CHAPTER 7
A PROTOTYPE IMPLEMENTATION OF SCENE

7.1 Introduction

E-learning efforts and experiments currently receive much attention across the globe. The availability of electronic and web-enabling technologies also dramatically influences the way we view the learning strategies of the future (Kramer, 2000). It is likely that e-learning, making use of technological advances such as the Internet, may also be dissatisfying and frustrating unless an e-learning application that can avoid potential complications is designed. In this chapter, the researcher proposes an e-learning application architecture that assists the designers of different e-learning settings to plan and implement a specific learning situation, with the focus on the individual requirements and milieu of the learning group. The e-learning architecture is composed of four layers, each consisting of different objects (components) addressing issues specific to each layer. When constructing an e-learning environment, the planners, schedulers and facilitators come together with a clear view of their particular learning situation in mind. Then they use the e-learning architecture to design their course layer by layer, including objects from each layer. Each object consists of one or more methods/strategies to be implemented in order to achieve the learning objectives of the course. The practical implementation and screen shots of the student-centric e-learning environment are explained in the following sections.
7.2 Practical Implementation

Upon learning about Gardner's theory of Multiple Intelligences, a teacher may be tempted to say that a student learns only through a specific intelligence and that this student has that particular intelligence. The theory, rather, implies that educators need to place all intelligences as equally important in the e-learning environment (both offline and online) and that all people have a little bit of every intelligence in them. With this understanding, educators allow every student to shine and succeed. SCEnE has seven learning concepts embedded in the e-learning environment for the developer of a e-learning module. They are: 1) the description of general learning objectives and for focus & vision, 2) the listing of pre-requisite knowledge, 3) providing an array of presentation styles, 4) the various testing approaches and enhanced feedback, 5) summary at the end of the lesson 6) allowing the student to control the pace and direction of the learning module, and 7) the information management, communication tools and online resources. In addition SCEnE manages the screen design and navigation as well as help menus for the students and developers. Each of these concepts is discussed in more detail in the following sections.

7.2.1 Description of General Learning Objectives and for Focus and Vision

Figure 7.1 is a screen shot where the subject matter expert (SME) is assisted to build the learning objectives for a particular module. At the top of the screen is a menu bar showing all of the components that need to be completed. This menu bar is also clickable and provides a backward and forward review of the work completed. SME can build from one
to ten learning objectives for a particular chapter. Learning objectives are limited to ten as on average a chapter consists of five to ten learning objectives. Once the SME has listed the general learning objectives, the SME or instructor identifies specific learning objectives, which are stated in doable and measurable terms. Examples of clear and specific learning objectives include the following: Students should: 1) list all the properties of mineral; 2) write a 500 word essay describing the properties of minerals; 3) create a poster comparing silicon compounds and calcium compounds; 4) interview an expert on the uses of various fractions of petroleum. The key here is to list specific objectives that students are expected to meet for that chapter. They use personal abilities and interests in order to meet real-world challenges which they perceive as meaningful. These objectives over time will extend into learning and assessment tasks for students.

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<table>
<thead>
<tr>
<th>Module Progress</th>
<th>Module Details</th>
<th>Learning Objectives</th>
<th>Pre-Requisites</th>
<th>Course Unit Creation</th>
<th>Glossary / Key Terms</th>
<th>Testing / Feedback</th>
<th>Summary</th>
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**Edit Learning**

<table>
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<th>Chapter Code</th>
<th>Chapter Title</th>
<th>Quick Review</th>
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<tbody>
<tr>
<td>BC</td>
<td>Land and its Resources</td>
<td>Land is a natural resource that supports the living things on earth. The minerals in land become raw materials in manufacturing industry. Other than that, various fossil fuels such as petroleum, natural gas and coal are natural resources that support development and progress in people. The</td>
</tr>
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</table>

The learning objectives of this Chapter are:

1. Analyzing the various minerals found in the Earth’s crust
2. Understanding the reactions between metals and non-metals
3. Understanding silicon compounds
4. Analyzing calcium compounds
5. Analyzing natural fuel resources and their importance
6. 
7. 
8.

**Figure 7.1:** Building the Learning Objectives for the Module
Learning Objectives

Help

Objectives help the student understand the overall purpose of the module which is divided into chapters.

