CHAPTER 1
INTRODUCTION

1.1 LEARNING OBJECTS

Times are changing. Today, it is the age of e-learning. The shift from instructor-centered to student-centered e-learning was the immediate effect of the radical increase in student numbers and the struggle to find a sufficient number of experienced instructors with suitable skills. In e-learning environment, the instructor inevitably became a facilitator of the overall learning process (Lin & Hsieh 2001). e-Learning system is a tool for empirically exploring how learners and instructors use learning objects in a variety of subject areas and across diverse age groups. e-Learning most often means an approach to facilitate and enhance learning by means of personal computers, CD-ROMs, and the Internet. Advantages that accrue are that just-in-time learning is possible, courses can be tailored to specific needs and asynchronous learning is possible. A learning object (LO) is an independent content component that can function as the learning content of a course module. It can be defined as any digital content resource that supports learning, that can be re-used and that can be
delivered on demand. Learning Objects (LOs) are elements of a new type of computer-based instruction grounded in the object-oriented paradigm of Computer Science. The LOs may provide instructional benefits by potentially increasing the speed and efficiency of e-Learning and instructional development.

Learning object comes from the idea of object oriented programming, where in parts of a computer code are reused for various software applications. This concept was transferred to repurposing content for different learning situations. Traditional learning content is designed as a large course that does not lend itself to potential reuse. However with a LO approach, content is designed as smaller units of learning that support potential reuse, that can stand alone, and that can be made accessible to meet the “just enough” and “just-in-time” requirements of learners. As developing quality content can be very expensive, time consuming and require specific expertise, LOs can be shared and reused in different courses.

1.2 DEFINITION LEARNING OBJECTS

In 2006, the Institute of Electrical and Electronics Engineers (IEEE) quality assurance and standards body defined LOs as “any
entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning.” A learning object is:

- A chunk of content structured to support learning through the possible inclusion of educational objectives, contents, resources, activities and assessments.
- Content designed to ensure reuse within different instructional settings.
- Content that can be stored within different digital learning management systems (LMS), or used in many different delivery modes.

1.3 REUSABLE LEARNING OBJECTS AND e-LEARNING

A learning object is an independent and self-standing unit of learning content that is predisposed to reuse in multiple instructional contexts. Learning objects are elements of a new type of Computer-based instruction grounded in the object-oriented paradigm of computer Science. Object-orientation highly values the creation of components (called “objects”) that can be reused (Dahl & Nygaard 1966) in multiple contexts. This is the fundamental idea behind learning objects. Instructional designers can build small (relative to the size of an entire course) instructional components that can be reused a number of times
in different learning contexts. Additionally, learning objects are generally understood to be digital entities deliverable over the Internet, meaning that any number of people can access and use them simultaneously.

David Wiley (2000) outlines the basic idea behind learning objects as “Instructional designers can build small (relative to the size of an entire course) instructional components that can be reused a number of times in different learning contexts.” Reusable learning objects are defined as “self-contained learning components...that are stored and accessed independently. Learning objects can be re-assembled to create new courses or sequenced to form individual learning paths.” (English 2001). In more detail, a learning object is a collection of assets covering a topic or complex task satisfying one learning objective.

1.3.1 Why learning objects?

Learning objects represent a key point of intersection between knowledge management and e-learning initiatives allowing organizations to improve the capture and use of knowledge through flexibility, ease of updates, adaptivity, interoperability, increased value of content and cost avoidance.
• **Flexibility** - relates to designing content so that it can be used in multiple contexts. Content designed with multiple uses and contexts in mind can be reused much more easily than content that has to be rewritten for each new use. The same content “can be assembled as training modules, documentation, reference, promotional brochures, technical manuals” (Colvin 1998). Having a library of learning objects to draw on will also shorten course development time allowing for faster deployment of the learning required to develop performers to the necessary level of competency. The digital nature and storage of learning objects makes them easy to manage. The labels or tags mentioned earlier facilitate updates, searches, and content modification by making each asset and object easy to identify and locate. Once located, a piece of content is changed once. All places linked to that content are updated instantly.

• **Adaptivity** - refers to the ability to recombine assets into any number of objects adapting them to meet specific needs. Objects can quickly be created and combined to meet individual knowledge, skill and attitude gaps within a competency-based model.

• **Interoperability** - means that organizations can set specifications regarding the design, development and presentation of objects based
on organizational needs while retaining interoperability with learning systems at other organizations.

- **Reuse** - Increased value of content and cost avoidance is realized through content reuse. The value of a piece of content increases every time the content is reused. Reuse also results in cost avoidance since there is far less new design and development required. In addition, content can now, realistically, be sold. All of this, along with the technical feasibility provided by intranets, extranets, and the Internet, make learning objects a very attractive proposition and one for which return on investments is fairly easy to postulate.

### 1.3.2 Learning object types

All learning objects have certain qualities. It is the difference in the degree to which or manner in which they exhibit these qualities that makes one type of learning object different from another. There are five types of learning objects:

- **Single-type** - For example, a JPEG of a hand playing a chord on a piano keyboard.

- **Combined-intact** - For example, a video of a hand playing an arpeggiated chord on a piano keyboard with accompanying audio.
• Combined-modifiable - For example, a Web page dynamically combining the previously mentioned JPEG and QuickTime file together with textual material, on-the-fly.

• Generative-presentation - For example, a JAVA applet capable of graphically generating a set of staff, clef, and notes and then positioning them appropriately to present a chord identification problem.

• Generative-instructional - For example, an EXECUTE instructional transaction shell (Merrill 1999), which both instructs and provides practice for procedures, for example, the process of chord root, quality, and inversion identification.

1.3.3 Learning object characteristics

• Number of elements combined – Describes the number of individual elements (such as video clips, images, etc.) combined in order to make a learning object.

• Type of objects contained – Describes the type of objects that may be combined to form a new learning object.

• Reusability of component objects – Describes the degree of ease with which constituent objects may be individually accessed and reused.
• **Common function** – Describes the manner in which the object is generally used.

