CHAPTER 5

DESIGN AND DEVELOPMENT OF REUSABLE OBJECTS FOR OS e-CONTENT

5.1 INTRODUCTION

Chapter 4 has provided a clear picture of the existing cognitive structures in the contents of NPTEL 2.0 e-content modules of OS. This study has established certain components for the need for proposing a structured, reusable and Problem Based Instructional model. The design of the model (later chapter) requires reusable but independent objects. The need for a highly structured instructional objects based on cognitive structures of the ‘First Principles of Instruction’ has thus been established. Chapter 3 has unleashed the need for a flexible and modular approach for designing an instructional model for e-contents, in addition to ‘Problem Based Learning’ approach. It therefore indicated the need for reusable objects for the instructional approach. Section 5.2 of this chapter presents the design and details of the model. Using the model an experiment is carried out with four concepts. These concepts are instructed through reusable modules called ‘objects’. The first object namely ‘Device Dependence’ followed by ‘Device Independence’ are elaborated in section 5.3 and section 5.4, ‘S/W and Application Integration’ is elaborated in section 5.5 and ‘Embedded OS’ in section 5.6. The sample experiment conducted with these objects in an actual e-content environment is briefed in section 5.7. Validation of the approach through social study is reported in section 5.8. The summary on how these objects that have been designed would be considered for the experimental work is narrated in section 5.9.
5.2 TECHNICAL DESIGN PRINCIPLES AKIN TO USABILITY FOR THE DEVELOPMENT OF e-CONTENT

The initial design of a draft e-content was based on Merrill’s First Principles of instructions, with restricted textual materials in slides based on Carroll’s Minimalist theory (Chapter 2). This draft e-content on OS (courseware) developed with a few slides (elaborated in later Section) was administrated through a pilot study from 20 respondents (e-learners). The following conventional design and development principles were applied for development and implementation in accordance with Macromedia Course Builder (2008). The responses on instructional strategies are referenced in each sub section.

Script design

The storyboard should be the base for development, but not limiting to the content specifications and the content script. The implementing model for the design of storyboard shall be based on SCORM (Sharable Content Object Reference Model). The following components have been considered for the design as per the SCORM standards.

The screen layout should portray the courseware to be developed. The format of a storyboard shall include:

Title and version as header, prepared as per the metadata. Data for the storyboard is presented in the following manner.

(a) Page number as a footer
(b) Category of SCO
(c) Graphics/illustrations
(d) Voice over script
(e) Text script
(f) Navigation buttons
(g) Directions of the navigation

(h) Notes to programmer

(i) Descriptions on the media objects

The important strategies as per the derivatives of this research are briefed in what follows. The following sections present the consideration of strategies followed. The strategy number taken in the questionnaire (Chapter 4) is indicated by the abbreviated letters ‘St.’.

**Navigation (St. no. 15)**

Storyboard navigation function shall conform to SCORM. All instructions on navigation shall appear in graphical form/icon. All instructions on navigation shall represent the actual navigation in courseware. Only essentially needed navigation procedures have been provided with clues http://www.edugrid.ac.in/ (2010).

**Strategy on animation (St. nos. 3 and 9)**

Graphic’s animation should be clearly illustrated or described. Graphics shall be clearly described, whether still or animated. All animations shall be indicated by brief descriptions. The volume of graphic animations shall be medium (10% to 50%). Animations used shall be smooth that is at least 12 fps http://www.nptel.iitb.ernet.in/, or, http://www.nptel.iitm.ac.in/ (2010).

Blinking texts shall conform to the following:

- The numbers of blinks for text shall be 3.
- Pause between blinks shall be 0.5 second.
- Color of the blinks shall be contrasting.
- Blinking text shall coincide with the original text.
Animation shall be related to content and must be accurate. Animation shall be used with purpose to support and enhance learning.

**Strategy for audio / video script presentations (St. no. 16)**

Voice over shall be synchronized with text, video, animation or graphic. Voice over used must be appropriate according to gender and age of the character portrayed. The voice talent used should be the same or at least a person or a few persons should have almost similar voice for the same character.

Volume, tone and pitch of audio shall be consistent and clear throughout the courseware. They shall not be auditory, shrill, tinny, bloomy, muddy, thin, distorted, scratchy, coarse, grainy, harsh, hiss, crackle or rustle.

Pronunciation must be correct and intonation must be clear and with neutral ethnic accent.

The language used should be linguistically correct, relevant to the subject and appropriate for the target group.

Standard British English shall be used.

Background music used shall adhere to the copyright act.

Sound effects shall be relevant to the context.

There shall be no overlapping of audio.

There should be more sentences in active voice than passive voice in audio instruction and should be direct.

**Example:** “Click on the next button to go to the next page” instead of “To go to the next page, click on the next button”

Where possible, short sentences should be used.
Measures, such as alternating male and female voices, shall be taken to avoid monotone, provide variety and to maintain users’ attention within a courseware.

The voice over should tell only relevant things.

Short and simple audio script shall be used. Long message shall be broken into chunks.

Audio icon should be provided to enable learners to choose what to listen.

Feedback in the form of the voice over should be used appropriately and discriminately.

Negative feedback in the form of voice over should be avoided.

Example: “Your answer is wrong”.

(i) Voice over should be fully scripted.

(ii) Gender and age group of voice over narrator and talents should be stated.

(iii) Sound effects should be suitable to the requirements of learning content but should not be limited.