In general objectives should be written to:
1) Help guide the development of the lesson
2) Help potential users determine lesson appropriateness
3) Allow the user to focus on important learning tasks

When writing objectives:
   a) create brief, clear statements of student outcomes
   b) describe what the student will achieve when completed with the module
   c) consider relating to an identified problem and needs assessment emphasising on multiple intelligences

Include strong verbs such as:

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<tr>
<th>build</th>
<th>choose</th>
<th>classify</th>
<th>count</th>
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<td>create</td>
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<td>discuss</td>
<td>identify</td>
<td>perform</td>
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<td>summarise</td>
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<td>list</td>
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</table>

General learning objectives:
Summarise the differences between satellite and microwave transmission of data
Identify the advantages of twisted pair transmission of data
Define the six basic means to transmit data
Select the transmission media based on security needs

Learning objectives for focus and vision (considering various intelligence types):

- **Contrast pros and cons of a controversial issue related to satellite and microwave transmission of data**
- **Raise three probing questions about a discussion, reading or project proposal on twisted pair transmission of data**
- **Create an interactive written dialogue or journal with two other students on basic means to transmit data**
- **Brainstorm new approaches of transmission media and enlist an expert’s help for researching some aspect of the security needs.**

Figure 7.2: Help Screen for Learning Objectives

### 7.2.2 Listing of Pre-requisite Knowledge

Brandt (1997) states that student construct knowledge by making sense of experiences in terms of what is already known. SCEnE system prompts the SME for a list of the previous
knowledge the student should have acquired prior to beginning this lesson. The system presents the SME a list of all topics already built for this course (same subject matter). The SME can then indicate if any of the previously built topics are pre-requisite knowledge to the current topic. If any of the previous tutorials are pre-requisite knowledge to the current topic, the system can require (should the SME indicate this option) the student to complete a previously built topic prior to completing the current topic. If there is no pre-requisite for this topic then the option none is selected.

Figure 7.3: Listing the Pre-Requisites for the Module

7.2.3 Providing an Array of Presentation Styles

Content provided in the e-learning environment are in the form of lecture notes, audio/video representation and other learning material such as lab or class exercises. Interactive materials are also available with student tracking. This reduces the need for long classroom sessions to deliver knowledge and also offer the students the flexibility to learn at their own pace.
Various information in the form of course overview, topic summary, objectives, detail notes, slides, flow diagram, flash card, self-exercises, group exercises, web activities, science input (your idea/think), worked examples, model and past papers with solutions, links to external resources, student prepared material and their solutions are provided to the students through the e-learning environment. Special interactive sessions with multimedia are also part of this system.

Figure 7.4: Creation of Topics and Lesson Content in Variety of Styles

Error message below reminds the instructor of the selection of appropriate learning objectives prior to the creation of contents for a topic.
Once the SME has created the learning objectives and the pre-requisite knowledge, the system enables the instructor to construct the learning content. Upon selecting the chapter code and the appropriate learning objective, the instructor has to select the topic. A topic is the breakdown of chapter into smaller components. A topic is also similar to the headings in a handout of a lecture. Once a new topic is selected, the system requests the instructor to develop the learning content based on four methods. The four methods supported by the prototype system are Tell, Show, Do and Practice. Figure 7.4 shows the screen for building the lesson content of a topic. Once the instructor clicks on the ‘TELL’ button, the system takes the instructor to a screen where the narrative section of the lesson content is developed. The building of content narrative is made simple for the instructor, as this is a WYSIWYG (What You See Is What You Get) editor, shown in Figure 7.5 and Figure 7.6. In addition to typical word processing features, the instructor may incorporate hyperlink to other documents, images, sound files and audio files. Other than creating content using WYSIWYG editor, instructor can also upload files created in various formats related to the topic to promote various presentation styles. The various formats include (.xls, .exe, .pdf, .pp, .mdb, .wmv, .rm, .jpeg, .gif, .bmp). The other three methods (SHOW, DO and PRATICE) are described in the following sections.
Minerals in the Earth's Crust

1. A mineral is an element or a compound that exists naturally in the Earth's crust.
2. Minerals that exist in the form of natural elements include gold, silver, platinum, diamond and sulphur.
3. Most minerals are natural compounds formed when various natural elements are chemically combined together.