• **Extra-object dependence** – Describes whether the object needs information (such as location on the network) about learning objects other than itself.

• **Type of logic contained in object** – Describes the function of algorithms and procedures within the object.

• **Potential for inter-contextual reuse** – Describes the number of different instructional contexts in which the learning object may be used, that is, the object's potential for reuse in different content areas or domains.

• **Potential for intra-contextual reuse** – Describes the number of times the object may be used within the same content area or domain.

1.4 **e-LEARNING**

e-Learning is “a combination of content and instructional methods delivered by media elements such as words and graphics on a computer intended to build job-transferable knowledge and skills linked to individual learning goals or organizational performance” (Clark, R. C. & Mayer, R. E. 2002). The sciences of instruction, learning, and knowledge are intricate and the “e-” before “Learning” adds another
dimension of complexity while paving new learning paths for e-

learning.

![Diagram](image)

**Figure 1.1: The basic general architecture of a Web-based e-
learning system**

1.4.1 Why e-learning?

E-learning is first and foremost about learning. Without a focus
on the learner, the learners' needs, and the aptitude of the learner, e-
learning cannot take place. However, the enabler, for all this online
learning is technology department. An online learner cannot learn if he
or she is encountering technical difficulties. e-learning can be defined
as “the use of Internet technologies to deliver a broad array of solutions
that enhance knowledge and performance.” (Rosenberg 2001) and it makes delivery of focused learning.

1.4.2 Advantages of e-learning

The general benefits of e-Learning when compared to traditional instructor-led training include all those shared by other types of technology-based training. These benefits are that the training is usually self-paced, highly interactive, results in increased retention rates, and has reduced costs associated with student travel to an instructor-led workshop.

- **Access is available anytime, anywhere, around the globe.** Students always have access to a potentially huge library of training and information whether they are working from home, in the office, or from a hotel room. As cellular modems become more popular, students will even be able to access training in a place that doesn’t have a traditional phone line or network connection.

- **Per-student equipment costs are affordable.** Almost any computer today is equipped with a modem and free browser software can access the Internet or a private Intranet. The cost of setup is relatively low.
- **Student tracking is made easy.** Since students complete their training while they are connected to the network, it is easy to implement powerful student-tracking systems. Unlike CD-ROMs that require students to print reports or save scores in a disk. This information can be as simple as who has accessed the courseware and what are their assessment scores, to detailed information including how they answered individual test questions and how much time they spent on each module.

- **Possible "learning object" architecture supports on demand, personalized learning.** With CD-ROM training, students have access only to the information that can be held by one CD-ROM. The instructional design for this type of delivery, therefore, has been to create entire modules and distinct lessons. However, with WBT, there is virtually no storage limitation and content can be held on one or more servers. The best WBT is designed so that content is "chunked" into discrete knowledge objects to provide greater flexibility. Students can access these objects through predefined learning paths, use skill assessments to generate personal study plans, or employ search engines to find exact topics.

- **Content is easily updated.** In today’s fast-paced business environment, training programs frequently change. With CD-
ROM and other forms of training, the media must be reduplicated and distributed again to all the students. With e-Learning, it is a simple matter of copying the updated files from a local developer's computer onto the server-computer. The next time students connect to the Web page for training, they will automatically have the latest version. Learning objects are also self-contained, context-independent units. While some may argue that each element in a learning intervention must be contextualized, in corporate performance-based training environments decontextualized, easily accessible information and learning bits focused on a specific task or goal are often what is most useful and most desired. Being self-contained and context-independent allows learning objects to be modular and free standing with no backwards and forward referencing across objects.

- There can be nothing in a reusable learning object that refers to other objects. From a design point of view, it means that there can be nothing in an object that requires it to reside in a sequence. A learning object must be "extractable or 'standalone'. It really should possess the ability to be plucked
from one learning environment and placed into another” (Mills 2002).

- While a learning object must be able to stand on its own, there is no reason to why the instructional designer cannot sequence objects into modules. The key is that each learning object must also be viable on its own, outside any sequence. With some corporate audiences, presenting learning objects in a traditional module / lesson / topic format may facilitate initial adoption. If the same objects are also easily available independently, then multiple learning styles, needs, and business requirements can be simultaneously met.

- Learning objects must also be reusable and transportable among applications and environments and repurposable to different delivery structures. To be reusable and transportable, an object needs to meet some technical coding standards and it must be instructionally designed for reuse. In addition, each RLO must be labeled to make identification of content, topic, purpose, etc. readily apparent and to make the object easily retrievable. There are “two requisite components of a learning object: the object content and its metadata tag” (Longmire 2000).
- Meta-tagging means linking or tagging objects and assets with specific metadata. “Metadata, literally ‘data about data’, is descriptive information about a resource. Metadata allows us to locate an item very quickly without investigating all the individual items through which you are searching” (Wiley 2000). Since they are stored in a database structure and managed through a Learning Content Management System via meta-tagging, learning objects make it easy to find and access content anywhere, anytime and they are easy to update and display.

- **Intent and design**- Learning objects are information objects which are differentiated by their intents and designs. The intent of a learning object’s designer is to facilitate learning, while information objects are designed to be a reference, and not necessarily for the purpose of retaining skills or concepts by the user (Sandy 2002).

- **Assets**- Learning objects are made up of assets. An asset is the smallest piece of the instruction that makes sense on its own, for example: a step-by-step procedure, a concept, or a short clip of a video showing a process. On their own, most assets are informational. Combined together they can become learning materials. Assets can also be reusable and transportable.
1.4.3 Learning objects Vs traditional types of instructional media

Learning objects are elements of a new type of computer-based instruction grounded in the object-oriented paradigm of Computer Science. Object-orientation highly values the creation of components called "objects" that can be reused. This is the fundamental idea behind learning objects. Traditional training is too large, expensive, general, and slow to meet the needs of many fast-paced corporations. "The new economy thrives on producing information and passing it at unprecedented rates among partners, employees, and customers" (Stacey 2000). Reusable learning objects (RLOs) are emerging as the "technology of choice in the next generation of instructional design, development, and delivery, due to its potential for reusability, generativity, adaptability, and scalability" (Wiley 2000). The design and deployment of learning objects, we can reuse parts of training rather than starting from scratch every time; cost-effectively and quickly customize learning to meet the needs of the individual or small group; and, dramatically reduce maintenance costs.

