Designing Effective Online Learning Resources

Ferdinand Krauss, B.Ed.
Instructional Designer

Resource Centre for Academic Technology
Educational Computing, Faculty of Medicine

I consult with faculty to select instructional strategies and technologies for online course delivery

The presentation will illustrate the process used to design an interactive learning application developed by the Faculty of Medicine to help students learn about the therapeutic principles of pharmacology.

The learning models and instructional strategies used to design the online tool will be examined

Results from the peer review evaluation and learning impact study will also be shared.

Detailed notes available at http://ideas.blogs.com/lo/learning_objects/index.html

IDEAS: Instructional Design for Elearning Approaches: http://ideas.blogs.com

Pharmacology Learning Object: http://icarus.med.utoronto.ca/lo

Learning Object Evaluation Results
http://icarus.med.utoronto.ca/LO/eval/instruct_results.htm

Presentation Overview

1. **Design process**
2. **Theories of learning**
3. **Instructional strategies**
4. **Benefits to the learner**
5. **Evaluation**
6. **Lessons learned**

Design process can be transferred to development of online learning resources in other disciplines

May hear me refer to our resource as a learning object: digital resource that can be used to enhance learning

During instructional strategies section you will have an opportunity to see the learning object

Design Methodology

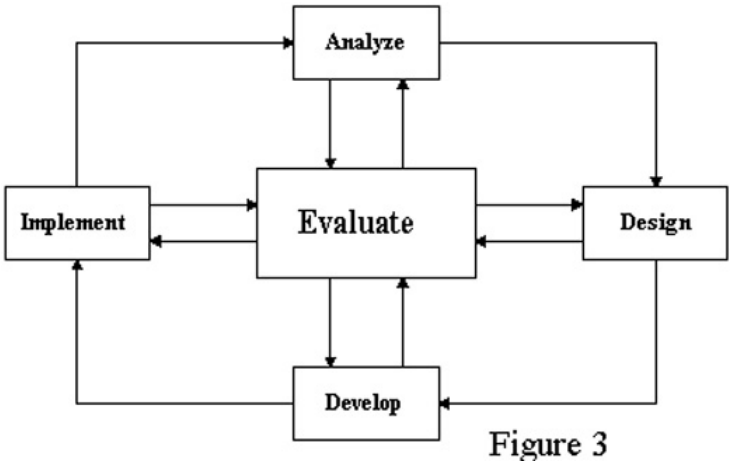


Figure 3

Source: Clark

Began by analyzing current instruction to identify an opportunity for technology to enhance learning

***strive to achieve outcomes which are not otherwise possible*.**

Typically, the therapeutic principles of drug administration is one of the least well understood topics in the medical curriculum due to the complex nature of the subject as well as the methods for teaching it.

The primary method for teaching this topic is via textbook with minimum lecture material.

Instructional Challenge

- **Enable learner to apply principles**
- **Predict result of changes in patient variables**

Resource Centre for Academic Technology 4

Textbooks explain individual concepts well but do not adequately represent the relationships which exist between the concepts

Came up with notion of creating a resource where students could practice the application of the principles by selecting different drugs from the database along with a variety of patient characteristics and routes of administration.

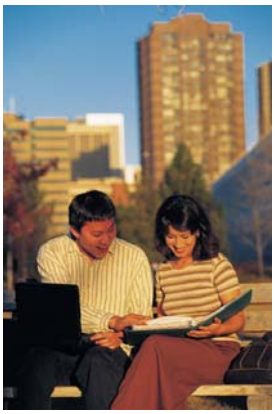
The feedback provided in a graph would help students to determine whether the principle was applied correctly.

Recognizing the situations in which the principle is applicable will enable the student to predict and explain the effects of changing the variables.

The student is able to fully acquire the principle, because they are able to apply it in a number of new situations.

