (ADL), an effort sponsored by the White House Office of Science and Technology Policy and the US Department of Defence (Friesen, 2005). SCORM defines how content may be packaged into a transferable file and also

communications between client side content and Learning Management Systems (LMS).

The ADL website provides a history of the evolution of SCORM. SCORM Version 1.0 was the first implementation released in January 2000. However, the wider acceptance of SCORM began with Version 1.2 released in October 2001. It added the ability to package instructional material, thereby satisfying an important criterion for interoperability. Metadata support was also added with this version. The latest version is SCORM 2004 2nd Edition.

As per the description of the standard on the website – *"This version built up its collection of specifications and standards adapted from multiple sources to provide a comprehensive suite of e-learning capabilities that enable interoperability, accessibility and reusability of Web-based learning content."*(ADL, 2008)

SCORM benefits enormously from the support of the United States Department of Defense (DoD) and mandatory requirements for all the design, development and management of DoD-related courseware to be SCORM compliant. The DoD has also mandated that the US military should also adopt SCORM. The apparent support of the US federal government has encouraged the wide adoption of SCORM into commercial products and services.

However, SCORM is not without its fair share of criticism. Some of it comes from one of the architects of the standard itself. Daniel Rehak opines that SCORM is essentially about a single learner whose learning is self-paced and self-directed. This rules it out of contention for higher education needs (Friesen, 2005). This might be because standards are expected to balance the needs of courseware interoperability for a wide audience with focused instructional grounding.

The premise of interchangeable use of the content also comes under criticism from some researchers (Bohl *et al.*, 2002). They contend that reusing granular portions of courseware called Shareable Content Objects (SCO) brings with it various issues regarding ambiguity in copyrights, suitability for pedagogical problem at hand and a different navigation system within SCOs generated using various authoring tools. Similar issues also arise with writing style and look-and-feel used with each SCO. In addition, some of the time saved by reusing content is traded off for time spent on identifying and evaluating potential SCOs that can be stitched together. Also, a SCO deemed to be important for providing continuity within a course might not be in existence at a given time and would have to be designed and created from the ground up in that case.

3.2.2 The AICC Standard

AICC (Aviation Industry Computer-Based Training Committee), established in 1988, is an international association of professional organisations with a stake in training and professional development. As the name indicates, the aviation industry is a major participant but the standards developed by AICC are not specific to that industry alone. This strategy was adopted to make the standards appealing to the wider

community of e-learning vendors and professionals and bring in standardisation in the development of e-learning.

The most important contribution of AICC to e-learning standards is the CMI (Computer Managed Instruction) 'Guidelines for Interoperability' (AICC-CMI, 2004) and a series of CMI-related guidelines and specifications. The original CMI specification was designed for the client/server operation model. It was updated in January 1998 to add a web-based communication protocol called HACP (HTTP-based AICC CMI Protocol). The implementation provides for details of HACP to be hidden with the help of high level JavaScript APIs (Nakabayashi, 2001).

Similarly, it also defines data models for learner-related information such as name, ID and current score to name a few. Implementation using Windows INI file format and CSV file format is provided. The newer version also provides for implementation of the data model with JavaScript APIs.

3.2.3 The IMS Standards

The IMS Global Learning Consortium is a non-profit organisation established in 1997 consisting of members made up from parties interested in learning technologies. Some of the constituent members include governments, academic organisations and educational service providers. The scope for IMS specifications and standards covers elements used in distributed and collaborative learning. They promote the adoption of learning and educational technology and allow selection of best of breed products that can be easily integrated with other such products.

One of the most important specifications developed by IMS is the Learning Resource Metadata Information Model**.** This specification is not presently in wide use but it assumes significance in the light of the fact that the work done on this standard was a major contributor to the effort involved in producing the current IEEE Learning Object Metadata (LOM) specification.

Two other specifications from IMS that are considered important within the industry are 'Question & Test Interoperability Specification' and the 'Content Packaging Specification'**.**

IMS QTI: The IMS Question and Test Interoperability specification (QTI) defines a standard format for the representation of assessment content and results, supporting the exchange of this material between authoring and delivery systems, repositories and other learning management systems. It allows assessment materials to be authored and delivered on multiple systems interchangeably. The specification consists of a data model that defines the structure of questions, assessments and results from questions and assessments together with an XML data binding that essentially defines a language for interchanging questions and other assessment material (IMS QTI, 2008).

IMS Content Packaging: A content package is a file containing content and metadata. It is used in e-learning to define some learning content or an assessment that can be delivered, for example by a Learning Management System. It's a standard

way of describing learning content that can be read by many programs. The most widely used content packaging format is that defined by IMS Global, which uses an XML manifest file called `imsmanifest.xml` wrapped up inside a zip file. The learning content itself is either included in the zip file if it is HTML or other media that can run on its own, or else is referenced as a URL from within the manifest (IMS CP, 2008).

3.2.4 The IEEE LOM Standard

The IEEE Learning Technology Standards Committee (LTSC) is chartered by the IEEE Computer Society Standards Activity Board to develop internationally accredited technical standards, recommended practices, and guides for learning technology (IEEE LTSC, 2005). It comprises 20 working groups dealing with broad range of learning technology such as multimedia content, learner model, competency definitions, and so on. Among these WGs, WG2 deals with learner information, WG11 deals with CMI specification together with AICC and ADL, and WG12 deals with Learning Object Metadata (LOM) specification in conjunction with IMS and ARIADNE (Alliance of Remote Instructional Authoring and Distribution Networks for Europe), an European organization for learning technology standardization (Nakabayashi, 2001).

3.2.5 The ISO/IEC JTC1 SC36 Standards Committee

The International Standards Organisation (ISO) is a network of national standards institutes from 140 countries and works in partnership with international organisations, governments, business, and consumer representatives. The ISO/IEC JTC1 SC36 (ISO, n.d) develops international standards in the field of Learning, Education, and Training, with an aim to enable interoperability and reusability of resources and tools. JTC1 stands for "Joint Technical Committee 1" which has a scope of standardisation in the field of information technology as a whole. SC36 stands for "sub committee 36".

The focus of ISO/IEC JTC1 SC36 is on existing standards and technical reports. The sub committee consists of working groups and ad hoc committees which focus on different topics within the field of learning, education, and training (CETIS, 2005).

ISO standards emerge from the work of these specification bodies, which are used and tested, then submitted to the standards bodies. There is a continuous feedback mechanism between research and development, specifications bodies, test beds, and standards bodies to produce standards.

3.3 Instructional Design

Instructional design is the practice of enabling learning with the help of media. It aims to transfer knowledge to learners in the most efficient manner. The process usually consists of assessing the current level of the learner's understanding of a topic, defining the level to which the learner aspires to reach and then effectively deploying the requisite learning through a media to get there. The process is guided by established learning theories and can be delivered in a student-only, instructor-led or community based setting. The outcome of the instruction may be measured or assumed. Instructional design borrows a lot of its foundation from cognitive and behavioural psychology.

3.3.1 General Teaching Philosophies

Behaviourism

The theory of behaviourism concentrates on the study of overt behaviours that can be observed and measured (Good & Brophy, 1990). It views the mind as a "black box" in the sense that response to stimulus can be observed quantitatively, totally ignoring the possibility of thought processes occurring in the mind. Some of the renowned researchers in the field of behaviourist theory were Pavlov, Watson and Skinner.

Pavlov's most famous experiment in exploring behaviourism involved food, a dog and a bell. His experiment consisted of first ringing a bell, which did not elicit any kind of a response for the dog (before conditioning). However, it was observed that placing food in front of the dog initiated salivation. During the conditioning stage, the bell was rung a few seconds before the dog was presented with food. After conditioning, the ringing of the bell alone produced salivation (Dembo, 1994).

Some other Observations made by Pavlov include:

- Stimulus Generalization: Once the dog has learned to salivate at the sound of the bell, it will salivate at other similar sounds.

- Extinction: If you stop pairing the bell with the food, salivation will eventually cease in response to the bell.

- Spontaneous Recovery: Extinguished responses can be "recovered" after an elapsed time, but will soon extinguish again if the dog is not presented with food.

- Discrimination: The dog could learn to discriminate between similar bells (stimuli) and discern which bell would result in the presentation of food and which would not.

- Higher-Order Conditioning: Once the dog has been conditioned to associate the bell with food, another unconditioned stimulus, such as a light may be

flashed at the same time that the bell is rung. Eventually the dog will salivate at the flash of the light without the sound of the bell.

John B. Watson was an American psychologist who used Pavlov's ideas. He is credited with coining the term 'behaviourism'. He conducted experiments similar to that of Pavlov to study the role of conditioning in generating responses to certain stimuli. This could explain certain phobias and fears that people experience. (Good & Brophy, 1990)

Skinner believed in the stimulus-response pattern of conditioned behaviour. Skinner's theory dealt with changes in observable behaviour, ignoring the possibility of any processes occurring in the mind. Skinner's work differs from that of his predecessors (classical conditioning), in that he studied operant behaviour (voluntary behaviours used in operating on the environment) (Good & Brophy, 1990).

Cognitivism

Cognitivism arose as a result of the limitations perceived with behaviourist theories. Behaviourists were unable to explain certain social behaviours. For example, it was found that children do not imitate all behaviour that has been reinforced. Furthermore, they may model new behaviour days or weeks after their first initial observation without having been reinforced for the behaviour. As a result of this, scientists began to emphasise more complex cognitive processes such as thinking, problem solving, language, concept formation and information (Ertmer & Newby, 1993).

"*Cognitive theorists recognize that much learning involves associations established through contiguity and repetition. They also acknowledge the importance of reinforcement, although they stress its role in providing feedback about the correctness of responses over its role as a motivator. However, even while accepting such behaviouristic concepts, cognitive theorists view learning as involving the acquisition or reorganization of the cognitive structures through which humans process and store information."* (Good & Brophy, 1990).

Cognitive theories are attentive to the acquisition of knowledge and internal structures. Rather than measuring response to standard stimuli, cognitive theorists also attach importance to how learners know and how they have come to know. This provides insights into how a learner can apply knowledge gained in a specific scenario to another unrelated scenario. Cognitive theories emphasise making knowledge meaningful and helping learners to relate new knowledge to existing knowledge. Therefore, Cognitivism is better suited to explaining much more complex learning phenomena such as reasoning, problem solving and information processing.

Constructivism

Constructivists believe that learners construct their own reality or at least interpret it based upon their perceptions of experiences, so an individual's knowledge is a function of one's prior experiences, mental structures, and beliefs that are used to interpret objects and events.

"*What someone knows is grounded in perception of the physical and social experiences which are comprehended by the mind.*" (Jonassen, 1991).

As an observer can infer from the definition, constructivist philosophy promotes a more open-ended learning experience where the methods and results of learning are not easily measured and may not be the same for each learner. Constructivists believe that the mind filters its own meaning from the world to create reality. They believe that human beings create meaning for reality as opposed to acquiring it, that what humans know of reality stems from our own interpretation of experiences. It is closer in nature to cognitivism rather than behaviourism.

Constructivist theories found wide use in instructional design after the advent of hypertext and hypermedia-based technologies in the 1980s and 1990s. These technologies allowed for a branched design rather than a linear format of instruction. Hyperlinks allow for a greater control over learning which is crucial to constructivist philosophy. However, this also comes with the added peril of confusing novice learners. Literature on the subject advocate a two-stage approach - a linear instructional approach with predetermined learning outcomes during initial stages of learning and a constructivist environment for the more advanced stages.

3.3.2 Instructional Design Theories

Bloom’s Taxonomy

The contributions made by Benjamin Bloom, a University of Chicago researcher, to the field of educational psychology acts as guiding light to educators and instructional designers around the world. Bloom classified educational objectives in his seminal work 'Taxonomy of Educational Objectives'. The taxonomy assumes significance in the light of importance attached to audience analysis before designing e-learning courses. The competence level of the target audience in a particular discipline is a major consideration for instructional designers.

The taxonomy describes a hierarchical structure which has six levels. Simple recalls of facts form the lowest level of the hierarchy. Higher up the hierarchy has increasingly complex and abstract mental levels which in increasing order of complexity include understanding, applying, analysing, synthesising and evaluating.

