

# SYSTEM DEVELOPMENT LIFE CYCLE OF E-LEARNING CONTENT MANAGEMENT SYSTEMS

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**Abstract** *The aim of this study is to provide a logical and profound relation in order to develop an e-learning prototype using Learning Content Management System (LCMS) and application of System Development Life Cycle (SDLC). Its immediate need is to improve performance and effectiveness of an e-learning management system. It will also help in making the online educational systems more consistent in perspective of quality and effectiveness.*

**Keywords:** *LCMS, SDLC, e-learning, System Testing, Learning Objects, Meta-tagging*

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## INTRODUCTION

E-learning is an umbrella term which encompasses various synonym terms like online learning, web-based learning, digital learning, internet based learning, web-enhanced learning, computer-based learning etc. E-learning is provided usually through website-based and/or webportal based digital environments. An effective and efficient e-learning portal is designed using latest software solutions like Learning Management Systems (LMS), Content Management Systems (CMS), and more sophisticated Learning Content Management Systems (LCMS) that follow various international standards for interoperability and other set of functions. An e-learning portal is a website that offers learners and organisations a consolidated access to a wide range of learning and training resources from multiple sources (Marjanovic, 1999). A learning portal is more than just a website that contains links to online courses, upcoming classes, job aids, downloadable content and links to websites, programs etc. It may also include a rating system, search functionality, bookmarking ability, and more (Schone, 2009). These Learning portals are easily accessible from any part of the world via an internet connection and are flexible enough to be accessed at our own schedule round the clock. E-learning portals have the capability of making the global educational system more uniform, qualitative and cost-effective. All these e-learning web-portals are designed using LMS, CMS, and/or LCMS platform. However, the main focus of this study is the latest integration of LMS

and CMS based learning system i.e. LCMS and its generic development cycle for effective and efficient need based logical structure of e-learning portal.

## LITERATURE REVIEW

The principle aim of this literature review is to better understand the research that has informed the design of e-learning software using different systems like Learning Management Systems, Content Management Systems, and more sophisticated Learning Content Management Systems. This section begins with a review of literature pertaining to e-learning and LCMS.

The main role of e-learning is to extend learning that involve the addition of discussion forums/email/virtual presentations, software simulations, etc. to existing learning and replace traditional learning with new and effective method of teaching and learning.

Saeed and Samani (2014) say that the revolution brought by information technology and tele-communication has put a challenge for modern educationists to cope up and move quickly to join the revolution. The objective of the education from education for all is to be changed to distinguished education and excellence for all with the aim of using ICT for teachers, students and business men. Scientific research looks forward to improve the coming generation in the application of acquiring skills. In order to realise those aims, it requires the changing of traditional education pillars like

teachers, learners and schools and changes it to more modern educational operations.

The most important plus point to e-learning is its ability to allow the student to control the learning process by offering him an immediate, action oriented, practical learning experience (Kamsin, 2005). The author feels it for sure that conventional learning will be replaced by e-learning in the forcible future. With web-based learning, communication among learners from remote places is enhanced, knowledge being acquired and transferred among the learners, the ability to conduct an open discussion is enhanced and students can learn according to their own schedule. All these facilities create the creative abilities that cannot be seen in conventional learning. According to author, the most important for the learning process, besides the above said points, is the flexibility and it can be best seen in e-learning.

The impact of e-learning can be seen more clearly by the facts that there has been an extent in the nature and use of e-learning in further education worldwide.

Patel, Patel, and Shah (2014) believe that teaching and learning phase has been changed nowadays. The students prefer global learning system rather than the physical, rigid learning process which was used till the time. Chalk sticks, board, duster, books, and all those physical things have been replaced by e-learning process where fundamental focus is on Internet. Students are posting their queries on the public forum to get answer and within short period of time they are getting very good response. The authors believe that the goal is to integrate software and hardware for e-learning system, online education, and web technologies based multi-agent system, information technology integration to teaching which will result in advanced teaching and learning system.

The success of e-learning has been visible with the growing market of e-learning. The market for global higher education has grown beyond expectations and today, the success goes in billions and still growing. With the limited capacity of existing classrooms at academic institutions and the prohibitive cost of building new facilities, e-learning is an attractive alternative.

The success of the e-learning is better analysed by the stakeholder matrix in which the responsibility for the success of e-learning is dependent on various stakeholders' viz. students, instructors, content providers, technology providers, employers and accreditation bodies (Wagner, Hassanein, & Head, 2008). Each stakeholder group has an important role towards the common goal of enhancing the overall learning experience. Students and Instructors should provide feedback to improve future experiences, and communicate the learning possibilities that e-learning creates. Institutions should provide the technical infrastructure and support while as content and technology providers should provide high quality, interoperable solutions that consider

learning principles. Accreditation bodies should provide and enforce clear guidelines for this new form of learning delivery. Employers need to recognise the validity of this form of education and work with other stakeholders to ensure that graduates meet the needs of the job market.