Learner Profile

- **Undergrad medical, nursing, pharmacy, dentistry, students**
- **Arts & science, pharmacology students**
- **Require knowledge of basic physiology, anatomy**



Resource Centre for Academic Technology 5

Defined target learner, pre-requisite knowledge and learning goals

Explicitly stating the learning objectives makes it easier to determine the type of learning outcome the goal represented and to prescribe the necessary strategy.

Goals describe knowledge as well as the skills to be developed and the conditions under which they will be executed

The learner will be able to **list and describe the major therapeutic principles** of drug administration.

Given a demonstration of a therapeutic principle the learner will be able to **identify and replicate the relationship between the concepts** (i.e. absorption, distribution, metabolism, and excretion of drugs) that underlie the principle.

The learner will be able to **identify the relevant principles which describe the magnitude and direction of change** plotted in the blood concentration time curve as well as a visual representation of the area under the curve (AUC).

By manipulating the patient variables, routes of administration and drug dosage the learner will be able to **correctly explain, predict and control the effect of these changes on the patient**.

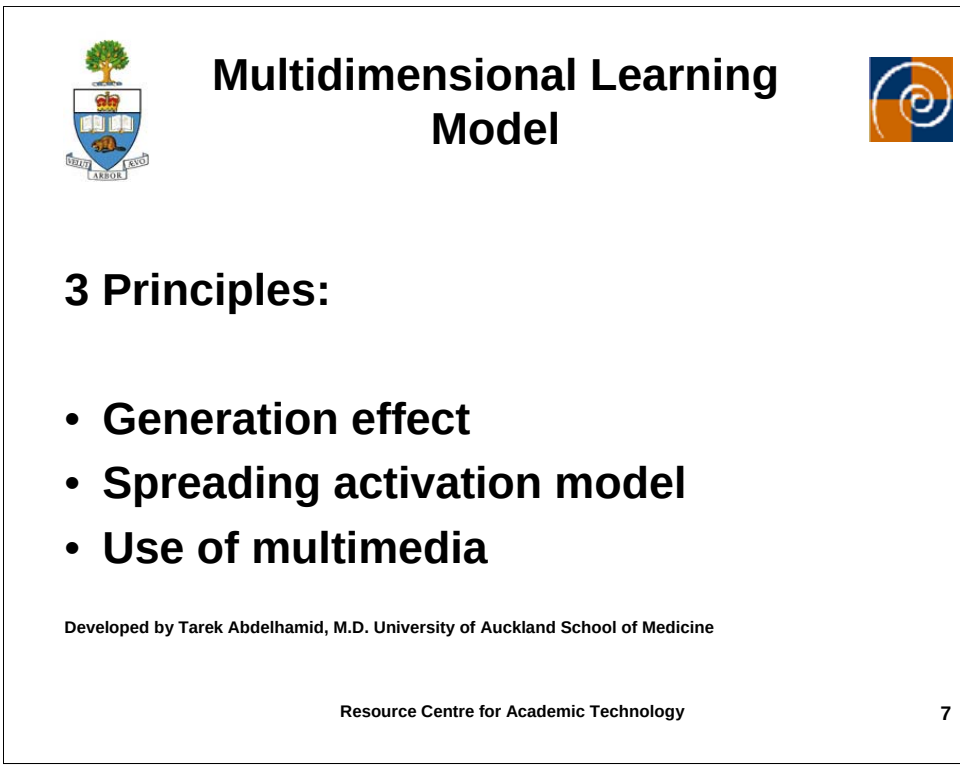
using Macromedia's Flash MX® to develop an interactive module which graphically illustrates the concepts and their relationship to each other

Lawrence Spero, PhD, is a Professor of Pharmacology and served as the subject matter expert who developed the curriculum to support the learning object.

Meaghan Brierly, MScBMC, is an Instructional Media Designer with the Biomedical Communications division. This program specializes in developing multimedia applications for medical education. Meaghan used her skills in flash programming to design the interface and graphics that corresponded to the learning object.