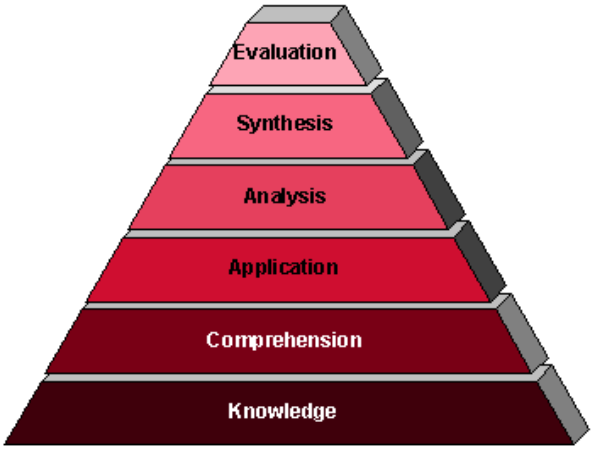


Figure 3: Hierarchy of Bloom's Taxonomy

The Taxonomy of Educational Objectives, often called *Bloom's Taxonomy*, is a classification of the different objectives and skills that educators set for students (learning objectives). Bloom's Taxonomy divides educational objectives into three "domains", Affective, Psychomotor, and Cognitive. The cognitive domain deals with a person's ability to process information in a meaningful way. The affective domain relates to the attitudes and feelings that result from the learning process. Lastly, the psychomotor domain involves manipulative or physical skills. Like other taxonomies, Bloom's is hierarchical; meaning that learning at the higher levels is dependent on having attained prerequisite knowledge and skills at lower levels. A goal of Bloom's Taxonomy is to motivate educators to focus on all three domains, creating a more holistic form of education (Bloom, 1956).

Bloom's classification of educational objectives primarily focuses on the cognitive domain (as opposed to the psychomotor and affective domains) of knowledge (Bloom, 1956). Bloom's taxonomy provides a structure in which to categorize instructional objectives and instructional assessment, often characterised in the form of verbs. The taxonomy is designed in order to help teachers and instructional designers to classify instructional objectives and goals. The taxonomy relies on the idea that not all learning objectives and outcomes have equal merit. For example, remembering facts, while important, does not equate to the ability to analyse or to evaluate. In the absence of a classification system (a taxonomy), teachers and instructional designers may choose, for example, to emphasise rote memorisation of facts (which makes for easier testing) rather than emphasizing other (and likely more important) learned capabilities.

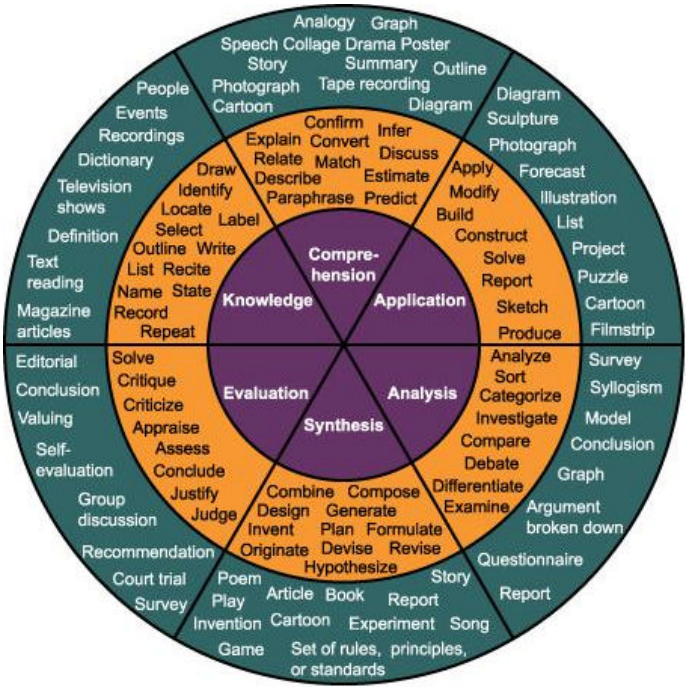


Figure 4: Verb Wheel associated with Bloom's Taxonomy (CSTEP, n.d)

Gagne's Nine Events of Instruction

Another recognised giant in the field of educational psychology is Robert Mills Gagne. His theories are elaborated in his best known work 'Conditions of Learning'. Gagne's major contribution to the theory of instruction was the model *Nine Events of Instruction* (Gagne et al, 1992). These nine events or steps are described below:

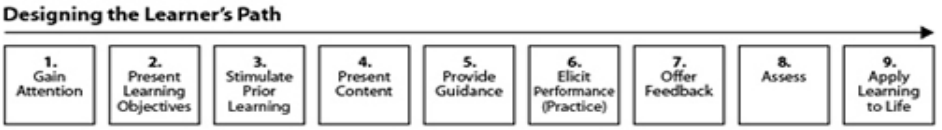


Figure 5: Gagne's Nine Events of Instruction

1.) Gain attention. Present a problem or a new situation. Use an "interest device" that grabs the learner's attention. This approach banks on the same principle of movie trailers. The idea is to pique the learner's interest so as to induce curiosity. Some techniques recommended are storytelling, demos, throwing out an unusual question to the audience or opening with a real life scenario/ case study.

2.) Inform learner of Objective. This allows the learners to organise their thoughts and around what they are about to see, hear, and/or do. This cues them and then provides a review which has proven to be effective. For example, describe the goal of a lesson, state what the learners will be able to accomplish and how they will be able to use the knowledge.

3.) Stimulate recall of prior knowledge. This allows the learners to build on their previous knowledge or skills. It is logical that learners are motivated when they build on existing knowledge relative to learning completely new inputs. Examples would be to providing a quick primer about the previous lesson and providing learners with a framework that helps learning and remembering.

4.) Present the material. Chunk the information to avoid memory overload. Blend the information to aid information recall. This allows learners to receive feedback on individualized tasks, thereby correcting isolated problems rather than having little idea of where the root of the learning challenge lies. Also, techniques like highlighting specific words in bold or colour aids in differentiating content.

5.) Provide guidance for learning. This is not the presentation of content, but is instruction on how to learn. This is normally simpler and easier than the subject matter or content. It uses a different channel or media to avoid mixing it with the subject matter. The rate of learning increases because learners are less likely to become frustrated by basing performance on incorrect facts or poorly understood concepts. Direct or indirect prompts help learners recognise patterns within the content easily and that acts as a motivating factor.

6.) Elicit performance. The learner is expected to apply the newly acquired behaviour, skills, or knowledge and do something.

7.) Provide feedback. Show correctness of the learner's response. This can be a test, quiz, or verbal comments. Learners need to be informed of the correctness or the degree of correctness of their performance to retain interest and continually improve.

8.) Assess performance. Performance can only be truly assessed by requesting a repeat of the activity that was part of the learning objective. This ensures that the learner has internalised the concepts completely.

9.) Enhance retention and transfer. Inform the learner about similar problem situations, provide additional practice, put the learner in a transfer situation and review the lesson.

Keller's ARCS Model of Motivational Design

John Keller proposes a four step instructional design process. The main components of this approach are Attention, Relevance, Confidence and Satisfaction (ARCS) (Keller *et al.*, 1988).

Figure 6: ARCS Model of Motivational Design (Peckham & Fallon, 2004)

Attention

The first part of this approach emphasises gaining attention. Attention can be gained in two ways:

- Perceptual arousal - uses surprise or uncertainty to gain interest. This approach uses novel, surprising, and uncertain events.

- Inquiry arousal - stimulates curiosity by posing challenging questions or problems to be solved. Maintain interest by varying the elements of instruction.

Methods for grabbing the learners' attention include providing visual stimuli like graphics and video, encouraging active participation, generating debate by splitting teams to argue for and against a particular concept and humour. After gaining attention, the key is to then maintain the learners' attention at an optimal level.

Relevance

Emphasize relevance within the instruction to increase motivation by using concrete language and examples with which the learners are familiar. Some of the strategies for maintaining relevance are taking into account the learner's present level of experience and explaining how the learning activity will build on it, highlighting immediate application potential of the new knowledge and providing a varied choice of learning options.

Confidence

Build confidence of the learners by presenting the instruction in a structured manner. Techniques recommended for confidence building include:

- Objectives and Prerequisites - Help learners estimate the probability of success by presenting performance requirements and evaluation criteria. Ensure the learners are aware of performance requirements and evaluative criteria.

- Grow the Learners - Every learning journey begins with a single step that builds upon itself. This allows a number of small successes that gets more challenging with every step.

- Feedback - Provide feedback and support internal attributions for success.

- Learner Control - Learners should feel some degree of control over their learning and assessment. They should believe that their success is a direct result of the amount of effort they have put forth.

Satisfaction

Satisfaction is based upon motivation, which can be intrinsic or extrinsic. Provide opportunities for the learner to apply the newly acquired knowledge or skill in a real or simulated setting. If learners feel good about the results, they will be motivated to learn. Provide feedback and reinforcements that will sustain the desired behaviour. However, satisfaction is also a function of the difficulty of the task. So, adequate measures must be adopted to ensure that the learner do not feel patronised by providing exercises that are too easy or limited.

Merrill's Component Display Theory (CDT)

The Component Display Theory (CDT) classifies learning along two dimensions: types of content and level of performance (Merrill, 1983). Types of content include facts, concepts, procedures, and principles. Content ranges from facts, which are the most basic forms of content, to principles. It is the actual information to be learned. The four types of content in component display theory are:

- Facts - logically associated pieces of information. Some examples are names, dates, and events.

- Concepts - symbols, events, and objects that share characteristics and are identified by the same name. Concepts make up a large portion of language and understanding them is integral to communication.

- Procedures - a set of ordered steps, sequenced to solve a problem or accomplish a goal.

- Principles - work through either cause-and-effect or relationships. They explain or predict why something happens in a particular way.

Level of performance is determined by ability to remember, capacity to use, and find patterns (generalities, frameworks). Performance is classified with remembering being the simplest form of performance, to finding the most advanced. Performance is the manner in which the learner applies the content. The three types of performance are:

- Remembering - the learner is required to search and recall from memory a particular item of information,
- Using - the learner directly apply the information to a specific case and
- Finding - the learner uses the information to derive a new abstraction (concepts, principles, etc.).

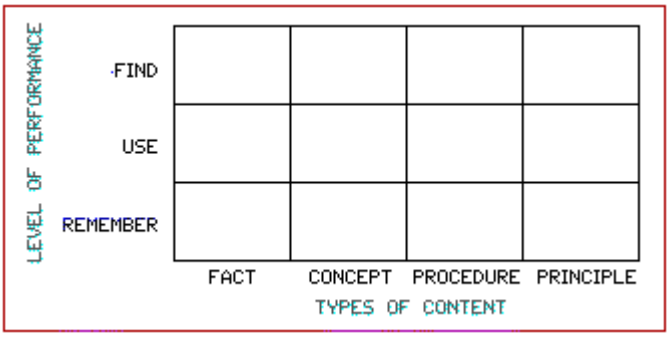


Figure 7: Component Display Theory (Merrill, 1983)

	Exercise 1	Exercise 2	Exercise 3	Exercise 4
FIND "a new generality"	Derive new working definition of conflict	Identify problems or disputes indicative of an underlying conflict		Think of three symptoms as manifestations of conflict from the various areas
USE "apply a generality to a specific case"	Identify differences between "problem", "dispute" and "conflict"	give specific cases from personal experience	give examples of intra/inter personal, intra/inter group etc from personal experience	identify symptoms of potential conflict for the given cases
REMEMBER GENERALITY "statement of a definition, principle or the steps in a procedure"	given a dictionary definition of conflict	common and differing characteristics of "problem", "dispute" and "conflict"	new working definition of the specific areas of conflict	diagnostic prescriptive approach to conflict resolution: "analyse existing or potential conflicts, diagnose causes and offer options for resolution
REMEMBER INSTANCE "specific illustrations"	thesaurus synonyms	examples	examples	examples of symptoms from the various conflict areas, inter-personal conflict, etc.
	FACT	CONCEPT	PRINCIPLE	PROCEDURE

Figure 8: Component Display Theory in Detail (Hintz, 1991)

Reigeluth's Elaboration Theory

Charles Reigeluth proposed the Elaboration Theory, which is a sequencing approach that is consistent with Merrill's Component Display Theory. The apparent relation between the two theories arises due to the fact that Reigeluth was a doctorate student under Merrill.

Reigeluth believes that instruction is made out of layers and that each layer of instruction 'elaborates' on the preceding idea. This has been compared to the working of a zoom lens in that it focuses from general to specific or simple to complex. This principle as applied to elaboration theory is called a 'cognitive zoom' (Reigeluth & Stein, 1983). Each level of zoom is called a sequence. Sequencing, in this case, relates to fundamental ideas or core principles. The basic ones are presented first, this in turn, leads to a great layer of specifics. Each sequence of ideas or principles are called 'epitomes' in elaboration theory. The epitome serves as a foundation from which more specific information may be developed. The seven steps of elaboration theory include sequence, organise, summarise, synthesise, analogy, cognitive-strategy activator and learner control.

Elaboration theory serves as a macro strategy of instructional design rather than an actual operational model.