The volume of audio/video should be minimal in accordance with the strategy adopted.

**Strategy for script presentations on conceptual learning (St. nos. 8 and 17)**

As the research will focus more on the instructional strategy or more specifically on objectives, conventional practices will be adopted in the draft e-content. They are explained first.
The introduction section should give a short overview of the lesson and motivates the learner to the lesson. The title of the e-content should also be displayed in this section.

The concept/skill learning section should be used for learning theories that will enable learner to master the concept. Explanations should be kept to the minimum; however, should more information be required, an option should be made available. Activities that elicit responses from learner shall be used as much as possible to engage them to learn. In this respect, the approach should always be that the learner shall be guided to discover or construct the concept or skill.

**Strategy for tests and guided exercises (St. nos. 7, 10 and 12)**

The practice section should contain guided exercises. These exercises should elicit responses from learner as much as possible and not merely animated explanation. The practice section should contain real life situations, where applicable.

The test section should have the following features:

- The test questions should be organized into three levels-easy, average and difficult.
- The questions should also be presented according to their levels of difficulty.
- It should contain a variety of questions, including but not limited to multiple choice, matching, drag & drop and fill in the working/answers.
- The questions should be chosen from those randomly generated by the systems.
- Templates for worded questions should not be refused.
The learner should be free to choose which question to answer first. Navigation between unanswered and answered questions should be permitted.

At the end of the test, a score should be displayed, stored and retrieved. Appropriate response should be given next to the questions for answers which the learner has got them correctly or incorrectly.

The extent to which the test items should be designed will be in accordance with the strategy taken for the design.

After the submission of the test, the learner should have the option to click on the question button to view the question, the wrong answer and the correct working (where applicable) and answer.

In any section of the e-content, a screen which explains the meaning of the term should be popped up. The explanation should be in form of text, animations, or graphics. The learner should have the choice to listen to the pronunciation of each term by clicking the audio button (Florida Centre for Instructional Technology - 2007). The level of explanation should be in accordance with the level of the learners.

In the test section:

(a) There should be immediate response to learners input in the evaluation.

(b) All answers relating to fractions should be in its simplest form but all forms (number) of correct answers shall be accepted and marked as correct. Where applicable, the question should mention that the answer must be in its simplest form.

(c) There should not be instructions specifying the number type (decimals, fractions etc.) for the answers except in very specific cases.
(d) Units of measurement should be indicated in the answers. The learners should not be required to input the units except for specific topics i.e measurements etc.

**Strategy on text / numeric input (St. no. 11)**

Text must conform to the general educational courseware standards.

The font and size of the entry should be similar to the size and font of the display.

The text entry should be lowercase by default.

If the text entry is the beginning of a sentence, then the displayed answer should show the first letter in uppercase after the learners hit the Enter/Return key.

Only text entry is allowed for box that requires text answer.

Only numeric entry is allowed for box that requires numeric answer.

All text boxes relating to text input have to be validated according to the answer types. Answers requiring numeric input must accept all types of numbers.

For example, integers, decimals, fractions and mixed fractions.

The validation of the text input should be done in accordance to every permanent icon displayed shall be accompanied by tool-tips. In calculations, there shall only be one equality sign in each line of calculation. Calculations shall be “equal sign” aligned for equations and calculations (Blackboard -1997).

Units related to the calculations, where relevant, should be shown at the end of each line of calculation and not only at the end of the calculation.

Explanations/calculations should be erased when they appears to be too long and cluttered on the screen. A pop-up screen containing explanations/calculations when requested (example: “Mouse over” the appropriate area) shall be used.

- Highlighting should be limited to 10% of the screen display.
• Words at the end of a line should not be hyphenated.

• Generous white space should be used to separate blocks of information.

• Headings should be used as content summarizers.

• Complex information in Science and Mathematics should be converted into tables.

• Reverse video or blanking should be used with extreme discretion. Chunks of text to be read shall not be blinked.

• Not more than one attention-getting technique should be used on a single screen.

**Strategy on figures, table and graphs (St. no. 14)**

All figures, tables and graphs should be titled.

• Numerical characters should be decimal aligned.

• Text should be left aligned.

• Column headings should be centre aligned.

• Variables should be in italics and centre aligned.

• Row headings should be left aligned.

Lines in tables should have 75% of the thickness of their borders.

Grids should be uniform in size.

Lines should be 100% tint.

Lines thickness of grids for graphs should be 1.0 point, 0.75 point or 0.5 point.

Points or multiples of it are arranged in such a fashion, so as to resemble the grid in a graph paper.

All diagrams should be neatly labeled.
Straight lines should be used for labeling diagrams. These lines should not intersect.

Text for labeling should be in lower case except for the case of proper nouns.

Polygons should be labeled in alphabetical order in an anti-clockwise direction.

Labels of corners of polygons should be in capital letters and italicized.

Angles of polygons should be labeled in lower case letters and italicized.

Characteristics of the polygons should be denoted with the appropriate mathematical symbols on the polygons, for example, parallel and perpendicular lines are indicated as such.

Construction lines or projection lines of polygons should be in a different color from the original line.

Dashed lines, when used, should begin and end with a dash that intersects with relevant points.

**Programming and coding concerns**

Due care should be taken to avoid the approach of “hard-coding” the courseware, but instead to apply a more flexible and re-usable modular approach throughout the programming of the courseware.