Newer technologies and the evolution of older technologies, such as forums, chatrooms, and pod casts help make the online learning environment highly interactive; however, without adequate preparation to use the technology, the technology seldom meets expectations.

The rapid expansion of Internet technologies has provided a range of learning management systems that can support teaching and learning activities through e-learning in educational and training institutions around the world. A web-based learning tool known as Course Management System (CMS) or Learning Management System (LMS) is generally used to deliver e-learning courses' (Daniel, 2013). One such example is the Divine Word University which is embracing the use of e-learning technology through the adoption of the Moodle platform to support and improve teaching and learning activities

## LEARNING CONTENT MANAGEMENT SYSTEMS FOR E-LEARNING

A Learning Content Management System (LCMS) is a sophisticated premeditated solution for planning, managing, and delivering all learning proceedings within an organisation, including online, virtual classroom, and instructor-led courses (Greenberg, 2002). The primary key is replacing inaccessible and fragmented learning programs with a systematic means of assessing and raising skills and performance levels throughout the organisation. International Data Corporation (IDC)'s white paper "Learning Content Management Systems: Comparative Analysis of Emerging Technologies" defines a learning content management system (LCMS) as a "system that is used to create, store, assemble, and deliver personalised e-learning content in the form of learning objects, also known as knowledge objects" (Brennan, Funke, & Anderson, 2001a).

According to various authors, any Learning Content Management System encapsulates four components in its learning objects:

1. **Learning objectives:** general and specific learning goals for a lesson plan, scenario or course module.
2. **Pre-assessment element:** the learner is tested prior to teaching and a learner's personalised learning plan is generated as a result of the pre-test.
3. **Learning content:** the subject matter to be taught, in various formats like text, audio, graphics, videos and animation.

4. **Post-assessment:** following instruction, the learner is tested to assess its mastery of the content as delineated by the objectives.

But, there is one more component which is metadata or a label providing information on the content of the learning objects in an LCMS in order to catalogue, access and utilises it. Metadata usually supplies details about duration of instruction, the target audience, or any prerequisite knowledge.

In essence, a learning object is the smallest entity in a LCMS and can be aggregated in various ways to form simple to complex learning scenarios. According to Ellis (2001) "learning objects, which are reusable, media-independent chunks of information organised by a metadata classification system and are modular building blocks of e-learning content." Its main task is storing and structuring of content files in a database, managing revisions and modifications, and ensuring that content is tagged for easy retrieval and reuse.

### Specific Features of LCMS

An LCMS power lies in its efficient, training administration capabilities. LCMS, also known as training management systems, training administration systems, or integrated learning systems, can register students for online or offline courses, launch online courses and assign the appropriate learning resources (e.g., providing access to lab equipment for e-learning experiments), track student's progress, and modify report test scores and overall manage the communities of users. With the help of integrated collaboration tools including email, discussion forums and chat rooms, an LCMS can allow users to engage in joint work and learning. Some LCMS have a special functionality for competency mapping and skills assessment to establish a competency profile, a (curriculum) training plan to bridge the competency gap with the corresponding training resources, and an evaluation of the impact on performance.

An LCMS's strength resides in its content management, delivery, and storage abilities. Sometimes described as providers of adaptive learning, LCMS can assist learners in selecting adequate combination of learning resources, generate personalised instruction plans by assembling different "chunks" of content, closely track the user interaction with the learning material to adjust the delivery instruction (update the content of the learning path) accordingly and can provide comprehensive reports on tests results. An LCMS allows an organisation to do more extensive tracking of learner's interaction with its content than the top-level tracking allowed by an LMS, where tracking is generally restricted to course completion and rudimentary test results (Brennan, Funke, & Anderson, 2001b).

### Key Features of LCMS

Some of the key features of LCMS are the availability of:

- A Learning Object Repository which supports different granularities of objects, such as :
  - Content assets, which are the most granular type of objects. Content assets are raw media such as photographs, illustrations, diagrams, animations, audio and video files, applets or simple text documents etc.
  - Reusable Information Objects (RIOs) are classified as a concept, fact, principle or procedure and are usually described by metadata which give some hints about the re-use of the object. To support reuse, RIOs already contains metadata to describe them.
  - Reusable Learning Objects (RLOs) are data formed by assembling a collection of (ideally 7±2) relevant reusable information objects to teach a common job task on a single learning objective and are self-contained, like e.g. course chapters. RLOs are the first level of granularity where it makes sense to automatically assign its objects to learners based on their skill gap analysis. However this will only happen in systems with very advanced competency management functions, usually only courses, which are the next level of granularity, are assigned to users.
  - Learning Components are a result of bundling and sequencing several learning objects together, such as courses or lessons. Sometimes (i.e. Autodesk Content Strategy Molecular Model View (Hodgins, 2000) lessons and courses are handled at different levels because a course can consist of multiple lessons.
  - A Learning Environment is the combination of several learning components (i.e. a personal curriculum) together with learning support services, such as communication and collaboration tools.