The ADDIE model

The ADDIE model is a process model traditionally used by instructional designers and training developers. The five phases of the model namely - Analysis, Design, Development, Implementation, and Evaluation give it the name. However, there does not seem to be an original, authoritative version of the ADDIE model claimed by any particular author in the field. Rather, it seems to be an umbrella term that serves as the basis for more elaborate models proposed on similar lines (Molenda, 2003).

The general consensus on the five phases of ADDIE model is as follows (LTK, 2008):

Analysis

During analysis, the designer identifies the learning problem, the goals and objectives, the audience's needs, existing knowledge, and any other relevant characteristics. Analysis also considers the learning environment, any constraints, the delivery options, and the timeline for the project.

Design

It is a systematic process of specifying learning objectives. Detailed storyboards and prototypes are often made, and the look and feel, graphic design, user-interface and the type content is determined here.

Development

The actual creation (production) of the content and learning materials based on the Design phase.

Implementation

During implementation, the plan is put into action and a procedure for training the learner and teacher is developed. Materials are delivered or distributed to the student group. After delivery, the effectiveness of the training materials is evaluated.

Evaluation

This phase consists of (1) formative and (2) summative evaluation. Formative evaluation is present in each stage of the ADDIE process. Summative evaluation consists of tests designed for criterion-related referenced items and providing opportunities for feedback from the users. Revisions are made as necessary.

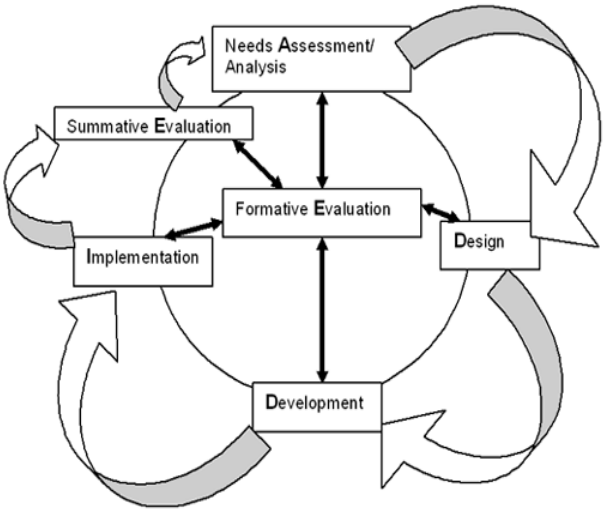


Figure 9: ADDIE Model of Instructional Design (NOAA, 2007)

3.4 Accessibility Requirements

Modern trends in e-learning point to a larger shift in publishing Learning Objects as web-based content for easy deployment and sharing. However, this also means that much of that content come under the purview of legislation that governs general web content and websites. One of the key factors to be considered for such content is its 'accessibility'. Accessibility (or web accessibility) is the practice of making web content usable by people with disabilities (Seale, 2006).

The World Wide Web Consortium's (W3C) Web Accessibility Initiative (WAI) has proposed standard guidelines so as to make websites accessible. Chief among them is the Web Content Accessibility Guidelines (WCAG). Some effort has also been expended by the IMS Global Learning Consortium in proposing accessibility guidelines specific to e-learning content (IMS Guidelines, n.d). Legislation also plays

an important role in motivating vendors to create accessible content. An initiative in the US called 'Section 508 Amendment to the Rehabilitation Act of 1973' was enacted for the benefit of disabled users. Section 508 was enacted to eliminate barriers in information technology, to make available new opportunities for people with disabilities, and to encourage development of technologies that will help achieve these goals (Section 508 standards). For e-learning operations in the US, this is particularly significant because legislation mandates that all federal government purchases be 'Section 508 compliant'. Similar legislation also exists in other developed nations.

However, developing accessible e-learning resources have additional challenges compared to conventional web content. E-learning developers are under the added pressure of understanding the accessibility guidelines while also trying to implement a pedagogically sound approach (Kelly *et al.*, 2004). They propose that rather than blindly following web accessibility guidelines to generate e-learning content, adequate attention must be paid to the learning outcomes as well. In summary, production of e-learning that is accessible is now a necessity rather than a nice-to-have feature.

3.4.1 Users of E-Learning Resources with Disabilities

Not all disabilities prevent learners from making full use of e-learning. However, some disabilities present serious obstacles to an effective and comfortable learning experience. A white paper on accessibility from consultancy Frontend (Frontend, 2005) classifies such disabilities:-

- Visual impairment which may include blindness, low vision or colour blindness could prevent the ability to peruse content on a computer monitor.

- Motor skills - inability to manipulate input devices like mouse or keyboard

- Hearing impairment – prevents learning with the aid of audio

- Cognitive difficulties - dyslexia, memory loss

3.4.2 Motivation for Providing Accessibility

Moral and ethical - It is simply the 'right thing to do'.

"The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect" (Berners-Lee, n.d.).

Learning is one of the most base and primal needs of society. It is how people improve themselves with associated ripple effects on society. Just as learning is never denied to somebody because of their cultural or ethnic background, it should not be denied to someone because of their physical limitations. Therefore, the onus is on e-learning developers to take adequate measures to ensure that the learning content created by them is accessible.

Technical - Web content and web sites lend themselves to easier maintenance and updates by designing them with a focus on usability and accessibility. Usability and accessibility are two factors that feed into each other (Seale, 2006). The savings in effort by having a standard style sheet (CSS, XSLT) to control the aesthetics of the web site also is a motivating factor.

Legal - As an endeavour that requires regulation, accessibility compliance is also mandated by legal processes. Legislation in various countries mandate all web related activities, and by extension e-learning, be accessible. The most prominent of such legislation appears to be 'Section 508 of the Rehabilitation Act' enacted in the United States. Similar laws also exist in other developed nations including the United Kingdom, Republic of Ireland, Australia, Canada and Sweden.

Financial - The financial benefits from creating accessible content results from a combination of the three factors described above. The goodwill generated for a company or brand from providing accessible content results in improved market share among people with disabilities. Improved market share translates into revenue and profits. The efficiencies and savings generated from having a strong technical architecture that supports accessibility contributes to the balance sheet. Legal compliance saves organisations the trouble and expense of litigation. It also pre-empts compensatory pay outs.

3.4.3 Guidelines for Accessible Web Development

The World Wide Web Consortium's (W3C) Web Accessibility Initiative (WAI) is an initiative to improve the accessibility of the World Wide Web (WWW). It aims to provide various guidelines for designing and creating web sites that can be easily accessed by people with disabilities. The WAI Guidelines and Techniques (WAI-G&T,n.d) web site lists a series of guidelines including Web Content Accessibility Guidelines (WCAG), Authoring Tool Accessibility Guidelines (ATAG), User Agent Accessibility Guidelines (UAAG) among others. Of particular interest to e-learning courseware developers is the Web Content Accessibility Guidelines (WAI-WCAG, n.d). WCAG 1.0 is the stable version recommended for referencing. WCAG 2.0 is a work in progress at the time of writing this dissertation.

Each of the guidelines has a series of checkpoints and each checkpoint is rated at priority level 1, 2 or 3.

Priority 1: Web developers must satisfy these requirements; otherwise it will be impossible for one or more groups to access the Web content.

Priority 2: Web developers should satisfy these requirements; otherwise some groups will find it difficult to access the Web content.

Priority 3: Web developers may satisfy these requirements, in order to make it easier for some groups to access the Web content.

Conformance to the priority levels are rated as follows. If all Priority 1 checkpoints are satisfied, it is rated at conformance level "A". If all Priority 1 and 2 checkpoints

are satisfied, it is rated at conformance level "AA" or "double A". If all Priority 1, 2and 3 checkpoints are satisfied, it is rated at conformance level "AAA" or "triple A". A "triple A" rating is the most desirable conformance level. It also includes recommendations, techniques and practices to be followed for attaining these conformance levels.

Specific to the e-learning industry, IMS Global Learning Consortium also provides its version of guidelines for producing accessible e-learning content. Their guidelines are based on six principles that address accessibility for people who have sensory or mobility disabilities (IMS Guidelines, n.d)

Criticism of WCAG Guidelines

WCAG guidelines act as the de-facto standards for producing accessible web content. But prominent researchers in the field also point out short comings of these guidelines while adapting it to the context of e-learning. Kelly *et al*. describe some of the main issues encountered while implementing the guidelines (Kelly *et al*, 2005):

Difficulties in understanding the guidelines: Guidelines were being rewritten for specific projects based on the originals and there was a feeling that the interpretations of the guidelines were not perfect in all instances. This would lead to the presence of multiple interpretations of the same guidelines.

Conflicts between accessibility and usability: Although accessibility and usability are factors that feed into each other, they are mutually exclusive in most cases. Therefore, a product deemed accessible is not always perfectly usable and vice versa.

Poor browser support for standards: The poor support for standards in older browsers, such as Netscape 4, leads to uncertainty in the deployment of technologies, CSS 2.0 being an example

Guidelines too theoretical: There was a feeling that some of the guidelines were too theoretical, promoting emerging Web standards, which have not yet been widely deployed or accepted within the marketplace. A case in point being the choice of PNG and RPG as recommended formats by the W3C, when neither of them are particularly favoured by the industry.

Need to make use of existing proprietary solutions: WCAG guidelines and compliance requirements promote the use of open formats developed by W3C. However, in many instances proprietary technologies are found to be much better suited for the task at hand. One such technology that has great appeal with the e-learning community is Macromedia Flash, which is very versatile for producing animations, simulations, and movies for students to interact with. Flash can be a tempting product to use when compared with the limited number of authoring tools and limited browser support for SMIL and SVG, the open formats developed by W3C which provide functionality that is similar to Flash.

Failure to recognise other IT developments: The WCAG guidelines do not acknowledge the developments in making proprietary formats more accessible, either through enhancements to the formats themselves or to operating systems.

3.4.4 Assistive Technologies

Assistive technologies are special aids that help disabled people cope with the demands of using a computer and the web. Jane Seale lists some of the common assistive technologies available presently (Seale, 2006):

Screen reader software, which can read out, using synthesized speech, selected elements of what is being displayed on the monitor (also helpful for users with reading or learning difficulties like dyslexia).

Videos with an audio description option as well.

Braille terminals, consisting of a Refreshable Braille display which renders text as Braille characters (usually by means of raising pegs through holes in a flat surface) and either a QWERTY or Braille keyboard.

Screen magnification software, which enlarges content displayed on the computer monitor, making it easier to read for vision impaired users.

Speech recognition software - they can accept spoken commands to the computer or turn dictation into grammatically correct text. This would be particularly useful for users with physical disabilities or reduced motor skills that would prevent them from using the mouse or keyboard.

3.4.5 A Case for Pedagogical Rigour

Although the case for accessibility and accessible e-learning is made clearly by several authors as evidenced from reviewed literature, researchers in this space also make a strong case for adherence to instructional principles and pedagogy while attempting to create accessible e-learning.

"At the heart of any e-learning experience is the pedagogy that drives it, the learning outcomes, the content, which illustrates those learning outcomes, the context in which the content is presented and the activities a student completes to aid his/her understanding of the learning outcomes. This can mean that a traditional course often has to be entirely re-engineered either for a wholly online experience or a hybrid approach of online and offline activities." (Kelly *et al.*, 2004)

Further, the same authors argue that learning professionals are often intimidated by the need to master and apply accessibility guidelines while also staying true to instructional theories. A blinkered approach, where the emphasis is on simply converting existing learning content into electronic format by applying these guidelines often results in an ineffective learning outcome. A discipline like learning, which is influenced to a large extent by external factors, should always be considered in totality and not just within the constraints of a few guidelines.

A holistic approach is recommended after studying factors associated with learning content and accessibility.

"Rather than relying purely on the guidelines developed by W3C WAI, the authors feel that these guidelines should form part of a broader approach to the provision of accessible e-learning resources. There is a need to address the usability of e-learning resources, the pedagogic aims of the e-learning resources, infrastructural and resources issues and to provide solutions, which are appropriate to the needs of the learner. We feel that a quality assurance framework is needed to support this model, which ensures that documented policies are provided and systematic procedures for ensuring compliance with the policies are implemented." (Kelly *et al*., 2004)

Figure 10: Holistic Model for E-Learning Accessibility (Kelly *et al*., 2004)

3.5 Conclusions

This chapter examined e-learning standards, instructional design, and accessibility constraints which are the three primary factors identified as crucial to the creation of Learning Objects.

E-learning standards and standard bodies were discussed. The positives and negatives of their work were identified from literature.

Next, the discipline of instructional design is explored. A detailed study of the philosophies, theories and models in the field was carried out.