Properties of minerals
1. Hardness of minerals

Figure 7.5: Building Lesson Content
Figure 7.6: What You See Is What You Get Editor (Creates the HTML code for the developer)

7.2.4 Various Testing Approaches and Enhanced Feedback

SCEnE incorporates various testing approaches (showing examples; doing exercises; practicing with projects, assignment or practical; and evaluating via test or exam). Figure 7.7 shows the editor to creating examples, exercises, and mini-quiz. The instructor may
choose from true/false, multiple choice, short answer and matching questions. The instructor may also include images in any question and also provide enhanced feedback for any answer. The student can perform exercises related to a given topic or to a whole course; such exercises are generally performed at the end of lessons, even if this is not mandatory. The role of exercises (Callear, 2001; Alvarez, 2001) is fundamental for:

- feedback purposes, thus on one hand a student can verify his acquired knowledge, while on the other hand the instructor can evaluate the student learning and the quality of the followed path;
- educational reasons; i.e. to allow students a better comprehension of a given issue

To increase the configurability, any test or exercise is composed of several basic elements; a question is endowed at least with a comment box where an answer in open or closed form can be provided. If needed, a link can be shown from which to download files containing data for the question in addition to the function of uploading a file as an answer itself (for the open form case). Finally, for assessment purpose, all tests are dynamically generated, offering questions always in a random order and with different answers picked up from questions that can be related to different topics provided by the instructor. Figure 7.8 shows the screen to creating an end of the lesson test questions.

In case of closed form answers, the student will receive a mark at the end of the test, while open form answers are not immediately evaluated, rather the instructor will receive the answer, evaluate it and e-mail to the student. The mark is expressed in percentage. The system calculates the maximum score obtainable as sum of the top quoted answers based on number of attempts in each question and it compares this with the student score.
Figure 7.7: Creating Examples, Exercises or Mini-Quizzes

The instructor may include enhanced feedback should the learner incorrectly answer the question.

Images may be inserted in exercises.
Should the student miss this question this box provides feedback and a link back to the appropriate section of the chapter.

*Figure 7.8: Creation of test at the end of the Lesson*

For a graded test, the link to the feedback is made not available.
Figure 7.9: Creation of assignment/projects related to the lesson

Figure 7.9 shows the screen for creating assignments or project titles. Various types of assignments are created to accommodate the multiple intelligences. Before the instructor posts the assignment questions he/she has to do the selection whether it is an individual or group based task. Other than posting assignments, the instructor can also post questions or
comments on “Your Idea” and “Think”. The questions/comments will enable student to further explore on the lesson or ponder other things related to the topic. ‘Your idea’ and ‘Think’ enhances students’ interpersonal ad intrapersonal intelligences.

Figure 7.10: Insertion of a New Glossary Term

To allow the use of special terminology within lesson content and to further support non-linear reading patterns, an automated Glossary feature is included in the system. An instructor or SME may insert a term into a glossary database for any topics created. As they create more topics, the expanded Glossary is available to all other modules. A key feature is that any term in the glossary will automatically become a hyperlink in the learning content documents. Should a student need help on the terminology, all they need to do is to click on
the term and a definition appears. Glossary definitions are given in two languages (English and Malay) and may also include images as shown in Figure 7.10.

### 7.2.5 Summary at the End of a Lesson

The summary component (see Figure 7.11) concludes the lesson, to review the subject which will assist students in self-assessment and self-reflection on understanding of the topics and applying knowledge and skills for problem solving at large. Three main parts in summary page are review, next steps and additional resources. The review part is to recap what students have learned explicitly linked with learning outcomes. Next steps list down the topics to be covered after understanding the current topic. Additional resources provide auxiliary links and other resources related to the topic.
Figure 7.11: Creating Summary at the end of a Lesson


7.2.6 Allow Students to Control the Pace and Direction of the Learning Module

Constructivist emphasises the students’ role in actively constructing their own understanding of a learning domain. We can improve learning effectiveness by giving the students control over, and responsibility for, their own learning (Kay, 2001). The e-learning environment is an excellent vehicle to provide this self-paced method of instruction (self-direction by the student is not available in a typical classroom teaching). However, all instructors caution that some control of the flow of the lesson must occur by the developer. SCEnE does have both of these features incorporated into its design. First the student must review the learning objectives, pre-requisites, and key points. However, from that point of the lesson on, the student can control the path through the hyperlinked topics. Some students may choose only examples, while other may choose the entire complement of narrative content, examples and exercises.