The repository also provides sophisticated reusing and structuring tools to build up objects of a higher granularity, e.g. learning objects made of multiple information objects, or courses made of multiple learning objects (Downes, 2004).

- Meta-tagging for search capabilities according to approved standards such as Learning Object Metadata (LOM). Meta tagging supports the creation of metadata by tagging wizards and tools which can provide automatic extraction or conversion of metadata. The meta tagging is tightly integrated into the repository. It is important to note that there exist two different kinds of metadata:

- Metadata which is steadily bound to the data object, e.g. creation date, size, type etc.
- Metadata which provides information about the use of the object, because data can be used in various ways and in different contexts. That one should not be stored together with the data, but separately in e.g. multiple areas of the repository for each incarnation. Into the same category falls meta-metadata, which is metadata about the metadata, e.g. the author(s) of the metadata.
- Workflow services
  - The workflow services offer generic learning content development, review and release workflows, with the flexibility for each workgroup to select variables to customise to their requirements.
  - A mandatory component of all workflows is registering content and baseline metadata into the repository before releasing the content.
- Collaborative authoring and editing is tightly integrated with the workflow services and the learning object repository and
  - Provides all of the traditional content management functions for learning and content objects, including
  - creation/upload, modification, copying, moving, linking and removing,
  - version control,
  - notifications, history and reporting of changes (auditing),
  - fine grained access control with users, groups and role handling down to the level of single documents to provide personalised training content and even
  - full text searching in addition to metadata and keyword searching mentioned above
  - advanced features like multiple language support and link management
  - Offers import/export and conversion of various content types and complete packages from and to 3<sup>rd</sup> party vendor systems.
- Authoring
  - Form-based authoring tool for (simple) online created content. Ideally this tool has a built-in quiz tool included, which can be used to create the following types of tests:
    - single/multiple choice
    - image map questions
    - list matching questions
    - randomised and calculated questions
    - timed quizzes
    - fill in-the-blank tests
  - short answer tests
  - Tight integration of external authoring tools enables content creators to write more complex learning objects such as text, graphics, and assessment questions that can be seamlessly linked to any level of the learning hierarchy.
  - Personalised and adaptive content delivery according to existing standards such as Aviation Industry CBT Committee (AICC), Sharable Content Object Reference Model (SCORM), and Integrated Management System (IMS). The content delivery needs to be tightly integrated with an LCMS to pass on all relevant activity and progress data (i.e. assessment results) to the according skill and record management modules of the LCMS.

It also makes sense to offer the already built-in collaborative and knowledge construction features for students for their personal workspace. That way the system could support the cognitivist and constructivist learning paradigm.

The growth of e-learning in organisations and institutions has strongly influenced the evolution of computer-based training architectures such as learning management systems and learning content management systems, in response to demands for better administration of training with personalised developmental paths, up to date records on training activities.

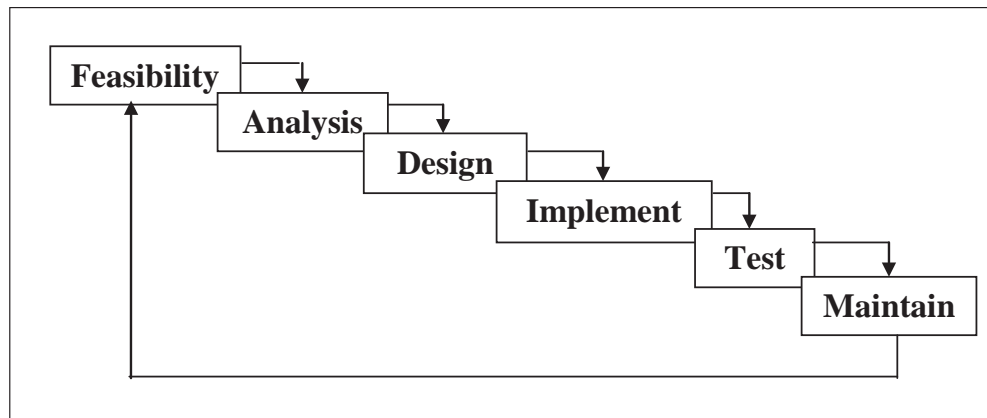
However, for the entire process of formal, logical steps taken to develop a software product by using LCMS, System Development Life Cycle (SDLC) is taken into consideration for its effective and logical operations. The complete SDLC framework has been modulated which provides various insights of developing a need based information system.