Finally, the chapter discussed accessibility legislation and guidelines and how it affected the development of e-learning content

4. Qualitative Analysis

4.1 Introduction

In addition to a review of academic literature on the topic, it is also essential to gather information and opinions from the professionals in the industry. This is essential to validate the ideas formed from the academic research and to understand which of those ideas are favoured by practicing learning developers.

This chapter discusses two surveys – one for instructional designers and the other for learning technology professionals. It lists questions in each survey and the rationale for each question. The idea of the surveys presented in this dissertation is two-fold; to qualitatively assess opinions about certain topics within the e-learning domain as well as to get quantitative data on certain other aspects.

4.2 Questionnaire Design

For gathering qualitative data, direct interviews are preferred over questionnaires. This is because a direct interview can be conducted in an exploratory manner and it allows the experts who are interviewed to speak freely with a degree of insight into their thoughts and experiences. This tends to encourage a monologue by the respondent (Oppenheim, 2001). However, in this case that was not possible because of the geographical dispersal of the specialists that were queried. The sample crowds were employees of a multi-national e-learning vendor and were located in India and the Unites States branches of the same organisation. Therefore, it was felt that the most efficient way of deploying the survey was as a questionnaire with both open-ended and close ended questions included in the same questionnaire. The individuals surveyed were contacted beforehand and apprised of the reasons and significance of the survey.

The respondents occupied a range of roles including instructional designers, content analysts and writers, courseware engineers and e-learning authoring tool developers. Although the sample itself was limited, the experience range of the sample was between 4 and 8 years in the e-learning industry. The author knew all the respondents and therefore they were contacted over telephone or Internet to inform them about the exercise.

The questionnaire was created on the publicly available questionnaire hosting website, SurveyMonkey. A total of 15 questions were framed and they were accommodated in two separate questionnaires. This is because a few of the questions were pertinent to people within the instructional domain i.e instructional designers, content analysts and writers whereas the remaining questions were aimed at professionals involved in the learning technology practice – namely courseware engineers and authoring tool developers. These roles are mutually exclusive within the industry. However, people who were experienced in both domains were encouraged to take both surveys. Two questions were repeated across both groups because it had significance to both set of roles.

4.2.1 Questionnaire 1: Instructional Design

1.) Which of the following roles do you handle?

*) Instructional Design/ Analysis/ Strategy
*) Content Writing
*) Content Engineering (using custom e-learning authoring tools or general purpose editors for graphics/coding etc.)
*) e-learning tool design/development

Rationale: The objective of this question is to ascertain all the roles and responsibilities handled by the respondent.

2.) Which of the following ID theories are you familiar with?

*) Bloom's Taxonomy
*) Gagne's Nine Events of Instruction
*) Merrill's Component Display Theory
*) Reigeluth's Elaboration Theory
*) John Keller's ARCS Model
*) Other (please specify)

Rationale: The objective of this question is to ascertain all possible instructional design theories that the respondent was familiar with. The literature review indicated that the theories listed above were considered important within academic circles. It is also essential to gauge their significance to practicing professionals.

3.) Rate the ID theories listed in question 2, in terms of relevance to courseware development in your organisation.

Respondents were requested to rate the theories listed on a scale and the options provided were: Default Choice, Frequently Used, Sometimes, Rarely used, and Never Used.

Rationale: The rationale behind this question was to determine statistically which of the theories were rated highly in the design of instructional material.

4.) The ADDIE model (Analysis-Design-Development-Implementation-Evaluation) serves a generic framework for instructional systems design. Briefly describe the process used within your organisation for courseware development, from inception of a project to delivery.

Rationale: This was an open ended question designed to identify the processes used within various instructional design teams and if they followed a specific version of the generic ADDIE model.

5.) In your opinion, how can the current process be improved to produce better courseware?

Rationale: This was an open ended question to ascertain if practicing instructional designers thought the generic model could be improved by adding or removing any steps within the process.

6.) Courseware developed on generic topics (examples would be customer service training, high school mathematics, English grammar etc.) lend itself to reuse. In your opinion, what might be potential barriers to their reuse?

Rationale: It is obvious from the literature survey that e-learning courseware (Learning Objects) is considered truly valuable when they can be reused. The rationale of this question is to identify factors preventing wide spread reuse of Learning Objects.

7.) The concept of 'Learning Objects' promotes the creation of pedagogically neutral, granular content so as to improve reuse and interchangeable use. What are your thoughts on this concept?

Rationale: This was designed as an open ended question to ascertain the respondents' thoughts on the dichotomy of creating learning objects which are pedagogically neutral yet effective for training. This question was repeated in the next survey also. This is because neutrality and granularity is a function of both instructional design as well as learning technology.

4.2.2 Questionnaire 2: E-Learning Technology

1.) Which of the following roles do you handle?

*) Instructional Design/ Analysis/ Strategy
*) Content Writing
*) Content Engineering (using custom e-learning authoring tools or general purpose editors for graphics/coding etc.)
*) e-learning tool design/development

Rationale: The objective of this question is to ascertain all the roles and responsibilities handled by the respondent. This was repeated in both surveys.

2.) The concept of 'Learning Objects' promotes the creation of pedagogically neutral, granular content so as to improve reuse and interchangeable use. What are your thoughts on this concept?

Rationale: This was designed as an open ended question to ascertain the respondents' thoughts on the dichotomy of creating learning objects which are pedagogically neutral yet effective for training. This question was repeated from the previous survey.

This is because neutrality and granularity is a function of both instructional design as well as learning technology.

3.) Does the instructional design/content engineering process within your organisation encourage granularity in courseware development?

Rationale: The rationale of this close ended question is to determine if the technology processes within the organisation are geared towards producing granular learning content which could split into smaller constituents and offered as stand-alone courses or combined with other courses.

4.) Does the instructional design/content engineering process within your organisation have provisions for building accessible courseware for the physically challenged? If yes, please state which guidelines are followed (Section 508, WCAG etc.) and briefly explain the accessibility testing procedures.

Rationale: This question was designed as an open ended one to test the awareness of accessibility and processes for building accessible courseware aimed at physically disabled learners. The respondent is also expected to provide a brief outline of the compliance testing procedure within their team.

5.) E-learning standards bodies seek to promote quality and interoperability. Which of the following standards are you familiar with?

*) ADL SCORM
*) AICC HACP
*) IMS Content Packaging
*) IEEE Learning Object Metadata (LOM)
*) ISO/IEC JTC1 SC36
*) Other (please specify)

Rationale: This question was designed to measure the awareness of learning technology professionals of the various e-learning standards.

6.) Does the content engineering/e-learning tool design process in your organisation encourage adding metadata to learning content? If not, do you think it helps promote easier discovery and reuse of the content?

Rationale: This question was designed to ascertain if the authoring tools used by the teams or the subsequent courseware engineering process has provisions that encouraged the addition of metadata to the learning content created. The second part of the question hopes to elicit the respondents' opinions about the role of metadata in promoting reuse of content.

7.) The true benefits of e-learning is realised at an organisational level when content is deployed on a Learning Management Systems (LMS). Please list some of the LMS you have worked with.

Rationale: This is an open ended question to get a feel for the most popular Learning Management Systems in the industry.

8.) What were the positives and negatives of your experience deploying/administering content on LMS?

Rationale: This was an open ended question to determine potential positives and pain points encountered while deploying content on Learning Management Systems.

9.) Have you worked with a Learning Content Management System (LCMS)?

Rationale: This was a close ended question to gauge the level of awareness of LCMS and to see if people really understood the difference between an LMS and an LCMS.

10.) How do you rate XML as a technology/platform for the needs of learning content deployment? Do you foresee any other technologies taking over the role of XML?

Rationale: This open ended question was designed to gather opinions about the robustness of XML as a technology platform specific to e-learning and interchange of data in this domain.

4.3 Conclusions

Two questionnaires were created on the publicly available questionnaire hosting website, SurveyMonkey and delivered to practicing professionals. A total of 15 questions were framed and they were accommodated in two separate questionnaires.

The first questionnaire was designed for instructional designers and the second one was for learning technology professionals

5. Data Analysis

5.1 Introduction

This chapter explains the analysis of data gathered from both surveys.

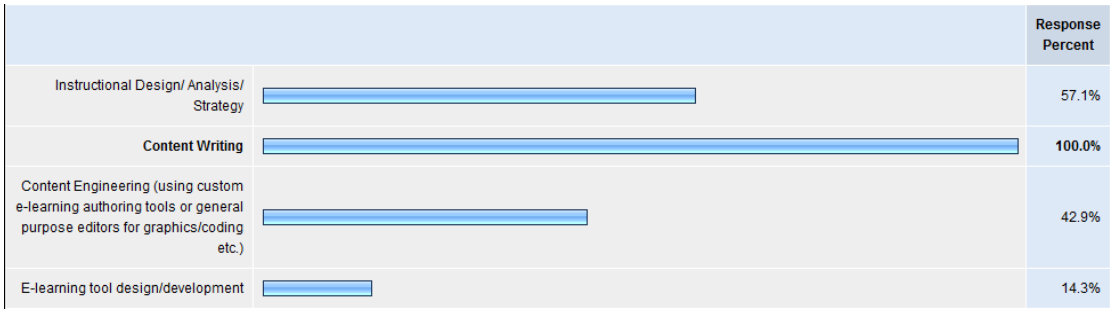
5.2 Analysis of results

The responses were gathered and analysed. The qualitative aspect was measured with a 'gist analysis'. This involves tracking salient phrases and sentences from the responses and identifying trends based on that. The objective of this exercise is to extract the general thinking about a particular issue based on themes common to most responses for that question.

The quantitative aspect was measured using the analysis tools built into the SurveyMonkey questionnaire service. It provides graphical and percentage based responses to close ended and scale based questions.

5.2.1 Questionnaire 1: Instructional Design

1.) Which of the following roles do you handle?

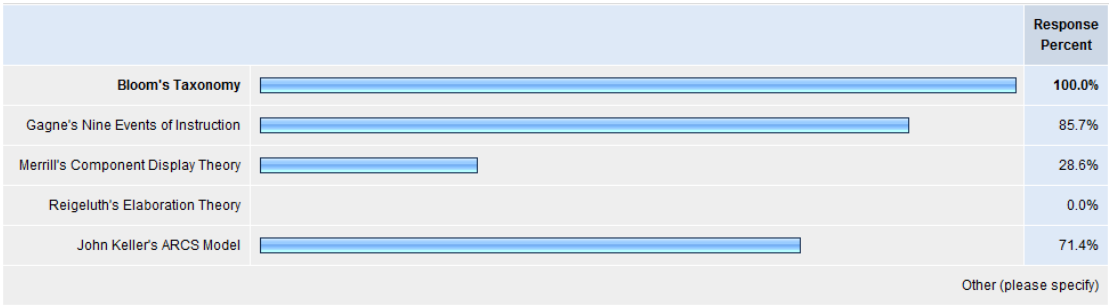


Analysis: As expected, the graphs and the percentage figures indicate that the biggest percentage of learning professionals who took this survey were involved in content writing and instructional design. A smaller percentage of people in the learning technology practice also attempted this questionnaire because they were experienced enough to comment in the instructional design domain as well.

Two additional roles were added by respondents (not part of the standard responses)

- Quality Analyst
- Template Designer

2.) Which of the following ID theories are you familiar with?



	Response Percent
Bloom's Taxonomy	100.0%
Gagne's Nine Events of Instruction	85.7%
Merrill's Component Display Theory	28.6%
Reigeluth's Elaboration Theory	0.0%
John Keller's ARCS Model	71.4%
Other (please specify)	

Analysis: Bloom's Taxonomy and Gagne's Nine Events seem to be popular among instructional designers. John Keller's ARCS Model of Motivational Design was also highly favoured.

3.) Rate the ID theories listed in question 2, in terms of relevance to courseware development in your organisation.

	Default choice	Frequently used	Sometimes	Rarely used	Never used
Bloom's Taxonomy	**57.1% (4)**	42.9% (3)	0.0% (0)	0.0% (0)	0.0% (0)
Gagne's Nine Events of Instruction	0.0% (0)	**57.1% (4)**	42.9% (3)	0.0% (0)	0.0% (0)
Merrill's Component Display Theory	0.0% (0)	0.0% (0)	33.3% (1)	0.0% (0)	**66.7% (2)**
Reigeluth's Elaboration Theory	0.0% (0)	0.0% (0)	0.0% (0)	33.3% (1)	**66.7% (2)**
John Keller's ARCS Model	0.0% (0)	14.3% (1)	**42.9% (3)**	14.3% (1)	28.6% (2)

Analysis: Following on from Question. 2, Bloom's Taxonomy and Gagne's Nine Events seem to be in wide-spread use in this particular organisation. Keller's ARCS model was also used.