Instructional designers can build small (relative to the size of an entire course) instructional components that can be reused a number of times in different contexts. Additionally, learning objects are generally
understood to be digital entities deliverable over the Internet, meaning that any number of people can access and use them simultaneously, compared to traditional instructional media, such as an overhead or video tape, which can only exist in one place at a time. Moreover, those who incorporate learning objects can collaborate on and benefit immediately from new versions. This is a significant difference between learning objects and other types of instructional media that have existed previously.

1.4.4 Learning objects standards committee

Learning objects is a significant advance in the creation of educational materials. However, they are not enough. A full realization of the possibility of personalized and reusable educational content requires the establishment of standards for the design and description of learning objects. The substantial potential benefits - reusability, interoperability, durability, accessibility - can only be realized if there is widespread adherence to the appropriate standards. Without such standards, the value of learning objects is substantially reduced.

To facilitate the widespread adoption of the learning objects approach, the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) was formed
in 1996 to develop and promote instructional technology standards (LTSC 2000). Without such standards, universities, corporations, and other organizations around the world would have no way of assuring the interoperability of their instructional technologies, specifically their learning objects. A similar project called the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) had already started with the financial support of the European Union Commission (ARIADNE 2000). At the same time, another venture called the Instructional Management Systems (IMS) Project was just beginning in the United States, with funding from Educom (IMS 2000a). Each of these and other organizations like Advanced Distributed Learning (ADL) began developing technical standards to support the broad deployment of learning objects. Many of these local organizations have representatives in the LTSC group.

1.4.5 The IMS project and adoption of the learning objects idea

The IMS project, which develops and promotes compliance with technical standards for online learning, is funded solely by members. The highest level of participation is “Contributing Member,” with an annual fee of U.S. $50,000, retroactive to the project’s beginning. Over 30 vendors, universities, and other organizations belong to Instructional
Management System program (IMS 2000b) whose membership list reads like a who’s who of software developers and high-powered organizations: Microsoft, Oracle, Sun, Macromedia, Apple, IBM, UNISYS, the U.S. Department of Defense, the U.S. Department of Labor, California State Universities, International Thompson Publishing, and Educational Testing Service, to name a few. The next level of membership down, the “Developers Network,” has over 200 members, most of which are universities.

1.4.6 The learning objects metadata

Metadata, literally “data about data,” is descriptive information about a resource. For example, the card catalog in a public library is a collection of metadata. In the case of the card catalog, the metadata are the information stored on the cards about the author, title, and publication date of the book or resource in question. Metadata allows us to locate an item very quickly without investigating all the individual items through which we are searching.

The Learning Objects Metadata Working Group is working to create metadata for learning objects (such as title, author, version, format, etc.) so that people and computers will be able to find objects by searching, as opposed to browsing the entire digital library one object at a time until they find the right one.
1.5 OBJECTIVES OF LEARNING DESIGN SPECIFICATION

The objectives of the Learning Design Specifications are to provide a framework of elements that can describe any design of a teaching-learning process in a formal way. More specifically, the Learning Design Specifications meet the following requirements:

- **Completeness**: The specifications must be able to fully describe the teaching-learning process in a unit of learning, including references to the digital and non-digital learning objects and services needed during the process. These includes:
  
  ✓ Integration of the activities of both learners and staff members
  ✓ Integration of resources and services used during learning
  ✓ Support for a wide variety of approaches to learning
  ✓ Support for both single and multiple user models of learning.
  ✓ Support for mixed mode (blended learning) as well as pure online learning.

- **Pedagogical flexibility**: The specifications must be able to express the pedagogical meaning and functionality of the different data elements within the context of a unit of learning. It
must be flexible in the description of all different kinds of pedagogies and not prescribe any specific pedagogical approach.

- **Personalization:** The specifications must be able to describe personalization aspects within a learning design, so that the content and activities within a unit of learning can be adapted based on the preferences, portfolio, pre-knowledge, educational needs, and situational circumstances of users. In addition, the control over the adaptation process must be given, as desired, to the student, a staff member, the computer, and/or the designer.

- **Formalization:** The specifications must describe a learning design in the context of a unit of learning in a formal way, so that automatic processing is possible.

- **Reproducibility:** The specifications must describe the learning design abstracted in such a way that repeated execution in different settings with different persons is possible.

- **Interoperability:** The specifications must support interoperability of learning designs.

- **Compatibility:** The specifications uses available standards and specifications where possible, mainly IMS content packaging, IMS question and test interoperability, IMS/LOM meta-data and IMS simple sequencing.
• **Reusability:** The specifications must make it possible to identify, isolate, de-contextualize and exchange useful learning artefacts, and to re-use these in other contexts.

1.5.1 Conceptual model - semantic aggregation levels in learning design

The conceptual model is expressed as a set of UML class models and a definition of the vocabulary used. Figure 1.2 represents the conceptual model of the semantic aggregations levels in the learning design specifications, represents aggregation relationships and the specializations of abstract classes.

![Semantic aggregation levels in learning design](image_url)

**Figure 1.2:** Semantic aggregation levels in learning design
The model shows that learning design provides a semantic view of a collection of resources on one hand, and on the other hand, it integrates a method, specifying the dynamic aspects of the learning design. The model shows three levels of semantic aggregation (the three horizontal layers of gray colored classes). The semantically highest level is the learning design. It aggregates a collection of components, objectives/prerequisites (short for: learning objectives & prerequisites), and a method. The lowest level of aggregation are the resources, plays, conditions, and notifications. The resources are aggregated into components and objectives/prerequisites. The plays, conditions, and notifications are aggregated into the method.

A component can be one of seven different types: role, property group, property, activity structure, activity, environment, or outcome. With the exception of outcome, these are all elements in the LD information model. Role can be one of two types: learner or staff. A resource can be one of Web content, person or service facility. These resources can be referenced from a learning design but are not explicitly part of the information model. The model also shows that the components, objectives/prerequisites, and resources are independent of
the learning design. They can be referenced and used in many other learning designs.