## SYSTEM ANALYSIS FOR CURRENT STUDY

A system approach was taken to develop information system which is known as System Development Life Cycle (SDLC). It is a step-by-step process which refers to a methodology for developing systems. It provides a consistent framework of tasks needed to develop systems (Mishra, 2002).

The SDLC methodology can be reduced to include only those activities that are appropriate for a particular project, whether the system is automated or manual, whether it is a new system or an enhancement to existing systems.

SDLC methodology tracks a project from an idea developed by the user, through a feasibility study, systems analysis and design, programming, pilot testing, implementation, and post-implementation analysis. Documentation developed during the project development is used in future when the system is re-assessed for its continuation, modification, or deletion.



**Fig. 1: System Development Life Cycle (SDLC)**

## SYSTEM DEVELOPMENT LIFE CYCLE (SDLC)

The System Development Life Cycle (SDLC) is a conceptual model used in project management that describes the stages involved in an information system development project from an initial feasibility study through maintenance of the completed application. Various SDLC methodologies have been developed to guide the processes involved including the waterfall model (the original SDLC method), rapid application development (RAD), joint application development (JAD), the fountain model and the spiral model (Whitten, Bentley, & Dittman, 2004). Several models are combined mostly into some sort of hybrid methodology. Documentation is crucial regardless of the type of model chosen or devised for any application, and is usually done in parallel with the development process. Some methods work better for specific types of projects, but in the final analysis, the most important factor for the success of a project may be how closely a particular plan was followed.

The system development life cycle (SDLC) is the entire process of formal, logical steps taken to develop a software product. The phases of SDLC can vary somewhat but generally include the following:

1. Conceptualisation;
2. Requirements and cost/benefits analysis;
3. Detailed specification of the software requirements;
4. Software design;
5. Programming;
6. Testing;
7. User and technical training;
8. And finally, maintenance.

## Brief Description of Different Phases

### Feasibility

Feasibility study is used to determine whether a project is worth doing and should go ahead. Feasibility studies are undertaken under tight and fixed time constraints and normally culminate in a written and oral feasibility report. The author has taken two weeks to study feasibility study with the co-developer. The contents and recommendations of this study helped as a sound basis for deciding how to proceed for system development. It helped in taking important decisions in deciding the software and hardware combinations etc. to be used. A set of alternatives and their feasibility is also considered in case of any failure in the proposed system. Thus, feasibility study is an important part in software development.

There are three main phase of feasibility study:

### Technical Feasibility

Technical feasibility determines whether the work can be done with the existing equipment, software technology, and expertise at hands. It is concerned with specifying tools, instrumentation and software that will satisfy user requirements. It checks whether the available hardware and software resources meet the established requirements of the analysed system. It also invokes the study of new alternative to solve the given problem.

### Economic Feasibility

Economic feasibility determines the cost effectiveness and cost benefits of the system. It establishes the return on investment (ROI) and signifies savings in terms of

monitory gains and the level of user satisfaction regarding its pre-assumed cost for developing a system. During the economic feasibility test, a balance was maintained between the operational and economic feasibilities as the two were conflicting. For example the solution that provides the best operational impact for the end-users may also be the most expensive and, therefore, the least economically feasible. The genuine consideration of the system developed is the approach the author followed to look the system in the way it is useful for the end users.

### Operational Feasibility

Operational feasibility criteria measure the urgency of the problem (survey and study phases) or the acceptability of a solution (selection, acquisition and design phases). People are inherently resistant to change, and computers have known to facilitate change. An estimate should be made of how strong a reaction the user staff is likely to have towards the development of a computerised system. It is common knowledge that computer installations have something to do with turnover, restraining, transfers, and changes in employee job status. Therefore, it is understandable that the introduction of a candidate system requires special effort to educate, sell and train the staff on new ways of delivering knowledge.

### Requirement Analysis and Design

This stage includes a detailed study of the needs and objectives of the organisation. During these phases, the software's overall structure is defined. Analysis and design processes are very crucial in the whole development cycle. Any glitch or anomaly in the design phase could be very expensive to solve in the later stage of the software development. Much care is taken during this phase. The logical system of the product is developed in this phase.

### Coding and Implementation

Coding and implementation require high level of expertise. In this phase, the designs are translated into codes understood by the computers. Computer programs are written using a conventional programming language or an application generator. Programming tools like Compilers, Interpreters, and Debuggers are used to generate the code. Different high level programming languages like C, C++, Pascal, and Java are used for coding. With respect to the type of application, the right programming language is chosen.