The following is the standard for the Modular approach:

(a) Common function libraries are used.

(b) The name of variables, functions and procedures must reflect the meaning of their program functions.

(c) Remark or descriptions used accordingly to highlight the respective functions, constants, variables, procedures and resource libraries.
(d) Spaghetti-code (high usage of “go-to” functions) approach is avoided if possible.

All courseware produced should comply to standard specified in SCORM 1.2 The standard for metadata (IEEE-LTSC-2005), should be based on the SCORM

These elements should be filled in:

(a) Title: General title
(b) Description: General description
(c) Keyword: General keyword
(d) Author or contributor lifecycle: Contribute entity
(e) Location, address or URL Technical : Location learning resource type: Educational learning resource type
(f) Learner level: Educational context

All Sharable Content Objects (SCO) should be LMS-enabled. LMS refers to a Standard SCORM-compliant Learning Management System.

**Content package design**

Content packaging adheres to standard SCORM 1.2

Metadata file should be saved as an external XML file to the manifest file.

**Objectives**

The e-content should conform to the curriculum in terms of its aims, learning outcomes, skills and values.

The e-content should promote the acquisition of knowledge: content, problem solving, epistemic and inquiry knowledge.

The e-content should depict some local real life problems.
The e-content should permit self-paced, self-accessed and self-directed learning.

For any exercise or practice activity, positive and negative reinforcements should be given.

The content should take the learner from the known to the new learning in appropriate stages on sound learning theories.

The content should follow a clear strategy to achieve learning.

The content should be accurate, valid, up-to-date and without errors.

The e-content should stimulate and motivate the learner.

**Standard references**

The standard reference for English language should be the Oxford Advanced Learner’s dictionary.

These references should minimize discrepancies in terms of content and language (Moodle - 1999).

**Table 5.1 Storyboard Overview File**

<table>
<thead>
<tr>
<th>COURSEWARE NO.</th>
<th>COURSEWARE TITLE</th>
<th>LEARNING AREA</th>
<th>LEARNING OBJECTIVE(S)</th>
<th>LEARNING OUTCOME(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>LO1</td>
<td>LO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LO3</td>
</tr>
</tbody>
</table>

VOCABULARY

Navigation buttons for FORWARD, BACKWARD and REPEAT would be used for screen movements. PAUSE, PLAY and MUTE would be provided for video & animation.
The length of the text should be minimal but the contents should explain the graphics or animation displayed on screen. The contents of text should adhere to the learning outcome.

Figure 5.1 Structure/Flow Chart
The text should describe specifically the nature of the graphics and/or the flow of the animation with regards to the intended learning outcome. The location of on-screen texts should be placed strategically on the screen. The location of the texts should be displayed in the storyboard. OST can be either labels or titles.

Each e-content may be matched to one or more learning outcomes in the curriculum specifications but they (the learning outcomes) should form the same learning objective.

The Introduction section should be a multimedia presentation, between 15-30 seconds, which should include any combination of text, animation, graphics and/or audio. These multimedia presentations should be unique to a title, and should not be refused in other titles.

The concept/skill learning section should start with an induction set for every sub-topic, which should be effective in rousing curiosity and interest towards the topic to be learnt. This can be in form of a story, a short quiz, or short activities and games. It should then include the main idea to be presented and can be a simulation of an activity or experiments.

The practice section should reinforce the learning objective. It should be done in a manner and with activities that differ from that used in the presentation.

Activities which should engage the learner to use his scientific skills in a fun filled and challenging manner should be developed in the Enrichment section. Examples of these activities are games, puzzles and problems with elements of prizes, treasures, scores and time limit. There should be instructions for each activity. A summary of the lesson and some important facts should be easily accessible to the learners.

Language

Each courseware lesson should be matched to the learning outcome in the curriculum specifications. However, a maximum of two learning outcomes may be
combined to form a courseware if each of these learning outcomes is not meaningful for a courseware lesson to be developed from it. Combination of learning outcomes should be the exception rather than the norm.

The courseware lesson shall have five sections:

(a) Introduction
(b) Skills learning
(c) Practice
(d) Enrichment
(e) Test

The introduction section should give a short overview of lesson and acts as a set induction to motivate the learners to the lesson. This should be in the form of an animated cartoon clip. The title of the courseware should also be displayed in this section.

The skills learning section should be based on learning theories that will enable learners to master the skills. Explanations should be kept to the minimum and activities that elicit responses from learners should be used as much as possible to engage them to learn. In this respect, the approach should always be that the learner should be guided to master the skills.

The practice section should contain drill and practice exercises. A sub-section, Re-learn should be available. If a learner does not get the exercise correct after two attempts, he should be automatically taken to the re-learn section so that the courseware guides the user to the correct answer. This guide should elicit responses from the user as much as possible and is not merely animated explanation. The Practice section should help the child to master the skills. It should cover the relevant topics/learning area. It should contain a minimum of five questions, arranged according to the level of difficulty.
Activities which shall engage learners to use their language skills in a fun filled and challenging scenario should be developed in the Enrichment section. Examples of these activities are games, puzzles and problems with elements of prizes, treasures, scores and time limit. There should be instructions for each activity.

Once an important word in any section of the courseware is clicked, a screen which explains the meaning of this word should be popped up. The explanation should be in text or the meaning of this word should be popped up. The explanation should be in text or graphic or both. The learner should have the option to listen to pronunciation of each term. The level of explanation shall be consistent with the level of the learning outcome. Help icon should be available for learner on the technical aspects of the courseware.