4.) The ADDIE model (Analysis-Design-Development-Implementation-Evaluation) serves a generic framework for instructional systems design. Briefly describe the process used within your organisation for courseware development, from inception of a project to delivery.

"Requirement for a course is arrived at by education manager in conjunction with other managers of departments such as engineering, development or even consulting"

"The organisation was involved across all stages of the ADDIE model. However the team that I worked with was mostly involved during the Development and Implementation phases."

"The solution is mostly in form of a HLDD and a prototype - either of an existing course or new. Once the prototype is accepted, storyboards are created and one topic is created and sent to client for approval. Once approval is received, we go through with the entire course."

"Expression of Interest Prototype High Level Design Detail Design/Story Board Course Construction with tool QA Corrections Packaging and Delivery"

Analysis: The ADDIE model is followed in one form or another across teams. The analysis phase was always done in conjunction with the customer or stake holder in the loop. Prototyping is also found to be carried out in certain projects. This is traditionally not part of the ADDIE model.

5.) In your opinion, how can the current process be improved to produce better courseware?

"By having better access to SMEs and the actual applications that learners will be working on"

"It could be improved with more focus on audience analysis rather than the courseware to be deployed"

"…..better understanding of the client's work would help and access to SMEs."

"….heavier emphasis on analysis of target audience needs and knowledge level."

Analysis: The two main themes seem to be access to Subject Matter Experts (SME) and a heavier emphasis on audience analysis. Perhaps instructional designers feel short-changed when designing courseware about highly specialised topics and lack of support from specialists in the discipline. Also, audience analysis has been identified as another key point that merits attention.

6.) Courseware developed on generic topics (examples would be customer service training, high school mathematics, English grammar etc.) lend itself to reuse. In your opinion, what might be potential barriers to their reuse?

"Topicality might be outdated"

"1. What is good for the Yankee is definitely not good for the Irish or the Arab. 2. Culture. Same as above. 3. Writing style and use of slang in context"

"The media applied during the courseware design is likely to become obsolete while being persistently reused"

"Look and feel. Indifference to local taste and cultures. Inevitable effort needed for customization"

Analysis: The main issue raised here is the local factors that affect the creation of courseware. Respondents feel that either the context of the learning content would be inappropriate of it could be outdated after a while. Also, a salient point was that the media over which the learning experience itself is delivered might be obsolete after a while.

7.) The concept of 'Learning Objects' promotes the creation of pedagogically neutral, granular content so as to improve reuse and interchangeable use. What are your thoughts on this concept?

"It's a good idea as it saves time and effort."

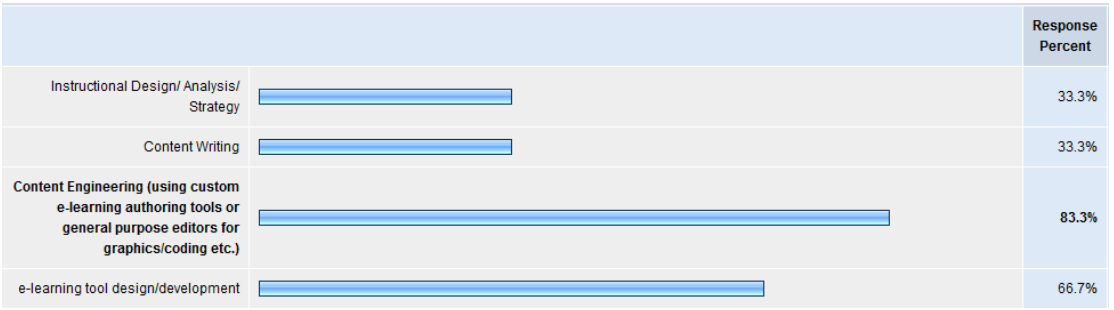
"Works very well if content can be restrained to core but general concepts"

"Yes, it is great if we can reuse and interchange objects of learning"

Analysis: The general response was in agreement to the concept as long as the learning objective was not too specific or complex.

5.2.2 Questionnaire 2: E-Learning Technology

1.) Which of the following roles do you handle?



Analysis: As expected, the graphs and the percentage figures indicate that the biggest percentage of learning professionals who took this survey were involved in content engineering and tool development. A smaller percentage of people in the instructional design practice also attempted this questionnaire because they were experienced enough to comment on learning technology as well.

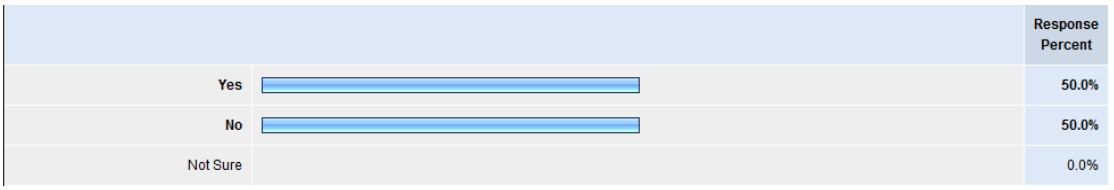
2.) The concept of 'Learning Objects' promotes the creation of pedagogically neutral, granular content so as to improve reuse and interchangeable use. What are your thoughts on this concept?

"Most of the materials we create don't easily lend themselves to be re-used and re-purposed as they're focused on a particular set of learning needs. The few instances where I've seen it used with moderate success have been within a curriculum or a training stream, where stable portions of an existing training could be easily combined with updated content to create a new learning activity"

When it comes to adult learners, smaller learning objects helps in retaining the interest in a curriculum due to "lesser content per serving".

Analysis: This question was repeated from the previous survey. However, respondents in this category seem far less optimistic about the potential for courseware reuse. Perhaps, this is because of the inherent technology bias they had while reflecting on this topic. Implementing this idea technically has as many challenges as implementing it instructionally.

3.) Does the instructional design/content engineering process within your organisation encourage granularity in courseware development?



	Response Percent
Yes	50.0%
No	50.0%
Not Sure	0.0%

Analysis: The response was an even split with exactly half the respondents agreeing and the other half disagreeing.

4.) Does the instructional design/content engineering process within your organisation have provisions for building accessible courseware for the physically challenged? If yes, please state which guidelines are followed (Section 508, WCAG etc.) and briefly explain the accessibility testing procedures.

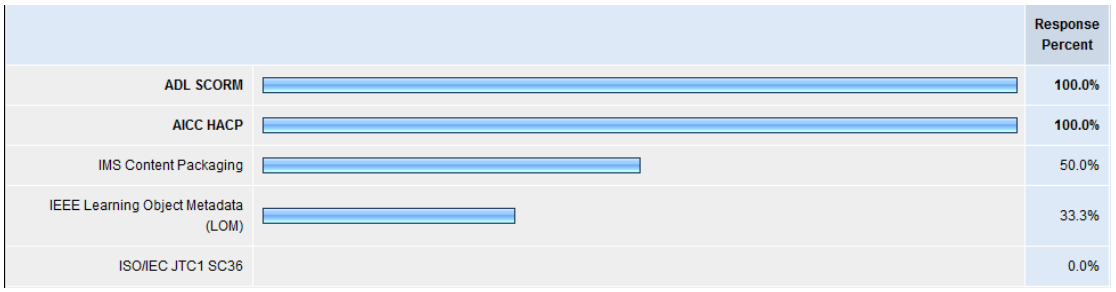
"All internal training materials (whether elearning, facilitated sessions) are meant to be Section 508 and WCAG compliant (at least AA) as per our Corporate Responsibility strategy"

"Section 508 and WCAG. Most of the testing is manual and. Jaws is extensively used for Visual impaired testing"

"We also use screen magnifier software and simple JavaScript widgets to test the course for colour blind learners"

Analysis: Section 508 and WCAG seem to be the guidelines judged most important by the technology team. However, this should also be considered in the light of the fact that the customer base of this particular organisation is primarily the United States. Compliance is also tested with screen readers and other techniques.

5.) E-learning standards bodies seek to promote quality and interoperability. Which of the following standards are you familiar with?



Analysis: ADL SCORM and AICC HACP are the outright winners here.

6.) Does the content engineering/e-learning tool design process in your organisation encourage adding metadata to learning content? If not, do you think it helps promote easier discovery and reuse of the content?

"Yes. Courses deployed on the LMS usually have tags associated to facilitate searching the catalogue"

"We do not use any metadata in our learning content. Not sure how it would promote easier discovery and reuse."

"The tool has options. But it is rarely used"

Analysis: Some agree with the idea of metadata. Some say that the metadata generation feature within the authoring tool is rarely used. This might be because of ignorance about the benefits of metadata.

7.) The true benefits of e-learning is realised at an organisational level when content is deployed on a Learning Management Systems (LMS). Please list some of the LMS you have worked with.

"Saba"

"SumTotal"

"Blackboard "

"Docent"

Analysis: The four Learning Management Systems listed above seem to be favoured by the technology practice in this organisation

8.) What were the positives and negatives of your experience deploying/administering content on LMS?

"Many LMS behave very differently from others. Often, it's only after deployment that we pick up on LMS-specific issues."

"Not all LMSs implement learning standards to the fullest."

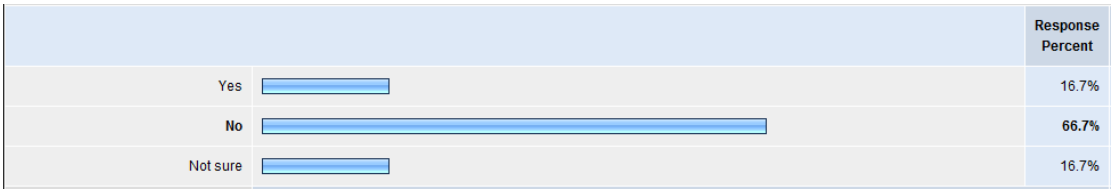
"1. Long process. 2. too many process to follow"

"…the control and reporting features that an LMS provides is an invaluable tool to learning consultants in determining the effectiveness of training."

"Track return on investment of eLearning implementation. Integration of LMS with HR systems for incentives, promotions, mandatory certifications, and reporting.."

Analysis: Both the positive and negative aspects were commented upon by the respondents. The main pain points seem to be the complexity of LMS to the lay user. Also, the processes and incomplete adherence to standards were noted as concerns. However, there was also agreement that it adds significant value by automating training needs.

9.) Have you worked with a Learning Content Management System (LCMS)?



Analysis: A significant percentage of the respondents had never worked with an LCMS. A minority were not sure of how it differed from an LMS.

10.) How do you rate XML as a technology/platform for the needs of learning content deployment? Do you foresee any other technologies taking over the role of XML?

"Excellent. Not in the near future."

"XML is the data layer. For now it is going to stay"

"For serialization and ETL operations, XML seems to be the most viable option at the moment."

Analysis: The general consensus seems to be that XML is the platform of choice for learning technology needs. Most respondents agreed that it will stay on unless a far superior technology comes along.

5.3 Conclusions

The main themes that emerged from the analysis are listed below:

Instructional Design: Learning theories, mainly Bloom's taxonomy and Gagne's Events of Instruction, seem to be favoured in this particular organisation. This validates the enormous respect these taxonomies command from within the academia as well. The ADDIE process model was familiar in one way or another to most of the respondents. The processes laid out in the model are adhered to in the organisation. However, it was also noted that prototyping was also favoured early in the analysis and design stage. Prototyping is not considered to be a part of the ADDIE model.

The respondents were also generally enthusiastic about content reuse and favoured the granular Learning Object approach despite inherent difficulties in implementing it.

E-learning Standards: A high awareness of E-Learning standards, especially ADL SCORM and AICC HACP, indicate that these are favoured over other standards. Learning Management Systems were criticised as being too hard to use but their use to corporate e-learning was not disputed. Also, there is a general consensus about XML being the learning technology platform of choice for the near future.

Learning technology professionals were found be generally pessimistic about the potential for courseware reuse. This may be because of the technical difficulties in implementing reusable learning objects

Accessibility: There was awareness about accessibility in every single response. In this particular case, accessibility legislation Section 508 and WCAG guidelines seemed to be cited in almost all the responses. Section 508 is specific to the US and the client market could be the deciding factor here. However, literature survey also does indicate these two to be prominent.

6. Authoring Tool Study

6.1 Introduction

To achieve a greater understanding of the implementation of the theories and standards discussed in the previous chapters, the author also conducted a brief study of three popular e-learning authoring tools – IBM Simulation Producer, Adobe Captivate and RWD uPerform. These tools are used to generate e-learning simulations that mimic actual application interfaces like ERP and CRM suites. The objective of this stage of the exercise is to ascertain how concepts discussed in the preceding chapters were implemented in a real-world scenario.