### Testing

In this phase, the programs are written as a series of individual modules, subject to separate and detailed test. The

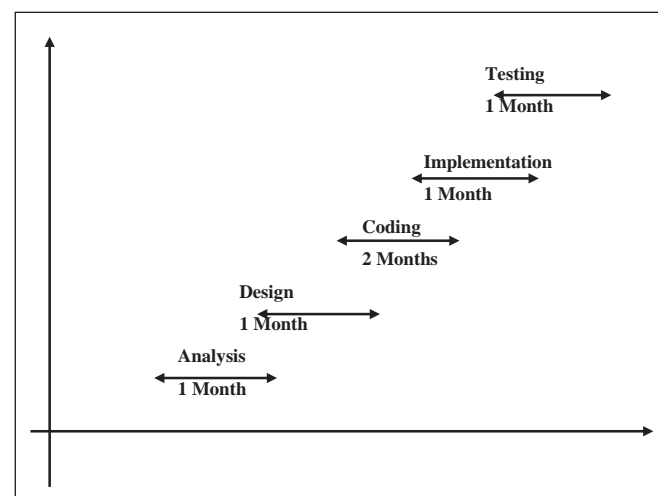
system is then tested as a whole by bringing together the separate modules as a complete system. The system is tested to ensure that the links and interfaces between modules work (integration testing), the system works on the intended platform with the expected volume of data (volume testing) and the system does what the users require (beta testing).

### Maintenance

Inevitably, the system needs maintenance on regular basis. Software needs to undergo upgradation or updation in order to incorporate new features. System needs to be checked for bugs and errors. Unwanted cookies and files needs to be deleted in order to regulate the speed of the site loading and browsing. No or less used modules, options or links need to be deleted and latest trends to be incorporated.

### Time Scheduling

Management tools such as PERT, CPM, Gantt charts, work breakdown structures and personnel staffing charts may be used to track and control progress. Basic planning uses bar chart that shows system activation and amount of time it will take. The Gantt chart uses horizontal bars to show the duration of actions and tasks. The left end marks the beginning of the task, the right end its finish. Time is projected in days.

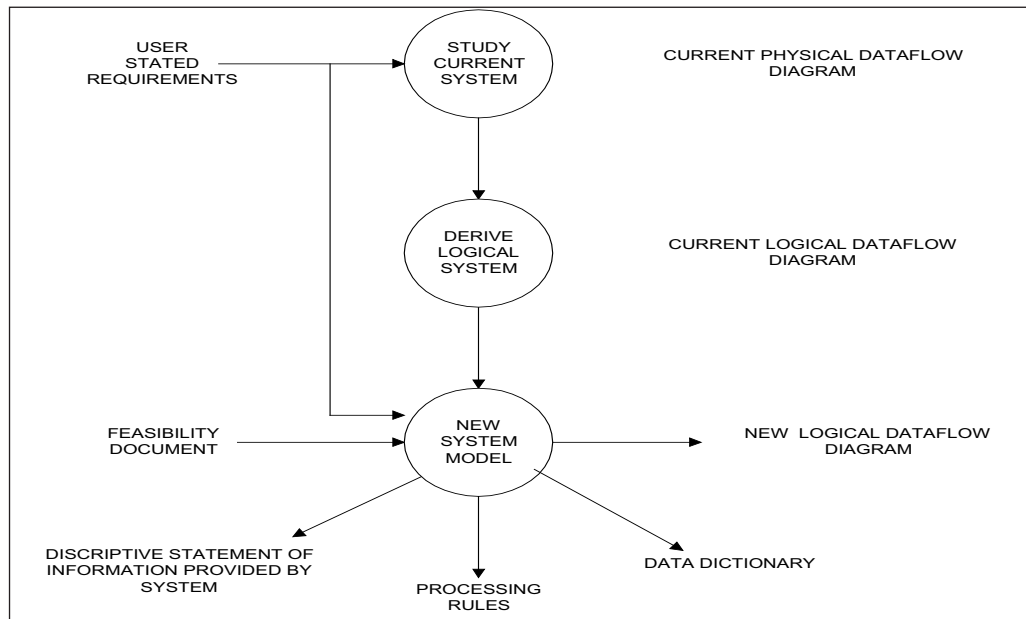


**Fig. 2: Requirement Analysis and Design**

The heavy horizontal bars are activities and the light horizontal bars are tasks. Broken horizontal bars are estimated time delays or slack time.