1.5.2 Conceptual structure of the learning design

Another conceptual view of the learning design is provided in Figure 1.3. In this model, the emphasis is on the functional relationships between the classes.

![Diagram of learning design](image)

Figure 1.3: Conceptual model of overall learning design
<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Explanation</th>
<th>Req</th>
<th>Mult</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>learning-design</td>
<td>This element specifies the learning design.</td>
<td></td>
<td></td>
<td>sequence</td>
</tr>
<tr>
<td>0.1</td>
<td>identifier</td>
<td>An identifier that is unique within the learning design file (ID).</td>
<td>M</td>
<td>1</td>
<td>ID</td>
</tr>
<tr>
<td>0.2</td>
<td>version</td>
<td>A version number.</td>
<td>O</td>
<td>1</td>
<td>string</td>
</tr>
<tr>
<td>0.3</td>
<td>uri</td>
<td>Specifies a URI.</td>
<td>M</td>
<td>1</td>
<td>Any URI</td>
</tr>
<tr>
<td>0.4</td>
<td>level</td>
<td>Specifies the lowest level of Learning Design that the document instance is valid against.</td>
<td>M</td>
<td>1</td>
<td>token</td>
</tr>
<tr>
<td>0.5</td>
<td>sequence-used</td>
<td>Boolean, when set to 'true' IMS Simple Sequencing is included at the appropriate places in the document instance. Default is false.</td>
<td>O</td>
<td>1</td>
<td>Boolean</td>
</tr>
<tr>
<td>0.6</td>
<td>title</td>
<td>A short name given to the resource, suitable for rendering in user-agents.</td>
<td>O</td>
<td>0..1</td>
<td>string</td>
</tr>
<tr>
<td>0.7</td>
<td>learning-objectives</td>
<td>Learning objectives describe the intended outcome for learners.</td>
<td>O</td>
<td>0..1</td>
<td>sequence</td>
</tr>
<tr>
<td>0.7.1</td>
<td>{itemmodel}</td>
<td>A schema group.</td>
<td>M</td>
<td>1</td>
<td>group</td>
</tr>
<tr>
<td>0.8</td>
<td>prerequisites</td>
<td>Prerequisites are the entry-requirements for students, e.g. the pre-knowledge needed.</td>
<td>O</td>
<td>0..1</td>
<td>sequence</td>
</tr>
<tr>
<td>0.9</td>
<td>components</td>
<td>Specifies the building blocks used in the method section.</td>
<td>M</td>
<td>1</td>
<td>sequence</td>
</tr>
<tr>
<td>0.10</td>
<td>method</td>
<td>The method contains a sequence of elements for the definition of the dynamics of the learning process</td>
<td>M</td>
<td>1</td>
<td>sequence</td>
</tr>
<tr>
<td>0.11</td>
<td>metadata</td>
<td>Placeholder for metadata. Includes IMS Meta-Data here, using its namespace.</td>
<td>O</td>
<td>0..1</td>
<td>sequence</td>
</tr>
</tbody>
</table>
The core concept of the Learning Design Specification, as expressed in Figure 1.2, is that regardless of pedagogical approach, a person gets a role in the teaching-learning process, typically a learner or a staff role. In this role, he or she works toward certain outcomes by performing more or less structured learning and/or support activities within an environment. The environment consists of the appropriate learning objects and services to be used during the performance of the activities. Which role gets which activities at what moment in the process, is determined by a method or by a notification.

Figure 1.4 : Conceptual model of learning design
The method is designed to meet learning objectives (specification of the outcomes for learners), and presupposes certain prerequisites. The method consists of one or more concurrent play(s); a play consists of one or more sequential act(s) and an act is related to one or more concurrent role-part(s), each role-part associates exactly one role with one activity or activity-structure. The teaching-learning process is modelled on a method based on the notion of a theatrical play. A play has acts, and in each act has one or more role-parts. The acts in a play follow each other in a sequence. The role-parts within an act associate each role with an activity. The activity in turn describes what that role is to do and what environment is available to it within the act. In an analogy, the assigned activity is the equivalent of the script for the part that the role plays in the act, although less prescriptive. Where there is more than one role-part within an act, these are run in parallel.

Activities can be assembled into activity-structures. An activity-structure aggregates a set of related activities into a single structure, which can be associated to a role in a role-part. A structure can model a sequence or a selection of activities. In a sequence, a role has to complete the different activities in the structure in the order provided.
Environments can contain two basic types: located learning objects and generic services. Located learning objects are typically specified by a URL with optional metadata. A user may further classify these learning objects by means of the vocabulary provided in the IMS LOM meta-data or the generic 'class' attribute that is available on all elements. Generic services are services that relate relates to a concrete service facility available at runtime. During design, a service has no URL assigned to it, but must be given a URL when the learning design is instantiated at runtime. Examples of a service include a discussion forum, chat rooms, monitoring tools, search facilities, etc. In learning design, the conditions for setting up a service at runtime are specified at an abstract level. For example, for discussion groups, it specifies which learning design roles have what type of access (participant, observer, moderator, etc.).

1.5.3 Need for OOAD of LO

The growing number of accounts of high drop-out rates, lack of user satisfaction and no differences in performance suggest that digital learning might not be the panacea often implied by proponents of digital learning products and services. While we cannot yet establish all reasons for the complaints, there are obvious contributing consequences
of a rush to "go-digital”: (a) poor quality content regardless of format, (b) poor instructional design, (c) technology and infrastructure problems, (d) inappropriate software decisions, and (e) inappropriate content for the business and learning objectives. Reusable learning objects (RLOs) are context independent, transportable and reusable pieces of instruction that are digitally managed and delivered. As such, they provide untold opportunities for easy access to tailored learning and are slowly being implemented in some large corporations.