Trial versions of IBM Simulation Producer and Adobe Captivate were downloaded for evaluation. Information about features of RWD uPerform were gathered from the vendor's website and the information brochures that were available as downloadable PDF files.

The evaluation focussed on the support for instructional design methodologies, conformance to e-learning standards and built-in accessibility features.

6.2 E-learning Simulations

The IBM website describes the capabilities of Simulation Producer as follows:

"Simulation Producer is an application simulation program, ideal for quickly producing learning interactions. In a manner similar to that of a "screen cam," Simulation Producer captures events (such as mouse and keyboard interactions) and the screen changes associated with those events in an application; however, Simulation Producer extends this function by making the images and events interactive: The user is allowed to click on buttons and to type text."

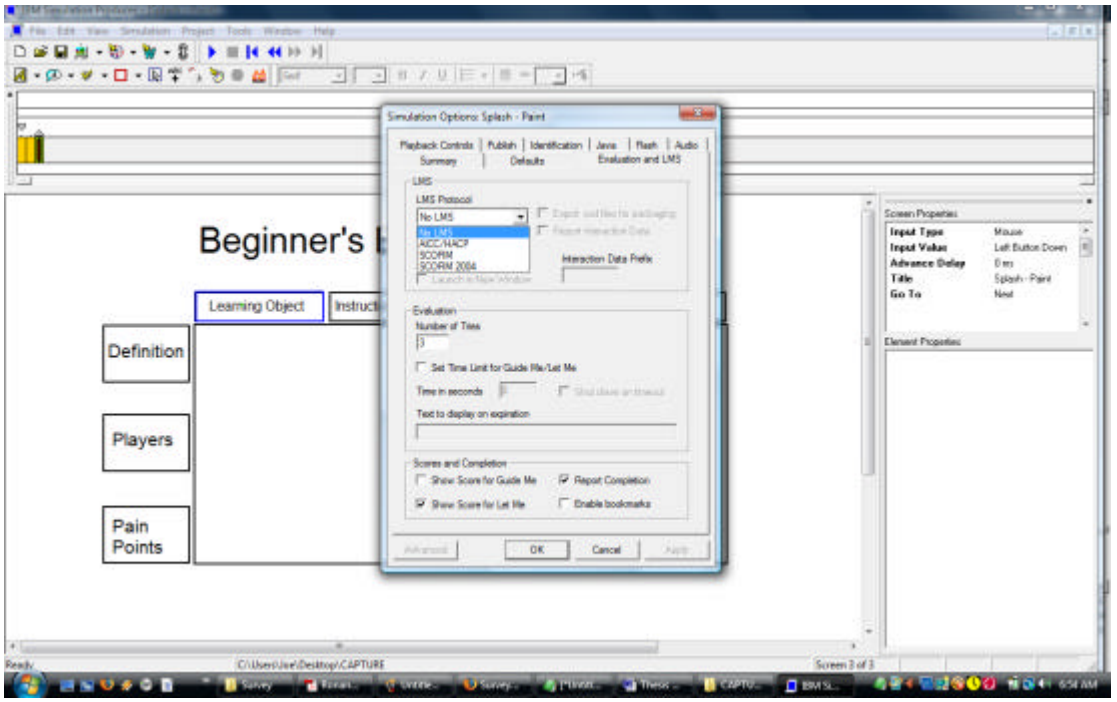
The other two tools also function on similar lines. All of them store information in their proprietary format files but has the option to generate XML-based output from those.

Developers can then enhance the individual screens of the capture by adding the following: comments, highlights, graphics, input areas, captions, assessments, feedback, and audio.

6.3 Evaluation

Instructional Design: Most e-learning simulation tools are meant to teach learners how a specific task needs to be carried out within a given environment without a lot of variables. Therefore, the instructional design capabilities of any simulation tool were to be evaluated against the Bloom's Taxonomy – it could be assumed that all of them encompass knowledge, comprehension and application. Higher order learning objectives like synthesis and analysis would not be possible with these tools. However, a host of other tools like web-based tutorials (WBT) are available, that have the capability to design e-learning courseware which would be rated at analysis, synthesis or evaluation levels.

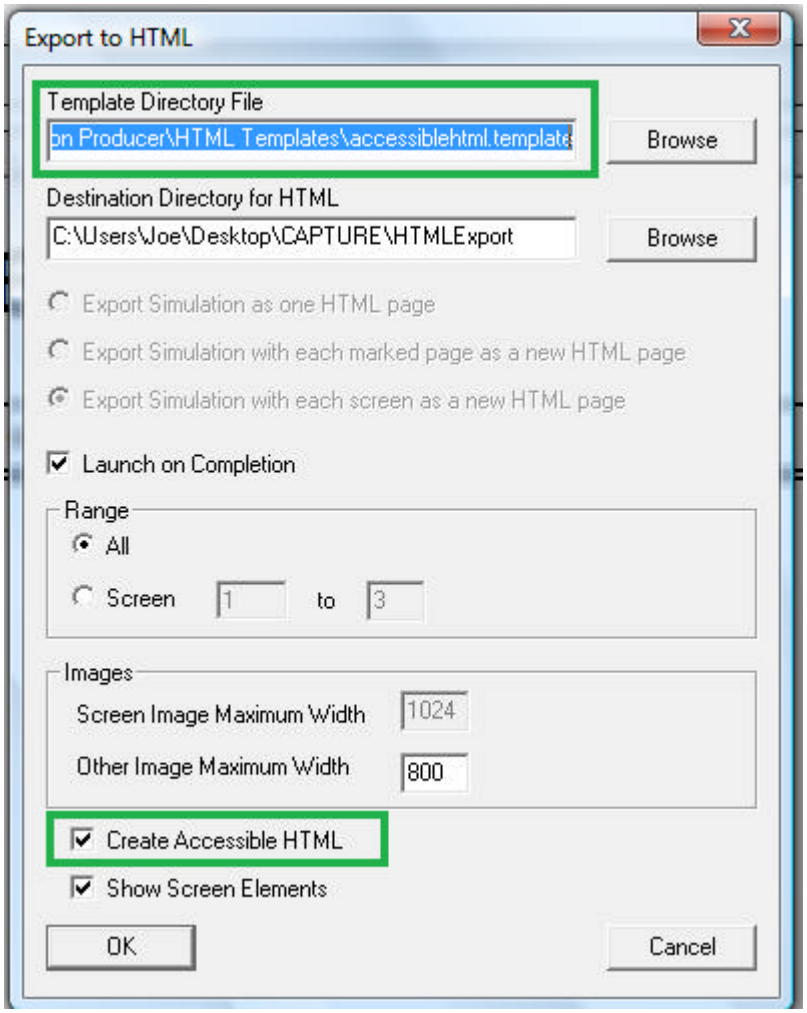
Standards Compliance: IBM Simulation Producer had the capability of produce e-learning simulations that could be packaged as compliant with AICC/HACP, SCORM or SCORM 2004. This means that standalone simulations produced with the tool could be directly deployed on an LMS which was based on any of these standards.



Similar functionality was also built into Adobe Captivate and RWD uPerform. This indicates the importance of these standards. It is apparent that for learning courseware to be truly reusable, standards compliance is a necessity.

However, some of the other standards discussed in this dissertation do not seem to have been implemented in any of these tools. This could be taken as a sign that the industry in general has settled on SCORM and AICC as the most favoured standards for the near future.

Accessibility: The two main accessibility features associated with IBM Simulation Producer were the capacity to export a simulation in 'accessible HTML' format and the functionality to record audio so as to aid learners with hearing disabilities.



Adobe Captivate and RWD uPerform also incorporate functionality to create accessible HTML. It is laudable that all the tools have made concerted efforts to be inclusive of learners with disabilities. However, the amount of knowledge that could be gained and applied by a visually challenged person would depend on specific scenarios.

6.5 Conclusion

Three popular e-learning authoring tools – IBM Simulation Producer, Adobe Captivate and RWD uPerform were studied and their functionalities were explored. The evaluation focussed on the support for instructional design methodologies, conformance to e-learning standards and built-in accessibility features.

7. Conclusions and Future Work

7.1 Introduction

This chapter concludes the dissertation. A general checklist is presented based on the research and general themes are discussed in the concluding section. Potential for future work in this area is also identified.

7.2 Learning Object Checklist

Based on the literature review, surveys and tool study a Learning Object Checklist is presented below. The most desirable factors for instructional design, standards and accessibility are included. This checklist can act as a template for future frameworks that aim to develop any of these facets that contribute to Learning Object design.

	Philosophy	Theory	Process
Instructional Design	Constructivism	Bloom's Taxonomy	ADDIE
		Gagne's Nine Events	
	Cognitivism	Keller's ARCS Model	Rapid Prototyping
	Behaviourism	Merrill's CDT	
		Reigeluth Elaboration	

E-Learning Standards	ADL SCORM
	AICC HACP
	IMS Content Packaging
	IEEE Learning Object Metadata

	Legislation	Guidelines
Accessibility	US Section 508	W3C WCAG
	<<Country Specific>>	W3C ATAG
		W3C UAAG
		IMS Global Learning

7.2 Conclusions

Learning Objects: Learning Objects were conceived with a noble intention. The idea behind the concept of Learning Objects was that they would be instructional components designed as pedagogically agnostic, granular portions which would lend themselves to easy reuse and more importantly, interchangeable use. This concept was similar to that of Object Oriented Programming (OOP). OOP originated as a result of a business need to reduce duplication and the cost and complexity involved in creating software.

However, this has been easier said than done when it comes to learning objects because they have to balance very different priorities. There seems to be a lot of debate about where to draw the line when it comes to classifying a resource as a learning object. The development of Learning Object Metadata standards is a step towards that direction. Also, Learning Object Repositories have been developed with a view to providing central storage and disbursal of Learning Objects. Many such open repositories let vendors share Learning Objects.

The three primary considerations for designing a learning object are instructional design theories, e-learning standards and accessibility requirements. An ideal Learning Object will incorporate a good mix of all three.

Instructional Design: Instructional Design is a combination of philosophies, learning theories and processes. It is the science of designing instruction. Learning developers have to develop a mix of skills to be considered as an effective instructional designer. Several taxonomies and models exist for the purpose of instructional design. However, there is no one-size-fits all solution when it comes to instructional design.

E-Learning standards: E-Learning standards were developed as a reaction to the lack of standard guidelines within the learning industry. Some of the major players are ADL, AICC and IMS. E-learning was already a reality before these standards bodies were born. But the efforts the standards bodies have provided direction and common guidelines to which all interested parties aspire. Standards organisations have been criticised at times for compromising on the pedagogical aspects while framing guidelines solely with technology considerations.

Accessibility: Services that are accessible to people with disabilities are ubiquitous in most industries. The same case applies to the e-learning industry as well. However, the present set of guidelines proposed by the World Wide Web consortium has problems when adapted to the task of generating accessible learning content. Most of the W3C guidelines do not consider the unique challenges involved in designing training. IMS Global Learning has proposed several e-learning specific accessibility guidelines. However, these do not seem to have gained as much traction as the W3C version.

7.3 Future Work

One of the most obvious projects that suggest itself in the wake of the debate surrounding Learning Objects would be a deeper dive into current trends and conducting a detailed study of potential barriers to their effective reuse. It is apparent that this will soon be a business priority because of its potential to reduce duplication and cut costs when the original ideals behind its conception are realised.