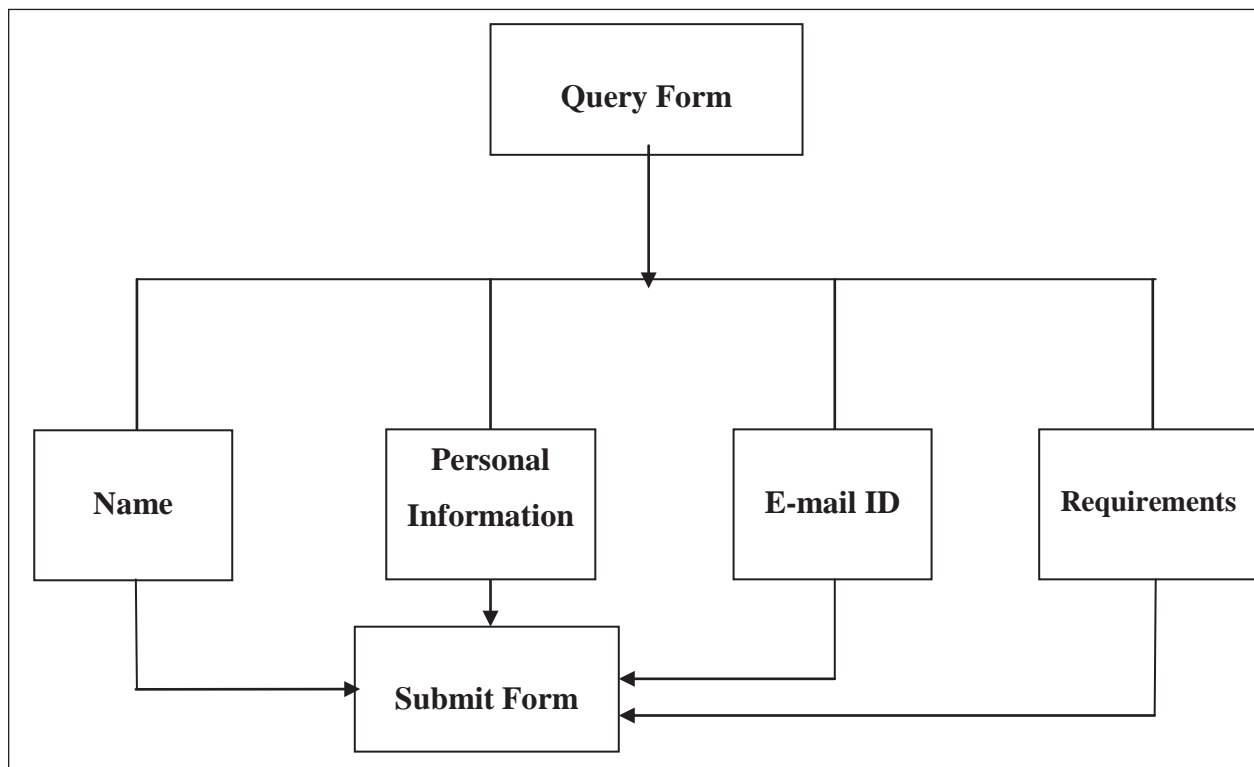
**Process and Dataflow Diagrams for System Analysis**