**Layers in the Model**

There are three essential layers in the model. The lower most layer has all the reusable objects of the e-content. The section’s layer has concepts for instruction based on each section at a time. A section may have one or more objects, but an object alone cannot describe a concept. The top layer has modules layer under the SCO (Sharable Content Objects). The model is shown in Figures 5.2 and 5.3.
Figure 5.2 Sharable content object of the model

Figure 5.3 SCO Black Box
5.3 OBJECT ON ‘DEVICE DEPENDENCE’

The exact slide(s) as designed and implemented in an object along with the briefing of audio narration is presented. The basic data for this independent reusable object is presented as follows.

Total number of slides: 10
No. of slides with almost pure texts: 1
No. of slides with semi graphics: 1
No. of slides with almost pure graphics: 8

SLIDE 1:

Cognitive type: Non cognitive structure
Portrayal: Real world problem (RWP)

Real World Problem 1

State-of-Art s/w Development Company

Hardware

System: WICAT super mini (Motorola), Interactive IBM systems (Intel) and AT & T UNIX PCs (Zylog)

Workstation: AED graphics system

Accessories: HP AO plotter, Roland plotter, CALCMP 64 button digitizer, table top digitizer etc.

Audio narration: Introduces a real life situation.

SLIDE 2:

Cognitive type: Non cognitive structure
Portrayal: Real world problem (RWP)
Audio narration: Presents a vivid picture of RWP and asks learners ‘How to connect these devices?’

SLIDE 3 (i):

Cognitive type: Cognitive structure

Portrayal: Activation
LAN with machines having same type of processors

Can you give an example of CPU for this LAN?

*Is it really a network?*

*Audio narration:* Presents a vivid picture of a day-to-day college situation and asks learners ‘Is it network in reality?’ After a pause, slide 3(ii) is displayed.

SLIDE 3 (ii):

Cognitive type: Cognitive structure

Portrayal: Activation
Audio narration: Motivates the learner with the RWP situation already put forth and tells the learners that this is more a network rather than the previous.

SLIDE 4:

Cognitive type: Cognitive structure

Portrayal: Demonstration

Audio narration: Elaborates ‘What is an Operating System’ and demonstrates ‘What are the s/w and h/w layers of a desktop system’. Demonstrates the importance of ‘assembler’ as invariably a language that is used for writing an Operating System.
SLIDE 5 (i):

Cognitive type: Cognitive structure

Portrayal: Demonstration

Audio narration: Through questions to learners, demonstrates the importance of ASCII for converting h/w into 1s and 0s; converts into decimals after grouping into bytes; converts the decimals into characters according to ASCII. After a pause, brings up slide 5(ii).
SLIDE 5 (ii):

Cognitive type: Cognitive structure

Portrayal: Demonstration

**Inside a CD**

Audio narration: Clarifies that conceptually the procedure is same for CDs as well as floppies, where as from technology point of view, CDs are newer to floppies. Further precautions that newer technology may be introduced in future, but concepts will remain for a longer period.
SLIDE 6:

Cognitive type: Cognitive structure

Portrayal: Application

**Audio narration:** Elaborates on three examples of h/w and their assemblers and indicates each OS is written in an individual assembler. Provides examples for three application areas for each set up.
Slide 7:

Cognitive type: Cognitive structure

Portrayal: Integration

Audio narration: Asks, whether any application could be portable to other set up?
SLIDE 8:

Cognitive type: Cognitive structure

Portrayal: Integration

MAC (APPLE) and WINDOWS hand shake?

Audio narration: Elaborates on the compatibility of MAC OS and Windows and informs that it is due to the presence of ‘Interface Routine’ with MAC OS. Integrates finally that these OSs are ‘Device Dependent’. End of Object on ‘Device Dependence’.

5.4 OBJECT ON ‘DEVICE INDEPENDENCE’

The exact slide(s) as designed and implemented in an object along with the briefing of audio narration is presented. The basic data for this independent reusable object is presented in what follows.
SLIDE I:

Cognitive type: Non cognitive structure

Portrayal: Real world problem (RWP)

Topographical arrangement

How to make it feasible?

Audio narration: Poses a motivating real life situation through a question.
SLIDE 2:

Cognitive type: Cognitive structure

Portrayal: Activation

**System needs to be device independent**

- Different types of machines networked
  - Motorola, Intel, Zylog

- Different kinds of devices networked
  - Plotter, Digitizer, Workstation

- Devices replaced during their function
  - *HP Plotter* to *Roland Plotter*

*Audio narration:* Presents a Real world situation with several devices and tells a system is need to integrate these devices.
SLIDE 3:

Cognitive type: Cognitive structure

Portrayal: Activation

**PROPRIETARY PRODUCTS (EXAMPLES)**

**COMPUTER MANUFACTURERS**
- IBM
- APPLE MACINTOSH
- HP
- SUN ...

**CPU MANUFACTURERS**
- Intel (80286, 80486, Pentiums)
- National Semiconductor (NSC 800)
- Fairchild
- Zylog () ; Cyrix ...

**OPERATING/BOOTING SYSTEMS/MANUFACTURERS**
- Microsoft
- Control program for microprocessor (CP\M)
- BIOS (Basic I/O SYSTEM)
- Basic Disc Operating System (BDOS)
- Console Command Processor (CCP) ...