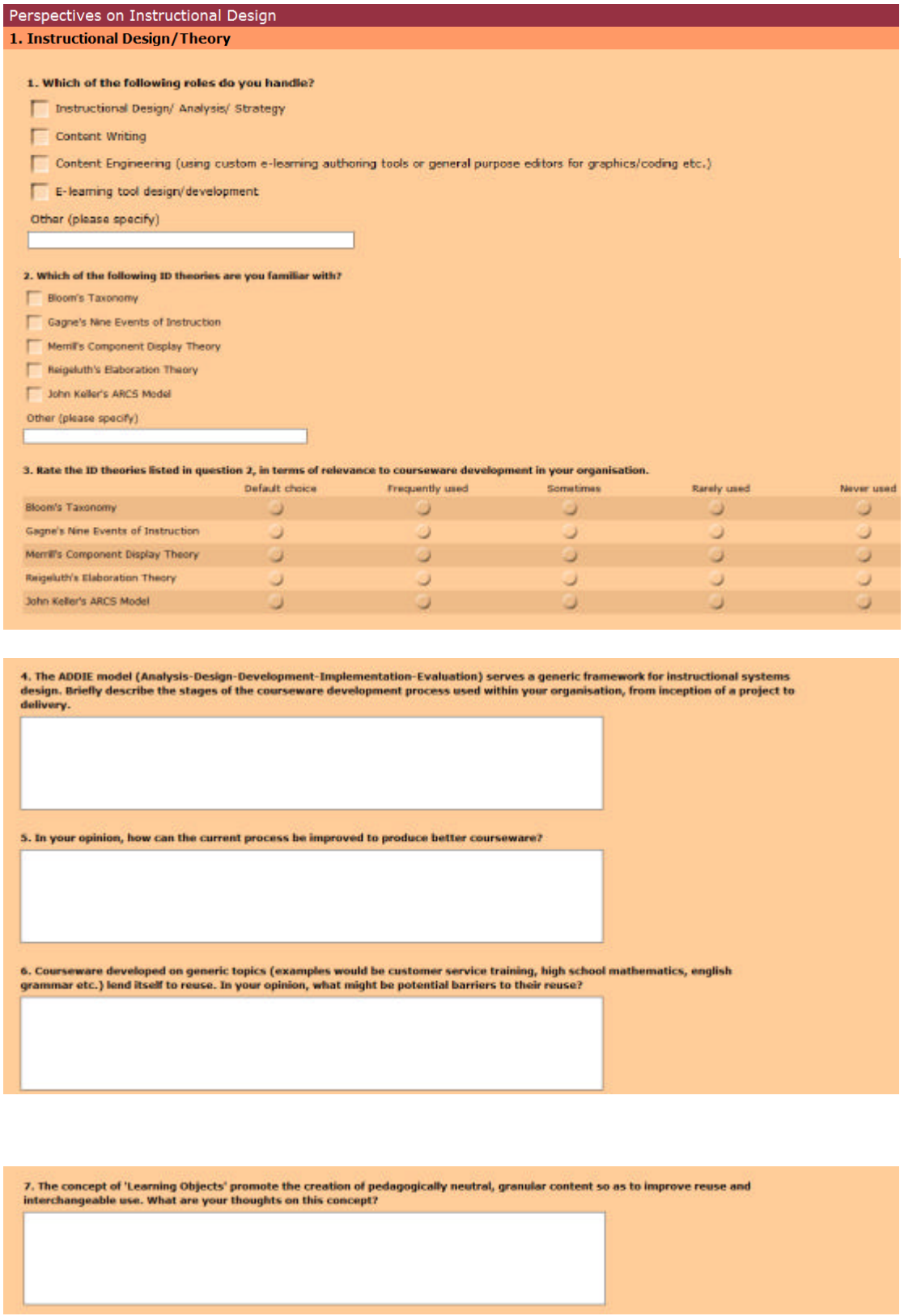
Learning technologies which are self-adapting and can provide recommendations for future courses based on current level of competence is not far away. When technology is able to capture and learn from its own experience and from its user, it gains a critical new power: accurate prediction of what will be needed next, in terms of information it can provide or suggestions it can offer. This is possible through the analysis of the experiential knowledge that has been collected, and it creates new knowledge in the form of patterns and profiles. It has often been overlooked that just-in-time learning and performance support are only possible with this predictability.

Also, peer-reviewed literature surrounding Learning Object Metadata and Repositories seem to be about five or six years old on an average. It will be interesting to study current trends in LOM and LOR. The role of metadata and repositories in furthering the cause of Learning Object reuse has been discussed in this dissertation

People working on research at the intersection of accessibility and the internet will naturally find a niche within e-learning to extend their research because of the web-based nature of most modern day e-learning.

Instructional design is an ocean unto itself, having been influenced by so many other disciplines. One potential research area could be how instructional design theories fit into framework of modern software engineering processes. Currently, most development activity seems to be within the constraints of the ADDIE which can be compared to the waterfall model of software engineering.

Appendix A: Instructional Design Survey



Perspectives on Instructional Design

1. Instructional Design/Theory

1. Which of the following roles do you handle?

- [ ] Instructional Design/ Analysis/ Strategy
- [ ] Content Writing
- [ ] Content Engineering (using custom e-learning authoring tools or general purpose editors for graphics/coding etc.)
- [ ] E-learning tool design/development

Other (please specify)

2. Which of the following ID theories are you familiar with?

- [ ] Bloom's Taxonomy
- [ ] Gagne's Nine Events of Instruction
- [ ] Merrill's Component Display Theory
- [ ] Reigeluth's Elaboration Theory
- [ ] John Keller's ARCS Model

Other (please specify)

3. Rate the ID theories listed in question 2, in terms of relevance to courseware development in your organisation.

	Default choice	Frequently used	Sometimes	Rarely used	Never used
Bloom's Taxonomy	○	○	○	○	○
Gagne's Nine Events of Instruction	○	○	○	○	○
Merrill's Component Display Theory	○	○	○	○	○
Reigeluth's Elaboration Theory	○	○	○	○	○
John Keller's ARCS Model	○	○	○	○	○

4. The ADDIE model (Analysis-Design-Development-Implementation-Evaluation) serves a generic framework for instructional systems design. Briefly describe the stages of the courseware development process used within your organisation, from inception of a project to delivery.

5. In your opinion, how can the current process be improved to produce better courseware?

6. Courseware developed on generic topics (examples would be customer service training, high school mathematics, english grammar etc.) lend itself to reuse. In your opinion, what might be potential barriers to their reuse?

7. The concept of 'Learning Objects' promote the creation of pedagogically neutral, granular content so as to improve reuse and interchangeable use. What are your thoughts on this concept?

Appendix B: e-Learning Technology Survey

Perspectives on E-learning Technology

1. Learning Technology

1. Which of the following roles do you handle?

- [ ] Instructional Design/ Analysis/ Strategy
- [ ] Content Writing
- [ ] Content Engineering (using custom e-learning authoring tools or general purpose editors for graphics/coding etc.)
- [ ] e-learning tool design/development

Other (please specify)

2. The concept of 'Learning Objects' promotes the creation of pedagogically neutral, granular content so as to improve reuse and interchangeable use. What are your thoughts on this concept?

3. Does the instructional design/content engineering process within your organisation encourage granularity in courseware development?

- ( ) Yes
- ( ) No
- ( ) Not Sure

4. Does the instructional design/content engineering process within your organisation have provisions for building accessible courseware for the physically challenged? If yes, please state which guidelines are followed (Section 508, WCAG etc.) and briefly explain the accessibility testing procedures.

5. E-learning standards bodies seek to promote quality and interoperability. Which of the following standards are you familiar with?

- [ ] ADL SCORM
- [ ] AICC HACP
- [ ] IMS Content Packaging
- [ ] IEEE Learning Object Metadata (LOM)
- [ ] ISO/IEC JTC1 SC36

Other (please specify)

6. Does the content engineering/e-learning tool design process in your organisation encourage adding meta data to learning content? If not, do you think it helps promote easier discovery and reuse of the content?

7. The true benefits of e-learning is realised at an organisational level when content is deployed on a Learning Management Systems (LMS). Please list some of the LMS you have worked with.

8. What were the positives and negatives of your experience deploying/administering content on LMS?

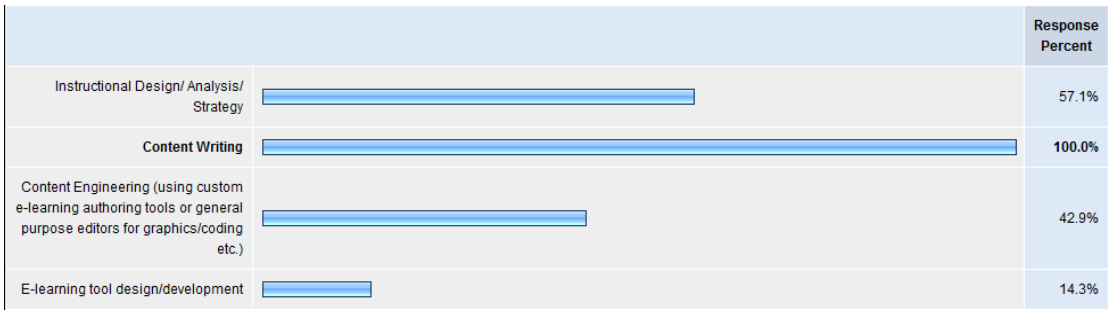
9. Have you worked with a Learning Content Management System (LCMS)?

- Yes
- No
- Not sure

10. How do you rate XML as a technology/platform for the needs of learning content deployment? Do you foresee any other technologies taking over the role of XML?

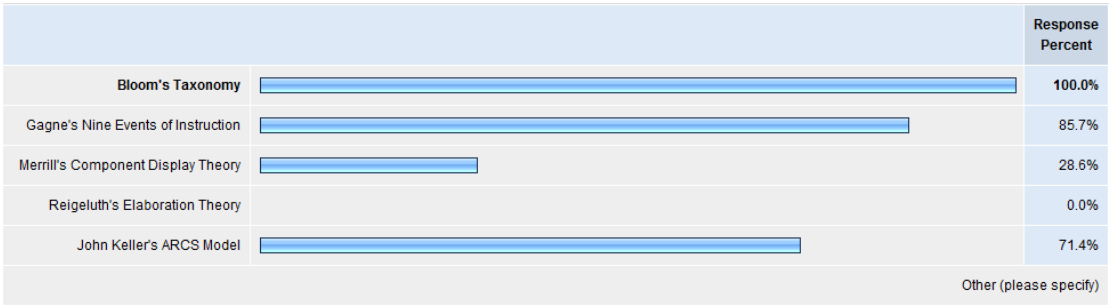
Appendix C: Instructional Design Survey Responses

1.) Which of the following roles do you handle?



	Response Percent
Instructional Design/ Analysis/ Strategy	57.1%
Content Writing	**100.0%**
Content Engineering (using custom e-learning authoring tools or general purpose editors for graphics/coding etc.)	42.9%
E-learning tool design/development	14.3%

2.) Which of the following ID theories are you familiar with?



	Response Percent
Bloom's Taxonomy	**100.0%**
Gagne's Nine Events of Instruction	85.7%
Merrill's Component Display Theory	28.6%
Reigeluth's Elaboration Theory	0.0%
John Keller's ARCS Model	71.4%
Other (please specify)	

3.) Rate the ID theories listed in question 2, in terms of relevance to courseware development in your organisation.

	Default choice	Frequently used	Sometimes	Rarely used	Never used
Bloom's Taxonomy	**57.1% (4)**	42.9% (3)	0.0% (0)	0.0% (0)	0.0% (0)
Gagne's Nine Events of Instruction	0.0% (0)	**57.1% (4)**	42.9% (3)	0.0% (0)	0.0% (0)
Merrill's Component Display Theory	0.0% (0)	0.0% (0)	33.3% (1)	0.0% (0)	**66.7% (2)**
Reigeluth's Elaboration Theory	0.0% (0)	0.0% (0)	0.0% (0)	33.3% (1)	**66.7% (2)**
John Keller's ARCS Model	0.0% (0)	14.3% (1)	**42.9% (3)**	14.3% (1)	28.6% (2)

4.) The ADDIE model (Analysis-Design-Development-Implementation-Evaluation) serves a generic framework for instructional systems design. Briefly describe the process used within your organisation for courseware development, from inception of a project to delivery.

1. The source content is first analysed, before storyboarding begins. The developed storyboard is then sent for construction by a team of Courseware Engineers. The developed course is then hosted on the LMS, where learners take the course and are evaluated at the end with a passing score.

2. 1. Requirement for a course is arrived at by education manager in conjunction with other managers of departments such as engineering, development or even

consulting. 2. Instructional Designer prepares himself or herself with the technology or knowledge required to develop the course. This includes writing a design document that will give a path for the preparation. Further, this will involve regular interaction with SMEs for getting up to speed with the knowledge required to start writing. 3. During the process of course development, writer interacts with graphic designers regularly to produce graphics that give the course a good look and feel. 4. Post development, testing of the course happens to remove bugs and typos.

3. The organisation was involved across all stages of the ADDIE model. However the team that i worked with was mostly involved during the Development and Implementation phases. Only sometimes were we involved with the Evaluation phase.

4. Analysis - Analysis of client requirements - audience analysis, task analysis, costing factors.. Design - Solutioning based on the client requirements. Design of a training solution, which would further be broken down during the dev stage. Development - Development of actual training material (sometimes the training delivery in included in the scope) Evaluation - Not done frequently in my team.

5. It starts with the analysing the client needs and suggesting a solution. The solution is mostly in form of a HLDD and a prototype - either of an existing course or new. Once the prototype is accepted, storyboards are created and one topic is created and sent to client for approval. Once approval is received, we go through with the entire course.

6. Firstly the training requirement is mentioned by the client. Then, based on the analysis done on the requirement, a sample prototype is created and sent to the client. This is done to ensure that the client knows and approves what he is going to receive. Once the prototype is approved, ID maps or curriculum maps are created and story boards are written based on the approved ID maps. After the storyboards get the final sign-off from the client, the course is created using an appropriate authoring tool.