**Process Diagram**



**Fig.3: Process Diagram for System Analysis**

**Query Form**



**Fig.4: Query Form**

### User Registration

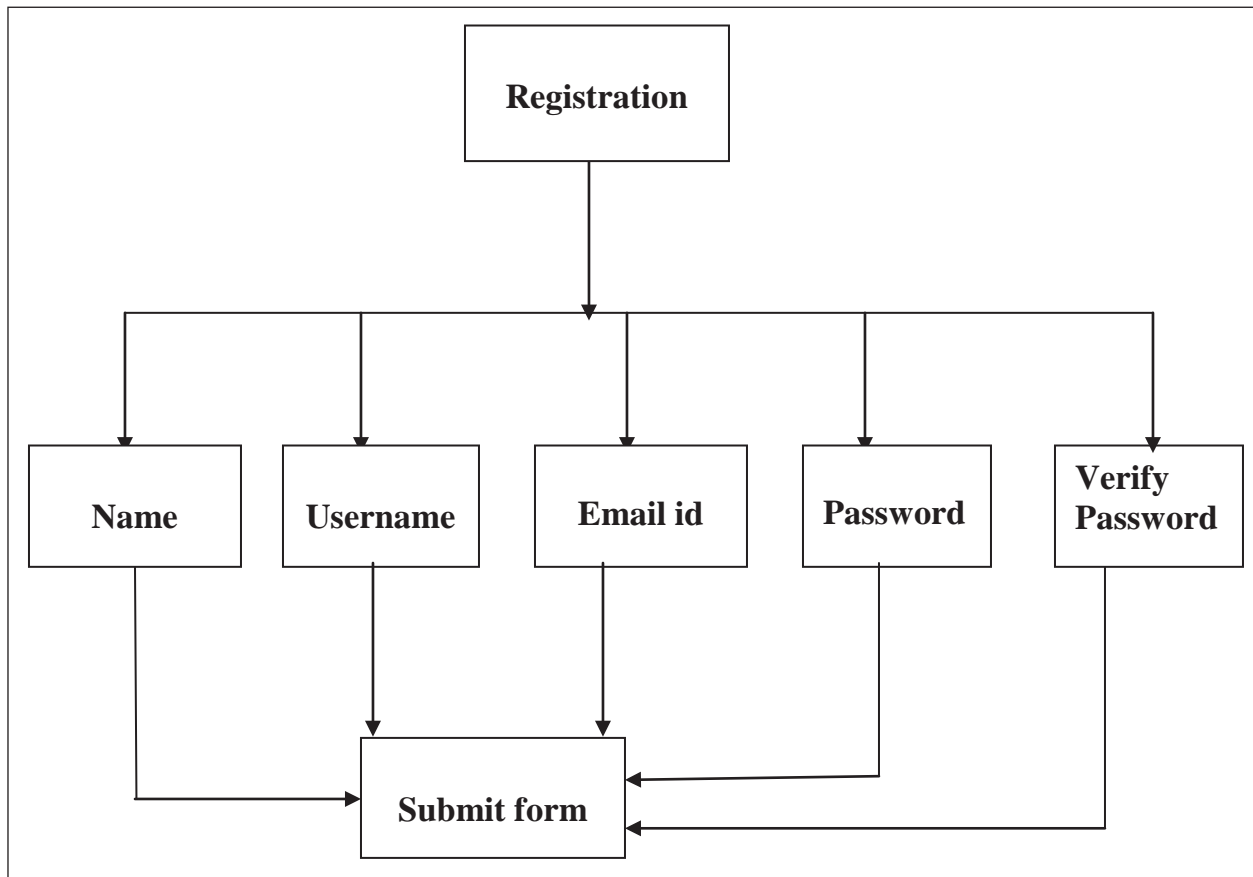


Fig. 5: User Registration

### Login to Website as a Registered User

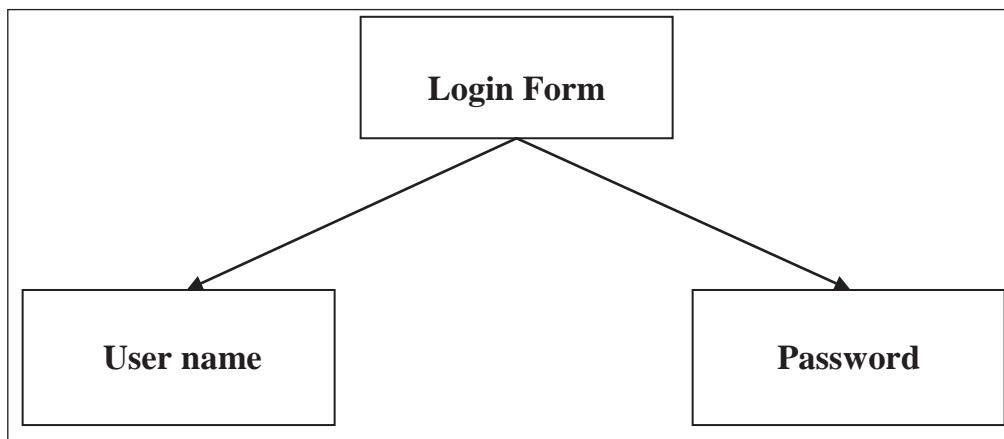
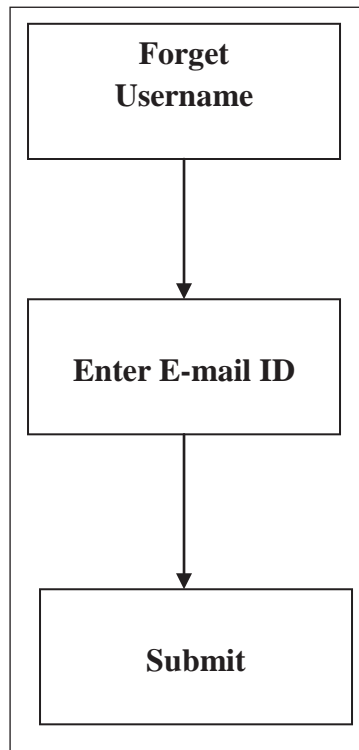
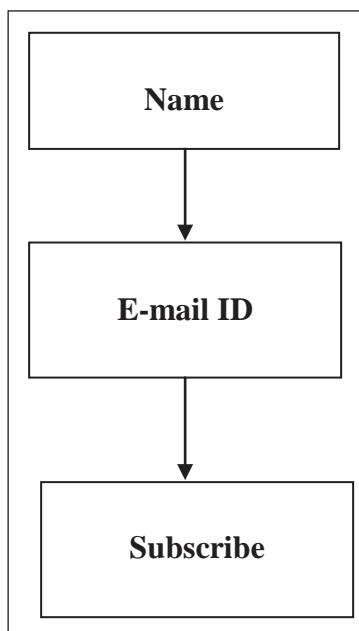