*Audio narration:* Presents the current scenario of H/W and S/W product developers and how an OS became popular because of ‘Device dependence’.
Audio narration: Elaborates on ‘What is an Operating System’ and demonstrates ‘What are the s/w and h/w layers of a Desktop system’. Demonstrate the importance of ‘assembler’ as invariably a language that is used for writing an Operating System.
SLIDE 4 (ii):

Cognitive type: Cognitive structure

Portrayal: Demonstration

**DEVICE INDEPENDENT LAYERS**

Audio narration: Demonstrates how the h/w layer can be conceptually separated from the s/w layer. Demonstrates the important role played by a ‘linking layer’ that connects s/w (application) with h/w (system).
SLIDE 4 (iii):

Cognitive type: Cognitive structure

Portrayal: Demonstration

**Audio narration:** Demonstrates that this linking layer is ‘UNIX’, a device independent OS.
SLIDE 4 (iv):

Cognitive type: Cognitive structure

Portrayal: Demonstration

Audio narration: Demonstrates the role of Shell and Kernel. Indicates that the role played by Inter Process Communication (IPC) of kernel. Also indicates that the kernel is monolithic in nature. Also indicates the size comparison of the shell with kernel.
SLIDE 5 (i):

Cognitive type: Cognitive structure

Portrayal: Application

Audio narration: Provides an example of a kernel and also indicates that the shell was re-written in ‘C’.
SLIDE 5 (ii):

Cognitive type: Cognitive structure

Portrayal: Application

Audio narration: Provides another example of a kernel and also indicates that the shell never changes but only the kernel.
SLIDE 5 (iii):

Cognitive type: Cognitive structure

Portrayal: Application

**DEVICE INDEPENDENT LAYERS**

<table>
<thead>
<tr>
<th>User developed software</th>
<th>Vendor developed packages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>UNIX SHELL (C)</strong></td>
</tr>
<tr>
<td></td>
<td>Unix kernel for IBM/Intel 845E</td>
</tr>
<tr>
<td></td>
<td>Assembler</td>
</tr>
<tr>
<td></td>
<td>specific hardware</td>
</tr>
</tbody>
</table>

*Audio narration:* Provides another example of a kernel and also indicates that the shell never changes but only the kernel does.
SLIDE 6:

Cognitive type: Cognitive structure
Portrayal: Integration

Audio narration: Elaborates a typical simple program of ‘C’. Integrates how this program is a correct program, while a device dependent ‘printf’ is treated as a variable.

‘C’ Program

main ()
{
    char printf;
    printf = ‘A’;
}

Is it a correct program?

Audio narration: Elaborates a typical simple program of ‘C’. Integrates how this program is a correct program, while a device dependent ‘printf’ is treated as a variable.

End of Object on ‘Device Independence’.

5.5 OBJECT ON ‘S/W AND APPLICATION INTEGRATION’

The exact slide(s) as designed and implemented in an object along with the briefing of audio narration are presented. The basic data for this independent reusable object is presented in what follows:

Total number of slides: 11

No. of slides with almost pure texts: 5
No. of slides with semi graphics: 2
No. of slides with almost pure graphics: 4
SLIDE I:

Cognitive type: Non cognitive structure

Portrayal: Real world problem (RWP)

Software

Development: (i) GUI Interface: 60,000 lines coding in ‘C’ and X-Lib
(ii) Applications: 90,000 lines coding in ‘C’ & FORTRAN 77
   - (Enormous coding requirement)
(iii) Third Party Source Code (linking languages)
   (a) NASA’s AMES Research Lab’s
       3-D Package: 30,000 lines source code
   (b) UC at Berkley’s
       SAP VII: 10,000 lines source code
(iv) Rapport routines + Plotter routines + Terminal access
    Package routines + ‘make’ files etc.,

Time frame: 6 1/2 years

Audio narration: Motivates learners with information about huge s/w development RWP.
Cognitive type: Non cognitive structure

Portrayal: Real world problem (RWP)

PROBLEMS FACED

• Calling function of one *language* from another *language*
  – *C to Fortran to Java*

• Compiling huge coding
  – 15,000 lines coding!

• Efficiently running and compact object module
  – *Loops of 1, 100,000!*

*Audio narration:* Presents a real world situation with a few s/w issues w.r.t RWP.
SLIDE 3:

Cognitive type: Cognitive structure

Portrayal: Activation

Merry with Windows

- Point and click operations – Simple and straight
- Directly used for production (Word; Database etc.)
- Widely supported s/w products
- Many are already familiar with ASP, ASP.Net, VB, VB.Net, MS SQL etc.

Your right choice will be Windows then!