Hodgins (2000) states that learning objects represent a completely new conceptual model for the mass of content used in the context of learning. They are destined to forever change the shape and form of learning, and in so doing, it is anticipated that they will also usher in an unprecedented efficiency of learning content design, development, and delivery. Creating learning objects facilitates learning that is “student-based rather than content-based. It focuses on what people want (or need) to do, rather than on what there is to know.” (Downes 2001).

1.5.4 The instructional design of learning objects

Learning objects are created at the smallest level, keeping the end goal in mind. “Object content doesn’t flow across objects either as an argument or as cumulative knowledge” (Longmire 2000). Instead of
looking at teaching as a linear procession with a beginning, middle, and an end. We think of training as clusters of independent, stand alone bits of knowledge, which are related and can be viewed together but which also can be viewed singly. We can enter and leave a Web site at any page and leave at any point.

1.5.5 Creating new content as learning objects

When creating learning objects we start the same way as with traditional courses by defining the gap and the audience, deciding what must be trained and what can be supported rather than trained. Determining the learning approach, media and identifying the terminal learning objectives. This is the point at which the processes begin to differ. We sequence the objectives and create learning and assessment that flows from one piece to another with carefully crafted links. In object design, each learning objective (which will become an object) is deconstructed into sub- or enabling objectives, each of which will become one or more assets. Each asset is then designed to work in multiple contexts. When all the assets are designed, objects are created and then a recommended sequence of objects is identified for learners.
1.6 LEARNING OBJECTS DESIGN METHODOLOGY

e-Learning is becoming a major component in academic world today. There is a need for formalized guidelines in e-learning so as to enable the designer to design, maintain, and manage a course. Some research has been done on the subject, but none has proposed formalized guidelines and none has drawn the results from the users’ perspectives. The users, students in this case, should be at the heart of the design and their thoughts, wishes, and needs should be implemented in the user-centered design.

There are so many e-learning systems available in the market. Content available for learning on the Web is variable. The content developers, educators and students needs can’t be addressed simultaneously and their will be a gap. To bridge the gap, a modified ADDIE model of e-learning system was proposed to build fragmented lesson plans.

1.6.1 Instructional systems design

The most widely used methodology for developing new training programs is called Instructional Systems Design (ISD). It is also known as Instructional Systems Design & Development (ISDD), the
Systems Approach to Training (SAT), or just Instructional Design (ID). This approach provides a step-by-step system for the evaluation of students' needs, the design and development of training materials, and the evaluation of the effectiveness of the training program.

1.6.2 Why use a systems approach?

A system is any set of components that work together to achieve a specified outcome or goal. Let us think of the cruise control system on our car. We set the desired speed (or goal) and the cruise control sets the gas injection to the proper level. An important aspect of any system is the feedback mechanisms that ensure that the goal is achieved or maintained. Using the cruise control analogy, the car does not just lock the gas pedal in one position. A systems approach with its requisite feedback makes cruise control a viable system to maintain driving speed, so also, the systems approach provides the smoothest development means for training programs.

1.7 THE ADDIE MODEL

There are more than 100 different Instructional Systems Design (ISD) models, but almost all are based on the generic "ADDIE" model, which stands for Analysis, Design, Development, Implementation, and Evaluation, as shown in figure 1.5, ADDIE is an instructional design
method, more particularly, an instructional systems design model. Each step has an outcome that feeds the subsequent step.

![Diagram of ADDIE model](image)

**Figure 1.5: Instructional design method ADDIE**

During analysis, the designer develops a clear understanding of the "gaps" between the desired outcomes or behaviors, and the audience's existing knowledge and skills. The design phase documents specific learning objectives, assessment instruments, exercises, and contents. The actual creation of learning materials is completed in the development phase. During implementation, these materials are
delivered or distributed to the student group. After delivery, the effectiveness of the training materials is evaluated.

![Diagram showing ISD Model](image)

**Figure 1.6**: Instructional system design concept map

**1.7.1 The advantages of using ADDIE model for e-Learning**

The systematic approach to development has many advantages when it comes to the creation of technology-based training. To create engaging metaphors or themes, artists and writers work together in a process that validates the creative approach with students early in the development cycle. Programmers and designers garner agreement as to
which learning activities are both effective as well as possible, given
the constraints of the client's computers or networks. Despite these
advantages, there are practical challenges with a purely systematic
design approach in the management of resources. In most cases,
training programs must be developed under a fixed and often limited
budget and schedule. While it is very easy to allocate people and time
to each step in the ISD model, it is harder to plan deliverables when
there are no distinct steps in the process.

1.7.2 A rapid prototyping phase

For best results, the development process for CD-ROM or Web-
based training programs should use a modified ADDIE model, which
borrows from the most valuable aspects of the systematic approach.
Specifically, a rapid prototype phase is inserted after, or as an extension
of, the design phase. A rapid prototype is simply a quickly assembled
module that can be tested with the student audience early in the ISD
process. The evaluation typically looks at things like how well the
learners responded to the creative metaphor, how effective the learning
activities are, and how well the program performs on the chosen
technology platform. Based on the feedback, the design can be revised
and another prototype developed. This iterative process continues until
there is agreement and confidence in the prototype. The work often
moves more quickly after a rapid prototype than in the traditional ADDIE model. Instructional designers and writers are able to proceed more efficiently since they know exactly what the program will look like and what it will be capable of doing. Additionally, with all of the major technical issues resolved, final programming becomes a simple matter of assembly of media components.

1.7.3 The analysis phase of an e-learning program

The analysis phase simply identifies the gap between actual behaviors and desired outcomes, and obtains information about the learner, environment, and technology that are relevant to closing the gap. This phase is the first and most crucial phase, with all subsequent work based on the outcomes of the analysis. An expedited analysis phase is used to uncover and document key items about learners, content, and technology.

Some of the tools that can be used to gather analysis information include:

- **Survey or questionnaire** is the most commonly used method in which specific questions are posed to a representative sample of the student population. Survey results are reviewed and summarized.

- **Direct observation** has the designer personally observe employee tasks taking place in the workplace.
• **Indirect observation** involves examining relevant performance data such as safety records, error rates, help desk call reports, sales data, or customer satisfaction surveys.