Fig.6: Login to Website as A Registered User



**If Forget Password****Fig. 7: Forgot Password****Newsletter****Fig. 8: Newsletter****System Testing**

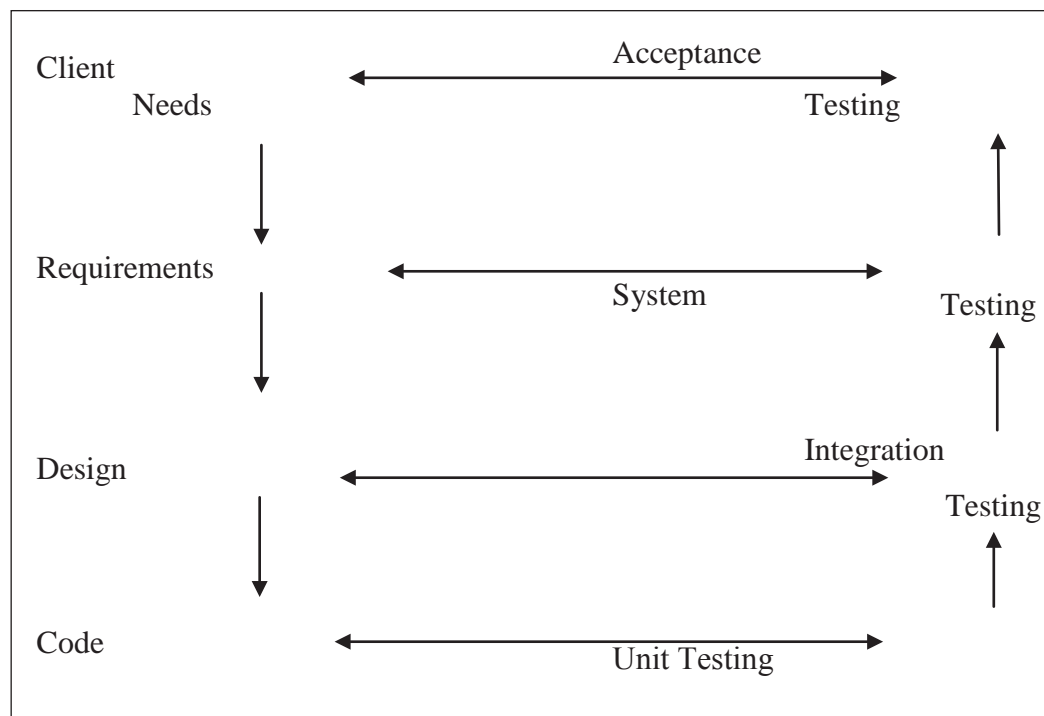
System testing is the expensive and time-consuming process. There are two strategies for testing software that we use for testing our system: code testing and specification testing. In code testing, we developed those cases to execute every instructions and path in the program. In specification testing, we examined the program specification and then wrote test data to determine how the program operates under specified condition. The different levels of testing are used in the testing process. The basic levels are unit testing, integration testing, system testing, and acceptance testing. These different levels of testing detect different types of faults.

**Levels of Testing**

We have tested each module separately i.e. have completed unit testing first and system testing was done after combining /linking all different Modules with different menus and thorough testing was done. Testing is a very important part of SDLC and takes approximately 50% of the time. Once the system is live, maintenance phase is important. Service after specified time is a must and users/learners must be helped after the system is implemented. If he/she faces any problem in using the system, one or two trained persons from developer's side can be deputed at the client's site, so as to avoid any problem and if any problem occurs, immediate solution may be provided.

The following are some attributes of a good test:

- A good test has a high probability of finding an error. To achieve this goal the tester must understand the software and attempt to develop a mental picture of how the software may fail. Ideally the classes of failure are probed.
- A good test is not redundant: testing time and resources are limited. There is no point in conducting the test that has the same purpose as another test. Every test should have a different purpose.
- A good test should be best of breed. In a group of tests that have a similar intent time and resource limitations may militate for the execution of only a subset of these tests. In such cases the tester that has the highest likelihood of uncovering a whole class of errors should be used.
- A good test should be neither too simple nor too complex: although it is sometimes possible to combine a series of tests into one test case, the possible side effects associated with this approach may mask errors. In general each test should be executed separately.



**Fig. 9: System Testing**

## CONCLUSION

Software plays an important role in structuring and scheming of an e-learning system. The whole infrastructure is dependent on the type of software's handling the system. Various software are available in the e-learning market and much new open source software is coming up due to the rising global software demand and competition. We are witnessing radical changes in the ways of delivering knowledge by institutions and organisations throughout the country. The use of learning content management systems have proliferated within few years but one still need to understand how it works before we can drive it. The latest generation of LCMSs from the major vendors shows signs of moving ahead in this direction, but still there is much work to be done.

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