7. Expression of Interest Prototype High Level Design Detail Design/Story Board Course Construction with tool QA Corrections Packaging and Delivery

5.) In your opinion, how can the current process be improved to produce better courseware?

1. By having better access to SMEs and the actual applications that learners will be working on.

2. 1. The design document should be prepared by the SME rather than the courseware developer. Of course, the developer can convert that document into a format that will appear attractive to those who believe in deadlines. 2. E-learning courseware to be loaded in favor of hands-on practicals rather than theory. 3. The process of self-learning to be made part of the ADDIE process.

3. It could be improved with more focus on audience analysis rather than the courseware to be deployed.

4. More focus on the evaluation stage so that we can incorporate changes in methodology in the design stage.

5. A better understanding of the client's work would help and access to SMEs.

6. If the level of communication is well established and clear from the client's side then the time taken for approving the course at various stages can be lessened.

7. A heavier emphasis on analysis of target audience needs and knowledge level.

6.) Courseware developed on generic topics (examples would be customer service training, high school mathematics, English grammar etc.) lend itself to reuse. In your opinion, what might be potential barriers to their reuse?

1. Topicality might be outdated. Also, with new industries coming up (like BPOs and KPOs), new methods of teaching and re-evaluating existing learnings need to be explored.

2. 1. Geography. What is good for the Yankee is definitely not good for the Irish or the Arab. 2. Culture. Same as above. 3. Writing style and use of slang in context. 4. Reuse is copy, paste with some editing. Large scale reuse is really scamming everybody. Minor scale reuse should be okay in any environment as long as you have a good proof reader.

3. The media applied during the courseware design is likely to become obsolete while being persistently reused. From the audience perspective, I assume it will not hold their interest if there are better media application/tools in courseware deployment. Perhaps there are newer learning theories being formed to improve the learning experience.

4. Lack of actual hands-on exercises in elearning courses. Interactive exercises reduced to specifics - rather than questions testing application of core concepts.

5. outdated content

6. The audience and their level of understanding is a major factor that strikes the reuse cos the course prepared for a generic audience will not be suitable for specific cases.

7. Look and feel Indifference to local taste and cultures. Inevitable effort needed for customization

7.) The concept of 'Learning Objects' promotes the creation of pedagogically neutral, granular content so as to improve reuse and interchangeable use. What are your thoughts on this concept?

1. It's a good idea as it saves time and effort.

2. I am afraid this one is for those who live in the rarefied heights of instructional analysis. So cannot answer this one because it boggles my mind.

3. NA

4. Works very well if content can be restrained to core but general concepts. The exercises need to test application of the concept rather than specifics. This is extremely difficult to storyboard and to develop - which is why most elearning course cannot be used as stand-alone independent re-usable objects. However, if designed and structured correctly, the Learning Objects concept not only helps in retaining and increasing learner attention, it also increases the efficiency of the development process.

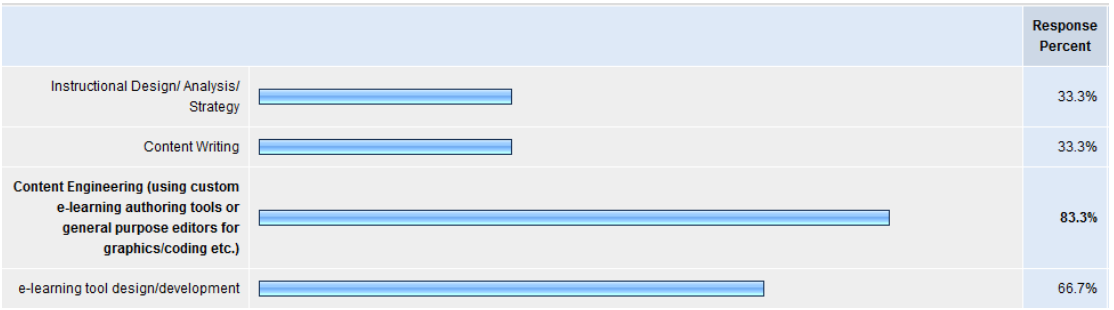
5. Yes it is great if we can reuse and interchange objects of learning.

6. -

7. As a concept for promoting improving overall efficiency and reducing duplicate effort, it is a good idea. But it might not be practical at all levels of education. Certain generic topics have the potential to be reused.

Appendix D: e-Learning Technology Survey Responses

1.) Which of the following roles do you handle?



	Response Percent
Instructional Design/ Analysis/ Strategy	33.3%
Content Writing	33.3%
Content Engineering (using custom e-learning authoring tools or general purpose editors for graphics/coding etc.)	**83.3%**
e-learning tool design/development	66.7%

2.) The concept of 'Learning Objects' promotes the creation of pedagogically neutral, granular content so as to improve reuse and interchangeable use. What are your thoughts on this concept?

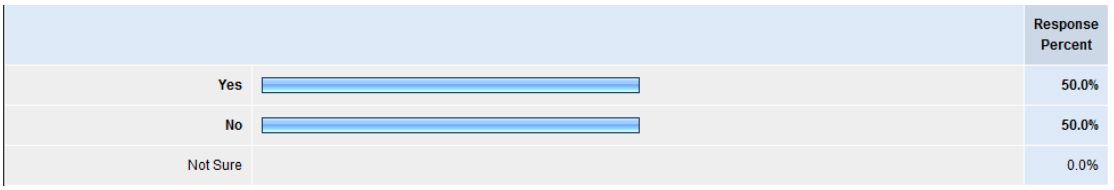
1. While the concept of modular content that can be combined and reused in various training scenarios is a laudable, such scenarios rarely arise, particularly when dealing with third-party clients. Most of the materials we create don't easily lend themselves to be re-used and re-purposed as they're focused on a particular set of learning needs. The few instances where I've seen it used with moderate success have been within a curriculum or a training stream, where stable portions of an existing training could be easily combined with updated content to create a new learning activity. Also the development of granular content makes creating engaging interactivity difficult.

2. While the concept of modular content that can be combined and reused in various training scenarios is a laudable, such scenarios rarely arise, particularly when dealing with third-party clients. Most of the materials we create don't easily lend themselves to be re-used and re-purposed as they're focused on a particular set of learning needs. The few instances where I've seen it used with moderate success have been within a curriculum or a training stream, where stable portions of an existing training could be easily combined with updated content to create a new learning activity. Also the development of granular content makes creating engaging interactivity difficult.

3. that's how it should be

4. When it comes to adult learners, smaller learning objects helps in retaining the interest in a curriculum due to "lesser content per serving". Larger content tends to throw off adult learners. Learning Objects reduces cost and it is easy to maintain

3.) Does the instructional design/content engineering process within your organisation encourage granularity in courseware development?



	Response Percent
Yes	50.0%
No	50.0%
Not Sure	0.0%

4.) Does the instructional design/content engineering process within your organisation have provisions for building accessible courseware for the physically challenged? If yes, please state which guidelines are followed (Section 508, WCAG etc.) and briefly explain the accessibility testing procedures.

1. All internal training materials (whether elearning, facilitated sessions) are meant to be Section 508 and WCAG compliant (at least AA) as per our Corporate Responsibility strategy. Prior to final delivery and deployment, courses are tested for screen-reader compatibility and standards compliance. Where the delivery method is not natively accessible (e.g Articulate, application simulations) we provide accessible documents (PDFs etc.) that provide a reasonable facsimile for challenged learners to use.

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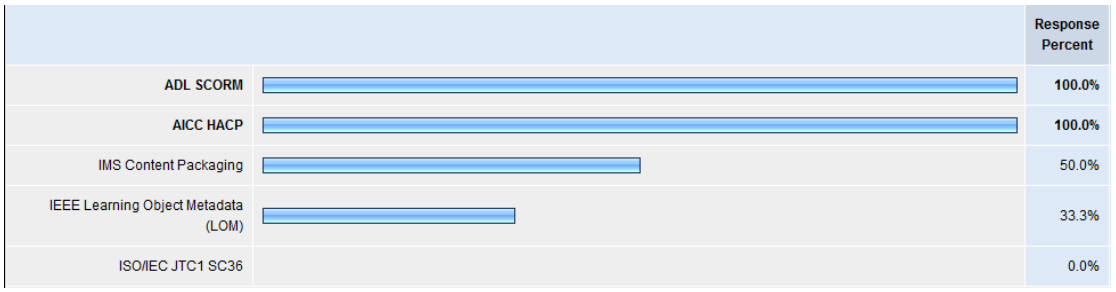
3. Section 508 and WCAG. Most of the testing is manual and. Jaws is extensively used for Visual imapired testing.

4. we follow section 508. the accessibilty course are testing using webking and jaws.

5. The tools used in our organization have provision for accessibility features. We use JAWS for most of the 508 testing. We also use screen magnifier softwares and simple Javascript widgets to test the course for color blind learners.

6. Yes, Section 508. All published courses are tested with screen readers. For specific requests, accessible HTML version of the regular course ware can be generated.

5.) E-learning standards bodies seek to promote quality and interoperability. Which of the following standards are you familiar with?



6.) Does the content engineering/e-learning tool design process in your organisation encourage adding metadata to learning content? If not, do you think it helps promote easier discovery and reuse of the content?

1. Yes. Courses deployed on the LMS usually have tags associated to facilitate searching the catalog.

2. Yes. Courses deployed on the LMS usually have tags associated to facilitate searching

3. We do not use any meta data in our learning content. Not sure how it would promote easier discovery and reuse.

4. sure. I would encourage it, meta would help search engines

5. The tool has options. But it is rarely used.

6. Yes, this is a customer specific activity. Depends on customer requests.

7.) The true benefits of e-learning is realised at an organisational level when content is deployed on a Learning Management Systems (LMS). Please list some of the LMS you have worked with.

1. Saba SumTotal Lotus LMS SAP LSO
2. Saba SumTotal Lotus LMS SAP LSO
3. SABA, Lotus LMS, Sumtotal.
4. Lotus SABA Blackboard
5. Docent, Lotus Learning Management System and Saba.
6. IBM LCAS SABA

8.) What were the positives and negatives of your experience deploying/administering content on LMS?

1. Many LMS behave very differently from others. Often, it's only after deployment that we pick up on LMS-specific issues. Sometimes these issues are implementation specific as well. For example, when an organization switched over to a new LMS, a two-year old course (which used a lot of media which was dynamically loaded) stopped playing the media files even though the files were available in the

correct location. But the control and reporting features that an LMS provides is an invaluable tool to learning consultants in determining the effectiveness of training.

2. Many LMS behave very differently from others. Often, it's only after deployment that we pick up on LMS-specific issues. Sometimes these issues are implementation specific as well. For example, when an organization switched over to a new LMS, a two-year old course (which used a lot of media which was dynamically loaded) stopped playing the media files even though the files were available in the correct location. But the control and reporting features that an LMS provides is an invaluable tool to learning consultants in determining the effectiveness of training.

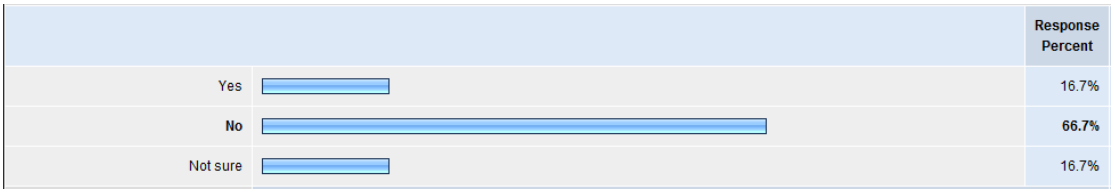
3. Not all LMSs implement learning standards to the fullest.

4. 1. Long process. 2. too many process to follow

5. Positives: Track return on investment of eLearning implementation. Integration of LMS with HR systems for incentives, promotions, mandatory certifications, and reporting. Negatives: Motivating and training the users to use the LMS. All the LMSes are designed for tech savvy users.

6. Ease of administering, generating on-the-fly reports. Improperly packaged manifest files can create havoc. Also, LMS servers do not appear to handle loads and speeds as well as conventional servers.

9.) Have you worked with a Learning Content Management System (LCMS)?



10.) How do you rate XML as a technology/platform for the needs of learning content deployment? Do you foresee any other technologies taking over the role of XML?

1. Excellent. Not in the near future.

2. XML is the data layer. for now its going to stay

3. As long as the XML remains behind the scenes and let the content developers use their familiar environment for development it is the best option. As of now this technology has proven to work with different platforms and applications seamlessly. So there is no need for a XML 2.0. It might change in future...

4. For serialization and ETL operations, XML seems to be the most viable option at the moment.

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