• **Interviews** put the instructional designer in touch with experts and/or a random sample of students through one-on-one interviews.

• **Focus groups** are similar to interviews, Only the designer poses questions to a group of experts or students. Data comes from direct answers, as well as from conversations among the focus group participants.

1.7.4 Evaluation of business and instructional goals

The first step in analysis is determining or clarifying the goals or desired outcomes. After understanding the business or instructional goals, further analysis is required of all the subordinate skills required to achieve the goal.

1.7.5 Analysis of required tasks and behaviors

This is a critical step towards developing behavioral learning objectives, and becomes the foundation for all of the content.

1.7.6 Assessment of learners

After understanding the desired goals and subordinate tasks, the target audience has to be analyzed. Learner information impacts
everything from appropriateness of metaphor to selection of content. Topics to be explored in assessing learners include:

- **Demographics.** What are the general characteristics of the audience? Is there uniformity in respect of gender, age, or educational background?

- **Psychographics.** What is the psychological makeup of the target audience? Do they want the information provided in a very direct manner or do they prefer a more time-consuming but engaging game format?

- **Attitude.** What are the learners' attitudes towards the content or to training itself? What is the attitude toward the use of technology-based training?

- **Experience with technology-based training.** Will this be the first experience using the corporate Intranet for learning or are they already accustomed to navigating online material?

- **Motivation.** What are the learners work and career goals? How can the training program assist them with the realization of those goals?

- **Prior knowledge and experience.** What will the learners bring to the training in terms of skills and knowledge? To what extent are they currently working towards achieving the desired business
goals? The audience profile can be used to direct both the interface as well as instructional design.

1.7.7 Conduct of technology assessment

Finally, we investigate the technology available to the student audience. What type of computers do they have? What kind of software is installed? What kind of network connection exists? What limitations will the Information Technology department put on the program?

Instructional designers should consult the programmers or other technical supervisors to gain an understanding of the limitations of the technology. Some common limitations include:

- Without speakers or headphones, the training program will not be able to use audio narration as the primary teaching media.
- Without a sufficiently fast processor or enough RAM, complex animations may not run smoothly.
- With Windows' standard AVI video format, video windows will be small and the video itself may be choppy and grainy.
- Web-based training is possible, of course, only if there is some type of connection to an Intranet or the Internet.
- If the connection is of low-bandwidth, the time it takes to download big files -- large graphics, animations, audio, and video
-- will be prohibitively long. Designers will have to stick to text and simple graphics.

- Web-based multimedia is possible with use of certain plug-ins.
- Complex activities, like drag and drop exercises, can only be implemented using later versions of popular browsers, using more advanced technologies like DHTML, Java, and Javascript.

1.7.8 Analysis of data

After completing a thorough analysis, the instructional designer has a series of worksheets, questionnaires, and other information that can be used to determine the most effective design.

1.8 THE DESIGN PHASE OF e-LEARNING

In the design phase, the outcomes from analysis are used to create a blueprint for the instruction. This blueprint, called a design document or design report, covers the training needs, instructional strategies, contents, and creative treatment. The document is used to communicate with all members of the development team and is invaluable for keeping the project on track and focused on the real training goals.
1.8.1 Determination of learning objectives

The first step in the design phase is to examine the tasks or subordinate goals that were listed in analysis and from these create a set of behavioral learning objectives. Objectives should be short, specific, and testable. Learning objectives, which are specific and testable, might be written as finishing the sentence: "After completing this course students will be able to:"

- The characters of class are listed and an associated benefit for each feature is identified.
- Five major applications of constructors and destructors are listed.

Figure 1.8: The learning design activities and concepts
1.8.2 Development of content outline

Learning objectives determine the actual content of the program. After reviewing source materials and/or interviewing subject matter experts, a content outline is developed. The outlines provide a lesson-by-lesson breakdown of topics, as well as a summary of any motivational strategies that will be employed.

One of the strengths of the ISD process is that it excludes background information and tangential content, which might be interesting but are not related to the specific learning objectives at hand. By paring down content, development time is reduced, learning time is reduced, and retention of relevant information is increased.

1.8.3 Indication of practice activities

In addition to presenting content, the design document specifies the strategies for practice. Practice and feedback are critical elements of effective instruction and should be planned carefully. Although the specific activities themselves are not created until the development phase, a general description of practice should be given.
**Figure 1.9**: Use case diagram of e-learning activities

The design document might include brief descriptions of simple questions (multiple choice, true/false, or fill-in), simulations, instructional games, on-the-job application exercises, or situational analysis activities.

1.8.4 Specification of technology and media

In technology-based training, the availability of CD-ROMs, audio speakers, bandwidth, and plug-ins often help determine the choice of media. The design document formally identifies the learners'
available technology, which drives many of the implementation
decisions later in the project. This specification should include not just
what is available, but what is allowed by an organization's Information
Technology department. Sometimes, technical specifications expand
into the choice of development tools, including specific authoring
systems, databases, or student-tracking systems.

1.8.5 Determination of user interface and creative treatment
The graphical user interface is the critical link between the
student and content. The design document spells out the buttons and
navigational features that will be available, what their labels or names
will be, and where on the screen they will be located. Ideally, an artist
creates the actual screen designs and these images can be embedded
within the design document.

The following list below indicates commonly prescribed interface
items:

- **Next** button, which advances to the next screen.
- **Back** button, which moves back to the previous screen.
- A **screen counter** to indicate progress through a lesson.
- **Menu** button to jump directly to the main menu.
- **Exit** button to exit the program.
- **Glossary** to access an online glossary.
• Help to access context-sensitive information, or navigational assistance.

• Notepad for recording student notes.

• Bookmark to tag the existing screen for future quick access.

The interface section of the design document should also describe or show the look and feel of the program. With due consideration for the learners' profile and the client culture, the visual treatment can be a conservative, functional screen, or something more creative. Training programs use a variety of metaphors or themes to increase student engagement.