As part of the navigation and self-paced direction features, students are provided a site map detailing the entire lesson plan and their current position in that lesson. Figure 7.12 details a site map with clickable links available to the student.
Figure 7.12: Self-navigational choice available to students

7.2.7 Information Management, Communication Tools and Online Resources

Other than sequencing lesson content based on sound pedagogy, the student-centric e-learning environment also considers on information management, communicational tools and online resources.

Information Management

Information Management includes services like maintaining the module, update syllabus, bulletin board, grade book, calendar, online diary, frequently asked questions and assessment. Online assessment is a key component of an e-learning system and it is used to evaluate students’ learning progress. Quizzes in the form of multiple-choice questions are part of this and it has the capability not only to give feedback for the student responses but
also to monitor students’ learning progress and achievement levels. The following section briefly describes the information management components.

Identification and Management of User Profiles

One of the main things to be managed in an online digital archive is the identification of correct user profiles according to which the access to the resources is made available in a suitable way; this, also so as to guarantee the immediate visibility of the materials and at the same time, to avoid (if possible already at the materials uploaded) any copyrights problem.

Registration

The SCEnE portal foresees a pre-emptive phase of user’s registration. Figure 7.13 shows the screen shot of user details. This step is fundamental to reach all the goals of the distributed didactics we want to reach. In particular, the users’ registration, with their subsequent authentication on entrance through username and password, allows to:

- Guarantee the access to the course materials only to authorised users
- Identify the user inside the portal, allowing him to use all the interactive services (for example, when the user logs into the system, he will be able to view the course presentation in accordance with his intelligence and while he uses the Chat his identity will be visible to all the people participating at the moment).

Each SCEnE user is supplied with its own username and password, through which he will accede a group of resources he is enabled to use. After the authentication phase through username and password, the student enters an environment from which he can accede the various courses arranged, as well as the general information regarding the SCEnE application (course syllabus, bulletin board, online diary, chat, etc.).
Users Categories

SCEnE foresees various user categories:

- Administrators
- Instructors (teachers, subject leaders, examiners, moderators, etc.)
- Students

The various categories assent different resources and services. The system administrator can add new registered users (giving them usernames and passwords). The administrators/instructors create new topic sections, add materials, creates chat group, etc.).

Syllabus

This module consists of uploading the current course syllabus.
**Bulletin board**

This service can be used by the instructor/administrator to give the users some important information regarding the course life. The bulletin board is characteristically used to send short notifications pertaining to the logistics organisational type (for example, to inform the users of upcoming school events, to inform the users about a chat appointment, the presence of new materials, etc.)

**Calendar**

This is a service that enables students to mark important events in their calendar. On the other hand administrators would be able to highlight school holidays, public holidays, key in school event and important dates like exam etc.

**Online diary**

This service can be used by students to keep track of their daily activities. This service is particularly beneficial for students with intrapersonal intelligence as they prefer to work at their own pace and keep a list of tasks to be accomplished for the day, month or year.

**Frequently asked questions (FAQ)**

This is the list of Frequently-Asked Questions about the theory of Multiple Intelligences and e-learning. It is restricted to questions about MI and e-learning in SCEnE context. Users can seek for questions in doubt based on a given set of titles. It is intended as a first resource for users, developers, and the interested readers, and does not form part of the SCEnE specification.

**Assessment**

This is a service that, on the one hand, allows the teacher to create new quizzes to be submitted to the users and, on the other, allows the students to answer the questions prepared, verifying the score.
This service can be seen in two ways:

- Administrator/instructor: it allows preparing the quizzes to be submitted to the students, and to examine the results reached by them.

- Students: it allows to answer the quizzes presented and to verify the score reached.

The quiz creation by the administrators takes place directly online inside the system. As soon as a new quiz set is available, the students can access it.

Other than quiz questions, administrators/instructors also post test and past-year exam questions. Each time the student clicks on the particular link for assessment, questions will be selected randomly from the test bank for assessment purposes and student evaluation. This is to discourage students to memorise the answer pattern.