Audio narration: Presents the current popularity of a proprietary OS. Also provides a few merits of this popular OS.
SLIDE 4 (i):

Cognitive Type: Cognitive structure

Portrayal: Demonstration

**Audio narration:** Demonstrates introducing a Window’s look alike front end above Shell. Also indicates that instead of a monolithic kernel, dynamic micro kernels for various operations could be designed.
Audio narration: Demonstrates how to differentiate between Unix and the suggested enhancement. Demonstrates the important role played by a Window’s look alike GUI and on the distribution of kernel.
SLIDE 4 (iii):

Cognitive Type: Cognitive structure

Portrayal: Demonstration

Linus Torvalds

Audio narration: Motivates learners with information about Linus Torvalds and his contribution in suggesting the enhancement.
SLIDE 4 (iv):

Cognitive type: Cognitive structure

Portrayal: Demonstration

Audio narration: Demonstrate (inform) on the birth of Linux.
SLIDE 5 (i):

Cognitive type: Cognitive structure

Portrayal: Application

KEY FEATURES AND ADVANTAGES OF Unix/Linux

1. Portability & portable Applications
2. Multi-user operation
3. Background processing
4. Kernel and shell approach
5. Text – processing tool
6. Software development tool
7. Open source & matured
8. Enthusiastic user community
9. Communications

Audio narration: Narrates various advantages of device independent OS.
SLIDE 5 (ii):

Cognitive type: Cognitive structure

Portrayal: Application

**DEMERITS OF UNIX** (No longer with *Linux*)

1. Poor documentation
2. Unfriendly
3. Unsupported
4. Tough to learn

*Audio narration:* Narrates various disadvantages of device independent OS.
SLIDE 5 (iii):

Cognitive type: Cognitive structure

Portrayal: Application

**LINUX BRANDS**

**Support**

- **Red Hat Linux** (Most popular)
- **Slackware Linux** (Simpler but old product)
- **Debian Linux** (Voluminous programs)
- **Linux Mandrake** (New and easy to use)
- **SuSE** (Supports 1024 processors)
- **Ubuntu** (Web based applications)
- **Others** (Caldera; MLD; LiveLinux; ...)

*Audio narration*: Provides various brands and their application areas.
SLIDE 6:

Cognitive type: Cognitive structure

Portrayal: Integration

Power of Linux

- Linux = Unix power + User friendliness
- Linux = Unix OS + Windows look alike GUI
- Linux = Dynamic Unix kernel + shell
- Linux = Unix + Support (through vendors)
- Linux = Unix + O.S scalability
- Linux = Unix = Open source
- Linux = International standards

Audio narration: Summarizes important points about Linux.

End of Object on ‘S/W and Application Integration’.

5.6 OBJECT ON ‘EMBEDDED OS’

The exact slide(s) as designed and implemented in an object along with the briefing of audio narration is presented. The basic data for this independent reusable object is presented in what follows.

Total number of Slides: 14
No. of slides with almost pure Texts: 8
No. of slides with semi graphics: 2
No. of slides with almost pure graphics: 4
SLIDE I:

Cognitive type: Non cognitive structure

Portrayal: Real world problem (RWP)

ADDITIONAL PROBLEMS

AT&T Unix PC (Zylog)

Plotter

Interactive IBM (Intel)

Work station

WICAT Super Mini (Motorola)

Mobile

Digitizer

This is really a network, indeed!

Audio narration: Motivates learners with information about adding a mobile phone in the network - RWP.
SLIDE 2:

Cognitive Type: Cognitive structure

Portrayal: Activation

*Activate*

**Inside desktop computer**

Multi-functioned; flexible & loosely constrained; sub-systems

*Audio narration:* Presents a vivid picture of the loosely coupled components of a desk top system. Learners are activated with the importance of device independence.
SLIDE 3:

Cognitive type: Cognitive structure

Portrayal: Activation

*Activate*

**Inside mobile phone**

Single-functioned; rigid & tightly constrained; embedded

*Audio narration:* Presents a vivid picture of the tightly coupled components of a mobile phone. Learners are activated with the importance of device dependence.
What is Embedded?

**Embedded**: A number of systems coexist to discharge a specific function in real time.

**Embedded system**: A union of subsystems to discharge a specific task coherently.

**Purpose**: To Perform pre-defined tasks.

A desktop system is not, but a mobile phone is!

*Audio narration*: The definition of embedded system is recalled to learners. They are motivated with an inference about desktop and mobile phone systems.
Cognitive type: Cognitive structure
Portrayal: Activation

Embedded Operating Systems for mobile phones

- There are an estimated 2.5 billion mobiles in the world.
- Till early 2000, 90% of mobiles were using MS embedded OS.
- From mid 2000, handset makers felt proprietary platforms were:
  - Rigid (because of policy)
  - Costly (because of excess royalty)
  - Non innovative (impersonal)
- Linux has hence started emerging to succeed MS E OS

Audio narration: Activates learners with historical statistical information about the embedded OS.
Embedded Operating Systems for mobile phones

- Mobilinux is the mobile OS of Linux
  - Not open source, but proprietary!
  - Commercial version by Monta Vista
  - More than 35 million mobiles are under Mobilinux
  - Its GUI is written using Eclipse
  - Monolithic kernel!

Audio narration: Activates learners with a case history of an embedded OS.
SLIDE 4 (iv):

Cognitive type: Cognitive structure

Portrayal: Activation

Embedded Operating Systems for mobile phones

- Quote by Motorola:

  “We chose Linux, because of its
  - Open standards
  - Stability
  - Inbuilt networking capabilities”

Audio narration: Activates learners with a case history of an embedded OS.
SLIDE 5:
Cognitive type: Cognitive structure
Portrayal: Demonstration

Five key Characteristics* of mobile phones

1. They are small and mobile
2. They are ubiquitous and professionally used
3. Sometimes connected
4. Have to be innovative (to be competent)
5. Platform independent (plug-ins)

* [www.symbian.com](http://www.symbian.com)

_Audio narration:_ Narrates certain key characteristics of mobile phones.
Embedded Operating Systems
for mobile phones