1.8.6 Final sign-off

Once all revisions are made, the "client" should officially approve the design document as the blueprint for the entire program. If we are managing a project inside an organization, the internal client, such as we boss or the project contact in the sponsoring department, should sign a release document, so that the other phases of the project can proceed, based on the design document. This final acknowledgement step helps to communicate the importance of the design, and the fact that changing the program at a later stage of development will be considered out of scope.
1.9 CREATING RAPID PROTOTYPES FOR e-LEARNING

In this phase of a project lifecycle, an instructional software module is created for quick testing with a sample of the student audience. The rapid prototype creates an early iteration loop that provides valuable feedback on technical issues, creative treatment, and effectiveness of instruction. The design document itself is changed to reflect this feedback, and in some cases, a new prototype module is developed for subsequent testing of the refinements.

1.9.1 Value of rapid prototype

With the addition of the rapid prototype phase, the value of the ADDIE model for technology-based training is greatly enhanced. The prototype overcomes the limitations of the traditional ADDIE approach in that it involves all team members earlier in the project cycle, and enables both the client and students to provide an early feedback. This early review process is critical to software development and can detect actual errors, as well as identify client preferences. A detailed design document and prototype are the best insurance policies against last-minute alterations.

1.9.2 Creation of "Vertical Slice" of a program

Some developers consider a prototype to be nothing more than a couple of screen designs that show the look and feel of the program.
However, for reviewers to provide truly valuable feedback, the prototype must include a cross section of the entire program. This cross section is sometimes called a vertical slice.

A vertical slice of a program typically includes the title screen, Main Menu, one complete lesson, and sometimes a portion of the post-test. All features that will be available from within a lesson should be tested in the prototype phase. These often include glossary, notepad, and bookmark. We make sure that all types of media, such as video or audio, are included to reveal any technical problems. Finally, creative themes or metaphors are the most subjective element to any program, and among the most time-consuming to change. so they should also be included in the prototype.

1.9.3 Evaluation of the rapid prototype

Ideally, four to eight individuals selected from the student audience review the rapid prototype or three / four training managers or subject matter experts review the prototype. In the latter case, the reviewers must have a clear understanding of the learner population in terms of demographics, culture, and level of technical expertise, to provide an accurate and useful evaluation.

The main purpose of the review is not to evaluate the content or instructional design, but to evaluate the ease of navigation, the screen
design and layout, appropriateness of metaphor, and the technical performance. Specific questions the designers should ask of the reviewers include:

- Did the program immediately capture your attention?
- Was the creative theme or metaphor engaging and appealing?
- Was it easy to navigate the program? Did you ever feel lost or confused? Are the buttons' functionality easily identifiable?
- Was the quality of the audio acceptable?
- Was the quality of the video acceptable?
- Was the tutorial lesson interactive and engaging?
- Did program features such as the glossary, notepad, and bookmarking, perform flawlessly?

Depending on the results of the prototype evaluation, adjustments may be made in the design document itself and incorporated into the script phase. If there are a lot of negative findings, it is common for the prototype itself to be re-created and evaluated for signs of improvement.

1.9.4 Creation of scripts and storyboards for e-learning

The development of scripts is the first step in the creation of programmer ready materials, called PRMs. The script or storyboard is simply a screen-by-screen description of what students will see, hear,
and do when running the program. Once the designer completes the script, it becomes the guidebook for all other team members: artists, audio/video producers, and programmers. They use verbal descriptions of on-screen graphical items while storyboards use sketches or clip art to visually depict required art elements. In view of the time it takes to create even rough composite artwork, a scripting approach typically takes less time, but storyboards provide a more complete picture of what the final program will look like. Regardless of the format chosen, every script or storyboard has the following eight major elements:

- **Project information** includes the name of the client, curriculum title, course title, date, draft or version number, and script page number.

- **Screen label** indicates which screen of the program is being described. Sometimes, screens are called frames or events. These screen labels are generally coded with both a lesson number and screen number.

- **Audio/narration** is specified in the script if the technology used supports it. Sometimes, the audio segment of a script specifies "Play dramatic music," "Buzzer sound on incorrect answer," or some other sound effect.
- **Video clips**, if used, are described in the script, giving both camera direction and writing out the actual dialogue for on-screen actors. Descriptive notes to the director are included, such as "executive at his / her desk," or "slow zoom as he / she reaches her conclusions."

- **Graphics** are provided in the script as a verbal description of what should appear on screen, or a sketch, to help both the reviewer and the artist who must create the final images, to visualize what the designer has in mind. Descriptions might be "Show group of business people around a conference table, gender balanced and multiculturally diverse".

- **On-screen text** section of the script describes which words will appear on the screen. In many Web-based training programs that cannot support audio, text is the primary learning media, thus this section of each script page may be quite long. In other programs, where audio narration is the primary instructional media, the text is used to reinforce the audio. In these cases, the text is likely to appear as brief bullet points or short statements.

- **Navigation and interactivity** describes the action items of the program - what can the student do on this screen, and what will happen next. Standard navigation options include phrases such as "Next button moves to next screen in sequence" and "Menu button
jumps back to Main Menu." These types of options that are available from every single screen are often excluded from the description.

- **Notes** is the final section in a script that provides an area for any additional comments that do not fit easily into one of the above categories. This informal area allows the designer to communicate directly to an artist or a programmer. Comments might be: "This question segment needs to be tracked for final report purposes. We need to track specific answers in addition to correct/incorrect information."

Once all revisions are made to the script, the client needs to officially approve it. This approval is critical since even small revisions to wording in audio narration or video segments will require the re-hiring and scheduling of actors and voice talent, additional time in a studio or recording booth, and the digitizing and editing of sequences. Whoever has final approval rights of the scripts needs to know that they have to be perfect, before production begins. An official sign-off memo makes this point explicit.

**1.10 OBJECTIVES**

The main objectives of the thesis are:

- Object oriented analysis and design of learning objects
• The ADDIE model based instructional development of e-learning systems

• To give an overview of the learning object approach to create learning content and converting e-content to learning objects

• To bridge the gap between the needs of students and learning content by making use of agent based learning objects

• To propose an agent based reusable learning object model for personalizing the learning content and fixing the granularity of learning objects for different levels of students like undergraduate and post graduate based on the three dimensional aspects of breadth, depth and the degree of autonomy.