Figure 7.14 shows the screen shot of the list of modules whereas Figure 7.15 shows the page to create the module details.
Figure 7.14: Screen Shot of the List of Modules
Communication Tools

In SCEnE, students are able to communicate with their instructors through email and discussion groups. In this situation students do not get immediate response from their instructors and sometimes may also not get what they want within the required time. However the e-learning environment also offers online discussions among students, instructors and other participants via chats, whiteboard and forum. Here students are able to get immediate response to their questions despite not being physically present. Communication tools in SCEnE are e-mail, forum, chat, whiteboard, and file-sharing archives (submission and posting assignments). The following section briefly describes the communication tools used in the e-learning environment.
**E-mail**

The most commonly used function of the Internet and SCEnE is e-mail, which speeds up the personal exchange of information to a much higher level. Nowadays, almost every school and higher learning institution offers their students and employees free e-mail accounts. Students can easily contact their instructors through e-mail and instructors can make announcements to their classes by simply sending group e-mails. There was a high level of interactivity between the instructor and students as well as among students as recommended in some prior research (Sampson *et al.*, 2002)

**Chat**

This is a service that allows a real-time interaction among the people participating in the same virtual class. Through this service, as shown in Figure 7.16, the users can contact the people who in a given moment are connected to the course, and so can exchange messages among them.

This service is especially useful if the tutors or teachers define timetables and appointments in which it is possible to discuss the topics concerning the course, according to an agenda that can be made available online and managed in an interactive way. Students and instructors can record their voice using the voice recorder function shown in Figure 7.17.
Figure 7.16: Chat room

Figure 7.17: Voice recorder
Forum

This environment allows exchanging messages structured according to their topic. The instructor has some control on the messages entered in the Forum, as he can create new discussion threads and, where needed, cancel the unsuitable messages. Discussion forums enable group work between students from different locations within a school or outside, without travel expenses or cultural differences, using only a computer and a browser. Discussions remain as threaded tree-structures of messages, therefore when attempting to recall a discussion the messages are easy to find and the progression easy to comprehend.

Whiteboard

The whiteboard lets students collaborate in real time with others. The features are described below:

- Review, create, and update graphic information.
- Manipulate contents by clicking, dragging, and dropping information on the whiteboard with mouse.
- Cut, copy and paste information from any Windows-based application into the Whiteboard.
- Use different colours pointers to easily differentiate participants’ comments.
- Save the Whiteboard contents for future reference.
- Load saved Whiteboards pages when needed.

File-sharing archive

The services provided in file-sharing archives are uploading assignment on the web by the instructor for students based on the course taken and submission of assignment to the instructor concerned. The instructor/tutor gives the assignments to the student by making
them available online on the assignment service. The student can then carry out the assignments by using the browser or conventional paper and pen, depending on the type of assignment. The solutions can be submitted to the system directly by the student, corrected automatically and the results are stored in a database.

Web activities

The link to web activities is presented on the content area of course presentation. Students will be able to view the list of web activities related to the topic. Web activities include activities like surfing the net based on the given URL, key in formulas in spreadsheet, search information by given keywords using search engines like MSN, Yahoo and Google.

Online Resources

Online resources have annotated links to external websites as well as library access. This annotated links will allow students to search for more information pertaining to the lesson.

Appendix G illustrates the main application scenarios on how the seven learning concepts discussed in Section 7.2 are being exercised by students.

7.3 SCEnE’s Architecture

A learning system generally consists of different modules, each performing a given task (Vassileva, 1995; Anido et al., 2001; Hampel et al., 2001; Gehne at al., 2001). The proposed e-learning architecture, is four-tier architecture as described in Figure 7.18, permits a full range of services in the construction of a specific e-learning environment. Procedures are defined within each of these tiers, facilitating the design of, and suggesting a
subsequent workflow structure for student-centric e-learning environment. The e-learning environment consists of selected objects and specific methods (within the selected object) that are appropriate within the boundaries of the implementation environment. The four-tier architecture, in particular, permits the interaction between the selected methods to be defined so that learning may be achieved effectively within the boundaries of the available technologies.

![Diagram of four layered architecture of SCEnE]

Figure 7.18: Four layered architecture of SCEnE

7.3.1 A Layered Architecture

The basic structuring technique in the e-learning architecture is layering. In terms of this approach, student-centric e-learning environment is composed of an ordered set of layers. Each layer represents a subsystem that is constructed from a selection of related service objects.
An object within a layer is defined by a specific set of functions, relating to that layer, that it is able to perform. Each of the service objects consists of a collection of methods. A method describes the specific strategy that is used to accomplish the service being offered by the object.