• ‘Symbian OS’ for mobiles
  – Exclusively for mobile phones
  – Originally owned by Nokia+Sony Ericson+Motorola+Psion
  – Recently (June 2008) Nokia announced buying entire Symbian
  – Nokia announced Symbian to be open source and non profit
  – Basically written in C++
  – Java ME (or J2ME) used for applications
  – Possible to understand Linux & Mac E OS
  – Supports M.S Visual Studio, VB.Net and PEARL
  – Uses consortium of device descriptors (OEMs)

Audio narration: Provides various application features of a popular embedded OS.
SLIDE 7:

Cognitive type: Cognitive structure

Portrayal: Integration

**Symbian OS**

Symbian OS = **User friendly** + Secure

Symbian OS = **Window’s compatible** +

  Linux compatible

Symbian OS = **Device dependent** + Open

  source

Symbian OS = **Commercial Success** +

  Wireless standards

*Audio narration:* Summarizes inferences on the concepts of a popular embedded OS.
SLIDE 8:

Cognitive type: Cognitive structure

Portrayal: Application

Current challenges

• The world must support 375 million e-mail users now
• 6.75 trillion photos need to be stored
• There are 10 billion Web searches per month
• We want responses within 0.15 sec among millions of simultaneous users
• Applications we need – Hundreds!

Audio narration: Activates learners with the current statistical data on Internet.
155

SLIDE 9:

Cognitive type: Cognitive structure
Portrayal: Integration

Where are we and what we want, now?
< 1980s = Many men – 1 computer (Main frame)
80s – 2005 = 1 Man – 1 computer (PCs)
> 2005 = 1 Man – Many computers (Now, Cloud Computing)

Audio narration: Summarizes the need for cloud computing for ‘Applications on demand’.

Integrate

Which OS to choose? Net based or stand alone?
What is Android?

• It is a LINUX based OS for Mobiles, Smart phones and Tablets

• Andy Rubins et al. – Purchased by Google in 2007 under Open Handset Alliance

• Open Standards
  • Originally developed in Java

• Device Independent to 86 h/w and s/w

• 4,50,000 Applications are available in 2012 (Good for CLOUD)

• Over 10 Billion down loaded till 2011.

• Over 300 Million devices use Android (Feb. 2012)

Audio narration: Demonstrates on the features of Android. Emphasize on its derivative from Linux.
SLIDE 10 (ii):

Cognitive type: Cognitive structure

Portrayal: Demonstration

Features of Android

- **Main objective is applications**
- **Based on LINUX micro kernel**
- **3D graphics included**
- **SQLite used for databases**
- **Connects Wi-Fi, Bluetooth, WiMAX and CDMA**
- **C2DM = Cloud to device management**
- **Additional H/W: touch screen + thermometer + pressure sensor**

Audio narration: Demonstrates with additional features of Android.

5.7 EXPERIMENTAL ANALYSIS WITH OBJECTS

The above objects have been implemented for experimental purposes in an actual South Indian Social Network Site, called ‘www.chokut.com’, which has been rented out for a brief period of time. The implementation routines were written in Java. 25 (see Table 5.2) subjects (e-Learners) in the discipline of MCA were chosen for the proposed experiment. The e-contents were displayed through the rented out e-mode for a brief period. Oral feedbacks through interview were obtained as a pilot study. It was observed that almost the entire feedback showed a very positive reaction from the learners. However, for a scientific study, the same slides were administered in CD form through Self Instructional Materials (SIM) for the selected 232 (see Table 5.2) sample learners for validating the model.
5.8     VALIDATION OF THE APPROACH

5.8.1   Sampling and actual samples for validation

Universal sampling for the Instructional materials of the selected area has been adopted. Purposive sampling has been considered for the feedback analyses, as it is known to be representative of the total required data, and known to represent well-matched groups (Sharma B.A.V, (1988)). The questionnaire used for feedback analysis for validating the model is presented in APPENDIX II. The samples used for the validity study is presented in Table 5.2.

**Table 5.2 Actual samples considered for validity study**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Samples</th>
<th>Purpose</th>
<th>Validation</th>
<th>Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>Pilot Study</td>
<td>Validating experiment</td>
<td>Mixed respondents</td>
</tr>
<tr>
<td>2</td>
<td>232</td>
<td>Formal study</td>
<td>Validating experiment</td>
<td>Student learners respondents</td>
</tr>
</tbody>
</table>

Scale: Strongly Agree = 5.0; Agree = 4.0; Neutral / No comment = 3.0; Disagree = 2.0; Strongly disagree = 1.0

Frequency variables=VAR00001, VAR00002, VAR00003, VAR00004 /STATISTICS=STDDEV MEAN MEDIAN MODE /BARCHART FREQ /ORDER=ANALYSIS.
# Frequencies

## Notes

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<thead>
<tr>
<th>Input</th>
<th>Output Created</th>
<th>27-Aug-2012 23:53:10</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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<td>Split File</td>
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</tr>
<tr>
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</table>

## Missing Value Handling

<table>
<thead>
<tr>
<th>Definition of Missing</th>
<th>User-defined missing values are treated as missing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases Used</td>
<td>Statistics are based on all cases with valid data.</td>
</tr>
</tbody>
</table>