• An agent based learning object architecture is designed by encapsulating the agents with learning objects to bridge the gap between the students need and the e-learning content and learning content reuse. in the proposed model, analysis and design time software reuse was implemented.

• To propose an ABLO architecture with the advanced features like future compatibility, longer lifetime of materials, smoother migration with multiple platforms, easier to locate, access, archive, and reuse.
• The ABLO has compatibility with learning management systems for enhanced functionality and to realize the substantial potential benefits like reusability, interoperability, durability and accessibility.

1.11 ORGANIZATION OF THE THESIS

The thesis investigates object oriented analysis and design of learning objects and applications of agent based reusable learning objects in e-learning system design. The thesis is divided into five chapters. First chapter explains various fundamental concepts of object oriented analysis and design and modified ADDIE model. A discussion on learning objects and reusable learning objects is presented. The modified addie model is based on the most valuable aspects of the systems approach, the disadvantages of traditional approach, the need for using systems approach and improved (advanced) prototype theory for learning object design and blended approach of e-Learning technique to make e-learning to work are also described.

In the second chapter, a brief literature survey has been presented pertaining to learning objects and e-Learning systems. The traditional and e-Learning architecture and instructional system design models are described. The problem of reusability and personalizing the learning objects to fulfill the needs of students are discussed.
The e-learning software that is commercially available has been developed mainly to satisfy the needs of the industry, whose goal is the fast acquisition of competitiveness. On the other hand, universities deals with learning processes that develop themselves on a long term period, and their main idea is to help students to develop a cognitive representation of those sectors in which they are expected to operate. This is just one of the reasons that induced us to develop our own e-learning systems using learning objects.

A study has been conducted to know the impact of learning objects and e-Learning in education sector. The study intends to analyze and to find out the difference between the traditional teaching method and teaching by using e-Learning among students of SCSVMV in concepts of object oriented programming using C++. The results of the study show that the systematic use of learning objects as part of the instructional design process will improve the quality of teaching and learning and it plays an important role in e-learning.

The third chapter describes conversion of learning contents to reusable learning objects and the need for a blended approach to make e-learning work. The evaluation techniques, usability evaluation, design prescription and the results of the case study conducted using School e_Learn System are presented. Agent based learning object technique is
identified as a mechanism to dynamically organize and deliver learning materials to satisfy individual learning requirements. The agent technology gives personalization, adaptivity and dynamic support. The steps involved in agent based learning object design for personalized e-Learning system are explained.

The usability of learning objects is an independent and self-standing unit of learning content that is predisposed to reuse in multiple instructional contexts. The e-learning system designed using learning objects provides instructional benefits by potentially increasing the speed and efficiency of e-teaching and instructional development. The School e-Lean is an interactive e-learning tool developed using learning objects. Using the School e-Learn, a case study has been conducted among 100 students to know the performance, usability, adaptability and user friendliness of the learning objects. The actual meaning of the qualitative attributes mentioned in the prescriptions are listed before respondents and based on that, the questionnaire and multiple choice question answers was used for evaluation. All respondents opted 100% for the blended approach. It gives more information and understanding. It makes them to remember easily and recall information from the memory, makes them to tells the correct answer and they scored better in final examination. The blended approach has other learning
advantages. Students found it good in learning. It gave the students excitement and excellent development, dynamic, easy-to-use and interactive data. It has all the advantageous of the current technology.

The fourth chapter discusses agent based learning objects for e-learning system design in detail. A learning object is a digital learning resource that can be reused for different levels of students and for different courses. Since learning objects are essentially static resources, reuse of learning objects is a difficult task that should be done by the faculty manually for different levels of (undergraduate and post graduate) students. This problem can be solved by making learning objects smarter, more active and capable of reusing. This can be achieved by using agents. The agent based learning objects present a personalized model that responds to requests from other agents in an intelligent manner, allowing more sophisticated kinds of learning object reuse than what is currently available. We propose an agent based reusable learning object model for personalizing the learning content and fixing the granularity of learning objects for different levels of students like B.Sc., B.E., and M.E., based on the three dimensional aspects of breadth, depth and the degree of autonomy.
Depth, for example, is not really one dimension; it breaks down into the complexity of concepts and the way in which the student is able to use concepts.

The Agent Based Learning Object (ABLO) architecture is designed by encapsulating the agents with learning objects. Practical features of the components satisfy various requirements of an intelligent learning object. These requirements include awareness of learning material, recognition of a learner’s request and ability to respond appropriately, managing and manipulating its learning material. They have knowledge of terminology used in the domain of the learning object and they interact socially with other agent-based learning objects. An ABLO fulfilling these requirements would be self-sufficient and be able to act independently without the help of human or artificial intervention when initiating tasks such as responding to learner requests or recommending its learning material. The ABLO is a practical solution to the problem because of the compatibility between the fields of learning and artificial intelligence. Agent technology is appropriate for creating intelligent learning objects since they can be employed to facilitate the reuse of learning content (McCalla 2004) and the communication between other ABLOs would not be limited to
single method invocation as in the object-oriented paradigm for learning objects (Azambuja 2004).

The task of repurposing learning material can be greatly eased by ABLOs because the intelligence of a content specialist can be built into the ABLO. Furthermore, an ABLO can fragment and reassemble learning content in a principled manner, given the semantic markup associated with its learning content. The interacting components that make up an ABLO are held together or encapsulated by an agent. This agent allows the learning material to be reused in different contexts and it is capable of interaction and negotiation with agents that submit requests from learners. The fourth chapter also discusses personalized e-Learning model using agent based learning objects to overcome the gap between the student expectation and the learning content. e-learning system design using agent based learning object technique has been proposed to achieve the above goal.

The fifth chapter concludes the thesis and suggests scope for future work. The thesis tries to give a solution for personalized student centered e-learning system design and reusability of learning objects in different programs according to student levels and implementing the reusability of learning objects in analysis and design stage itself using agent based learning object technique.