In e-learning, many methods exist that can realise specific outcomes, but the method or strategy followed to acquire these outcomes often relies on circumstances of the specific e-learning environment. The strategies for student-centric e-learning environment are discussed in Section 7.3.4.

7.3.2 Service Objects and Methods

Each general object within a layer may be made specific by the selection of one or more methods that determine the attributes of that object. To supply a practicable e-learning situation some objects are considered mandatory for inclusion during the design, while others are optional. The design also often includes one or more methods from the same object.

7.3.3 Workflow Within the E-Learning Architecture

The layered approach enables us to define a workflow between the distinct layers. Each \((N)\) layer, except the bottom layer, is supplied with a set of services, these being compiled from selected objects on the \((N-1)\) layer. The bottom layer is assumed to be compiled from a set of telecommunication technology objects, this being the standard electronic infrastructure that is required for the specific e-learning situation. The layer-to-layer workflow is described as follows: an \((N)\)-layer provides its \((N+1)\) layer with a set of services, and uses
the services of its \((N-1)\) layer. The top layer provides the e-learning architecture with transparency in that the students, instructors and administrators are provided with a set of services in a setting where electronic learning is promoted.

### 7.3.4 Layer Descriptions

The four layers in SCEnE architecture are presentation layer, information layer, e-paradigm layer and physical layer. The purpose of each layer is explained below:

**Presentation layer**

The purpose of the presentation layer is to serve as a window between the e-learning process and the underlying strategies necessary to establish the e-learning environment. As with the other layers, the presentation layer is composed of various objects, each containing one or more methods. The objects on this layer are described as follows:

The course communication object on the presentation layer provides the means necessary for communication between students and their facilitators (instructors and administrators) and also for communication and cooperation between students. The methods for this object are e-mail, discussion groups, chat and whiteboard.

The student-centric paradigm object from the presentation layer provides the means by which the students are exposed to course content and gain skills such as writing, construction, problem solving, critical thinking, deeper understanding, etc. The methods that are included in this object are (1) learning objectives (2) pre-requisites (3) course-unit creation (TELL, SHOW, DO, PRACTICE) (4) summary (5) glossary (6) assessment (EVALUATE). When designing a specific e-learning environment, it is important that all of these methods are included to provide a more sophisticated and complete e-learning environment to sequence lessons for diversity of students.
From the two objects (communication object and student-centric paradigm object) described above, it can be seen that there is also a relation between the different objects. The selection of methods from one object enforces the inclusion (or exclusion) of methods from other objects. For example, the inclusion of the collaborative learning as a student-centric paradigm method, calls for the inclusion of course communication methods which make collaborative learning possible. Collaborative learning enhances the Interpersonal intelligence.

**Information layer**

The information layer provides services for a reliable and effective e-learning environment. It accomplishes this task by supplying a set of tools to support e-learning programmes such as managing access for retrieval of courseware, authorizing data entries to the server, providing a central repository structure for course material, with efficient storage mechanisms optimised for different media types with indexing and retrieval facilities.

Three other major functions on this level include the provision of an integrated user interface, with the objective to buffer the student from the technology behind the content, the establishment of enabling technologies for electronic submissions of assignments for automatic assessment and grading, and the integration of the e-learning environment with other institutional systems.

**E-paradigm layer**

The objective of the e-paradigm layer is to provide an electronic learning paradigm composed of technological strategies possible in e-learning accommodating multiple intelligences. The objects found on this layer form the basis of the specific e-learning environment. They often prescribe which objects from the upper layers may be suitable for selection.
The *synchronous* and *asynchronous* objects are commonly identified on the e-paradigm layer. In synchronous learning environments that are geographically dispersed, students and instructors share a learning experience within the same physical time frame. Examples include remote classrooms with “white board” for students to participate in real-time activities. The asynchronous object is characterised by its being independent of location, time, learning speed and skills of the student. A typical example is that of the student who prefers to study at his/her own pace and time. The number of methods for objects on this layer is limited, and is realized on other levels. For example, selection of the asynchronous object will have a direct influence on the methods of the course distribution object found on the information layer. Methods may be through web downloads or precompiled course materials while in the synchronous environment, online material and online discussion topic may be more relevant.