## Syntax

```
FREQUENCIES
VARIABLES=VAR00001 VAR00002 VAR00003 VAR00004
/STATISTICS=STDDEV MEAN MEDIAN MODE
/BARCHART FREQ
/ORDER=ANALYSIS.
```

## Resources

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<tr>
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</tbody>
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[DataSet0]

## Statistics

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<th>VAR00003</th>
<th>VAR00004</th>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valid</td>
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<td>232</td>
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<td>0</td>
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<td>4.0000</td>
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**Frequency Table**

**VAR00001**

<table>
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<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
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</table>

**VAR00002**

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<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
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</tr>
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<td>100.0</td>
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</table>

**VAR00003**

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<th>Cumulative Percent</th>
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<tr>
<td>Total</td>
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<td>100.0</td>
<td>100.0</td>
<td></td>
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</table>

**VAR00004**

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<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
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</tr>
<tr>
<td>2.00</td>
<td>20</td>
<td>8.6</td>
<td>8.6</td>
<td>8.6</td>
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<td>Total</td>
<td>232</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>
Bar Chart

1. Introducing a ‘Real World situation’ has motivated you in learning through e-Mode

![Bar Chart](image)

**Figure 5.4 Real World situations**

**Observation**

On an average from the overall observations, it is clear that more than 50% of the responses have given a positive feedback. The real world situation has motivated them to learn through the e-mode. No one has strongly disagreed, while more than 25 respondents have provided a strong positive feedback.
2. Cyclic approach for every object has kept you alert throughout each e-Mode delivery

![Graph showing Frequency vs. VAR00002]

**Figure 5.5 Cyclic approach**

**Observation**

This is an important inference for the research. The cyclic instructional strategy will keep the learner active throughout. This is evidenced by the overwhelming positive feedback. In fact there is not even a single negative nor neutral response to this critical question.
3. **Object oriented reusable modules for e-delivery would be a valuable instructional approach**

![Bar Chart]

**Figure 5.6 Object oriented reusable modules**

**Observation**

This is a very critical question arising from the perspective of research and its objective. The overwhelming strong agreement shows that, Object oriented reusable modules for e-delivery would form a valuable instructional approach. As the case with previous question, this too did not carry any negative nor neutral feedback.
4. Problem Based learning would be appropriate for Self Instructional Materials including e-Mode.

![Graph showing frequency distribution](image)

**Figure 5.7 Problem Based learning**

**Observation**

Mixed responses are seen for this question on whether “Problem Based learning would be appropriate for Self Instructional Materials including e-Mode”? However there is no strong negative feedback seen. In an average it can be concluded that problem based approach would be apt for e-Mode.
5.9 SUMMARY

The design of the objects detailed above has clearly demonstrated that most of the slides use graphical media. Previous chapter elaborated on the need for graphical elements for better retention of instructions. Each object uses Merrill’s cognitive structures in a logical strategy. It is clearly demonstrated that these objects can be independently stored in an object data base so as to be used by the model. The next chapter elaborates the technical features and economic viability of the model for e-learning.
CHAPTER 6

ANALYSIS ON TECHNICAL FEASIBILITY AKIN TO ECONOMIC VIABILITY

6.1 INTRODUCTION

Section 6.2 presents the analytical results of the instructional approaches followed by NPTEL with reference to CPU time on uploading under laboratory conditions. This is followed by section 6.3 that deals with the technical study on the elapsed time of NPTEL’s modules. Section 6.4 presents the analytical results of the instructional approaches followed by researcher’s model with reference to CPU time on uploading under laboratory conditions. This is followed by section 6.5 that deals with the technical study on the elapsed time of researcher’s objects. Section 6.6 presents inferences of these studies.

6.2 ANALYTICAL RESULTS ON THE INSTRUCTIONS OF NPTEL

Existing instructional strategies are mapped in the form of the distribution of cognitive structures of the ‘First Principles of Instruction’. The contents of e-learning material of the case study are divided into four types of Instructional strategies:

- Slides that present the materials for direct instruction
- Descriptive materials (in textual form) made available for downloading
- Non-interactive questions (can be downloaded)
- Non-interactive worked-out examples (textual form)
Out of the above four components, except for the first one, the remaining three types, although residing in e-mode form, cannot be considered as part of pure e-learning. Hence, this thesis presents a comprehensive analysis on the first component only, namely, the slides.

The content analytical results are grouped under four cognitive structures of the ‘First Principles of Instruction’. Although, by definition, the cognitive structure ‘Demonstration’ should be demonstrative in nature (Merill 2002), most of the materials are found to be informative and not demonstrative. However, for analytical purposes, it is considered to be demonstrative. Similarly, according to ‘First Principles of Instruction’, ‘Application’ as per definition is done through guided practice. However, most of the materials grouped under ‘Application’ are of numerical examples. Yet they are grouped under ‘Application’ for the purpose of analysis.

Each instructional slide is judged in such a way that an approximately five minutes of viewing time is given to the viewer, although each slide need not explain an individual and explicit concept and may not strictly need five minutes duration of viewing. The contents of each slide may contain instructions in the form of the four cognitive structures. Each slide is thus analyzed with respect to the definition of each cognitive structure of the ‘First Principles of Instruction’. We assume that one unit of viewing (comprehending) by the learner is taken as approximately 1 minute, called a unit time of comprehending. Each slide is therefore computed for the presence of each cognitive structure in terms of such a time bound comprehending unit. The number of such viewing units in every module is exhibited in Table 6.1 through 6.20.