**Physical layer**

The physical layer provides for the transparent transmission of messages (which may be course communication, course material or course directives) between students and instructors tied together in an e-learning scenario. The physical layer includes the specification of hardware and software technology objects necessary to accomplish e-learning. The object on this layer is Internet connection. The methods of the Internet connection object describe the prerequisite hardware and software strategies necessary to accomplish an Internet connection. The hardware and software strategies are described in detail in Section 7.4.
7.3.5 Algorithms to Design SCEnE

There are many approaches to the design of an e-learning environment by mapping the four-layered architecture onto a specific scenario. A top-down algorithm and a bottom-up algorithm are two natural approaches to the design of a strategic model for a particular e-learning environment (Pressman, 2001). The top-down approach is preferable where the options available on the physical layer are not restricted. For example, where all students have full-time access to the Internet, there is no restriction and any e-paradigm object may be selected, because the underlying services are available. The bottom-up approach is suitable where limitations exist on the physical layer, such as restricted Internet access. In designing SCEnE, the researcher adapted the top-down approach. The following subsection describes the top-down approach.

7.3.5.1 Top-down Approach

In the top-down approach, mapping of the four-layered architecture onto the student-centric e-learning environment is initiated by first selecting objects from the presentation layer to be incorporated into the design plan. The services necessary to realise the chosen objects are then selected from the information layer. Other objects on the information layer which may not be of direct service to the objects from the top layer can also be identified. The objectives of these additional objects will be to enhance and enrich the infrastructure of the e-learning environment.

The target group of students and the objects chosen from the top layers will often suggest the objects and the methods to be selected on the e-paradigm and the physical layers. For example, selection of whiteboard method (from the course communication
object on the presentation layer), and a *specialized whiteboard layout* method (from the *interface* object on the information layer), suggest the selection of a *synchronous paradigm* object from the e-paradigm layer, with a *permanent connection* object from the physical layer.

### 7.4 Prototype Implementation

The prototype implementation includes SCEnE implementation model, PHP that integrates SCEnE transaction and how to access the system.

#### 7.4.1 SCEnE Implementation Model

As a first step, hardware technology and software technology objects are selected from the physical layer. Several goals influenced the choice of the technical features to use while implementing SCEnE prototype. First and foremost SCEnE must be a web-based system to allow its access anytime and everywhere. This also contributes to fulfilling the portability issue, as the prototype becomes platform independent. Therefore, a “PC with a minimum of 128 K RAM and 1 GB free hard drive space”, with a “modem capable of 28.8 kbps to an ISP (or other Internet connection)”, and “a permanent e-mail address” as suitable methods for hardware technology. Methods for the software technology object include “the Windows 95 (or higher) operating system”, “an Internet Browser”, and “e-mail software (often included in browser)”. On the e-paradigm layer, the asynchronous and synchronous objects are selected.

Secondly, on the presentation layer, the course is designed around the outcomes that have to be accomplished. Since outcomes differ from course to course, outcomes can never
be specified as a generic object with methods. In this research, the researcher focuses on the MI object and then selects suitable methods to realise the outcomes. The methods of this object often direct instructors/administrators to include certain other objects. For students with Interpersonal intelligence, if the “collaborative learning” method is chosen, provision must be made for group work through course communication object. Other objects that can assist in realizing the objectives include study material, assignments, and examination. It becomes clear from this example, that each selected object forces the person in charge of creating the course material to think thoroughly about what he/she plan to do, as well as how to accomplish the goals. The how part of planning is addressed by the information layer. In the previous step “collaborative learning” is chosen as a MI method. For collaborative learning, small work groups of students can be planned. For this type of grouping, e-mail is a suitable method, which forms part of the selected course communication object on the presentation layer. On the information layer this implies the need for a mail server and the setup of a course or class e-mail address.

Another object on this layer is that of the course interface. The maintenance of the consistent growth of the content has to be ensured. This includes the ability to seek and access information to the exact match to the given templates. To realise this goal, the researcher restricted rights on management and presentation of contents to the instructors only. Other administration rights are assigned to the administrator of SCEnE. HTML is used for information rendering at the presentation layer, while ASP was used as a middleware server to connect the presentation layer with the information layer through the TCP/IP protocol.

Finally, the information layer is implemented through MYSQL server which is open source Relational Database Management System. High-level outline of the SCEnE implementation model is shown in Figure 7.19.
7.4.2 PHP Architecture – Integrating SCEnE Transaction

In three-tier PHP architecture, the first tier is persistent to data storage. In the first tier, server side files or a database which is running on a web server such as Apache is implemented. The second tier is business logic layer, where the rules regarding the application to be stored are coded and it is generally the bulk of application. PHP normally runs in second tier where users are able to access the database. The third tier is presentation,
which enable users to see the results of the business logic applied to the data being stored. In this tier, users are able to see the output results of the PHP scripts.

For most sites with dynamic contents, a database will be the most appropriate choice for persistent data storage. In this study, MySQL is used as the database. Selecting a database is important to the overall performance, reliability and ease of maintenance of application.

On the server side, the presentation layer displays the entire interface with HTML code for the users. When users submit information to the system, it will send through the business logic phase. Business logic is where PHP code being embedded. PHP is in charge to control the logic of the application and integrate with the database for transaction purpose.

When everything is being recorded in the database, business logic sends some acknowledgement to the presentation layer and displays the output to the users through the Internet to browsers. Whereas, on client side, the browser is coded to check the correctness of the information before it is being sent to the server side. Figure 7.20 shows the architecture of PHP and how PHP work in a web server while integrating with SCEnE e-learning transaction.
The researcher designs the system adopting the “open source” approach (Open Source, 2007), assuring that just a simple browser is needed, as well as gaining simple expandability, wide support and high performance.

Based on these considerations, the prototype, core of the e-learning system is based on the Apache Web Server, completed with PHP (PHP language, 2006) for server-side scripting and MySQL (MySQL Database, 2006) for database management. The system is accessed from a site named SCEnE where students can attend courses; perform exercises and exams, as well as exploit several collaborative, personal tools, as described in Chapter Five. The e-learning environment includes the web server, which interacts on one hand with the SCEnE portal, while on the other it is connected to both PHP scripts and services. The former represents the main implementation of the system, as scripts implement the engine and allow domain databases and students/instructor profiles management. The later

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**Figure 7.20: PHP Architecture – integrating SCEnE transaction**

Presentation  
Internet  
Browser

Business Logic

Smartly Template File  
Contains all HTML code in SCEnE application

Main PHP Script  
Controlling the logic and flow of the application

Database Abstraction Layer

Use of MySQL SCEnE database

Rendering and any client side scripting logic

Presentation Internet Browser

Smartly Template File  
Contains all HTML code in SCEnE application

Main PHP Script  
Controlling the logic and flow of the application

Database Abstraction Layer

Use of MySQL SCEnE database

Rendering and any client side scripting logic
represents the implementation of all other services, for instance Services module could include a video server together with related plug-ins, if video streaming is provided, or Java-based chat service for collaboration. The last component of the e-learning environment is the MySQL database, which actually includes domain database, as well as profile databases.

### 7.4.3 Accessing the Prototype

The prototype is accessed through a web based interface, which is currently the platform most widely adopted (Kuittinen et al., 2001). The core of the system is an e-learning portal, i.e. a web site where several services are available to build a web based community for learning activities. Such portal is on one hand accessible by final users (both students and instructors), while on the other hand it is connected to the SCEnE System.

Students and administrators can access the system from anywhere, thanks to the web-based approach, provided that a proper user identifier and password must be provided in order to log in the system. The use of user-id and password grants access only to registered users. This provides the system with auditing (logging) capabilities for each single user, which is used for further monitoring and extracting personal and statistical information about system usage. It also provides a basic security level which can be further improved by using specific protocols, e.g. secure http (HTTPS), helpful especially when sensitive information are being exchanged (as during on-line test performance) allows to define user classes, in order to distinguish students from teacher and from system administrators (thus providing them with different rights and/or limitations), as well as grouping users for several purposes, as to create virtual classrooms or exam sessions, meetings, instructor update courses, and so on.
7.5 Summary

In this chapter, firstly, the practical implementation which incorporates seven learning concepts was described. Secondly, four-tier student-centric e-learning environment architecture was defined. The objective of this architecture is to supply a basis for designers, developers and facilitators to construct practicable strategic e-learning architectures suitable for their individual e-learning environments. By using a layered approach, the researcher separated different related functions into logical units which make it easier to design and maintain a flexible strategic e-learning environment. Next, there were some discussion on the prototype implementation and finally, the main application scenario of SCEnE which is shown in Appendix G.