Ju Ho Park, BASc, is the e-Based Instructional Developer and was responsible for programming the equation to calculate the effect of the drugs being administered and to create the database of drug information.

Ferdinand Krauss, BEd, is the Educational Instructional Designer (author of the study) who researched the cognitive theories of learning and the instructional strategies upon which the development of this learning object was based.



Abdelhamid (1999) studied how different cognitive strategies could be integrated with computer-based instruction to improve learning in medical students.

His multi-dimensional learning model combines the generation effect with the spreading activation model and the use of illustrations in an effort to shift information from short-term memory to long-term memory.

Generation Effect

- **Better information recall when individual generates an item as opposed to reading it**
  - Interaction

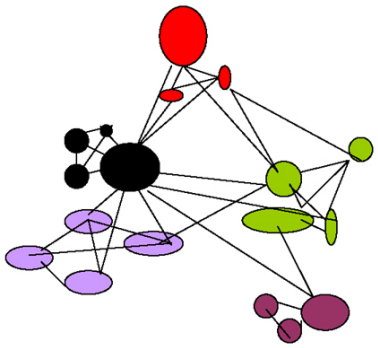
Resource Centre for Academic Technology 8

The learner is actively engaged and assumes primary responsibility for processing the information.

The pharmacology learning object requires students to interact with the resource to create an outcome (graph on blood concentration time curve).

Spreading Activation Model

- **Stored knowledge – network of interrelated data**
- **Processing of information leads to activation of others**



Source: Abdelhamid

Information is represented in patterns or connections with potentially multiple pathways.

students are able to see the relationship between the variables involved in drug administration and the effect this has on the patient

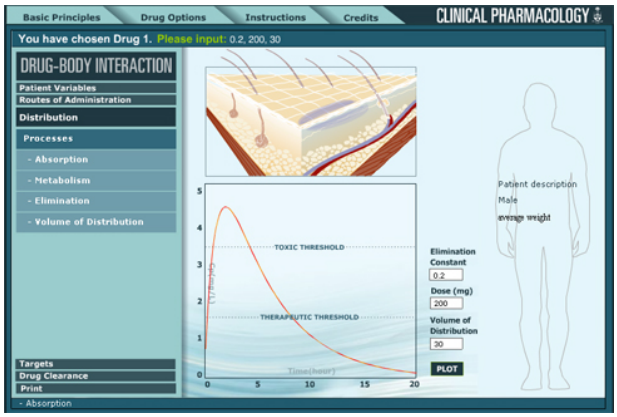
direct contrast to the textbook where the principles are treated as individual concepts

To process the information is to activate these patterns simultaneously

The deeper the processing, the more associations that are formed (Ally, 2003).

Use of Multimedia

Images can aid learning process better than verbal descriptions



Resource Centre for Academic Technology 10

Illustrations of routes of administration/ processes

Color used to highlight the explanations of principles.

The plotting of results in the graph is animated.

As the curve was being drawn, a green arrow focused the learners attention on the direction and magnitude of change in the graph.

MDLM pilot study

- **Medical students, University of Auckland**
- **Multimedia tutorial used with group of students after normal teaching**
- **1/3 omitted from teaching**
  - **tested for external acquisition of knowledge e.g. Clinical rounds, personal reading**
- **Pre-test/ post-test administered**

Empirical findings

MDLM pilot study results

- Student feedback questionnaire
- Data analyzed by psychometrician
- Student academic performance <u>increased significantly</u> in areas covered by MDLM
- Students strongly preferred this model

Source: Abdelhamid (1997)

Instructional Strategies

Expository Approach

- **Principles are presented and demonstrated**
- **Learners have an opportunity to practice the application of the principle**

Open http://icarus.med.utoronto.ca/lo **goto Basic Principles tab – protein binding example**

Corresponds to first 3 learning objectives

-list and describe the major therapeutic principles of drug administration.

-identify and replicate the relationship between the concepts that underlie principle

-identify the relevant principles which describe the magnitude and direction of change in graph

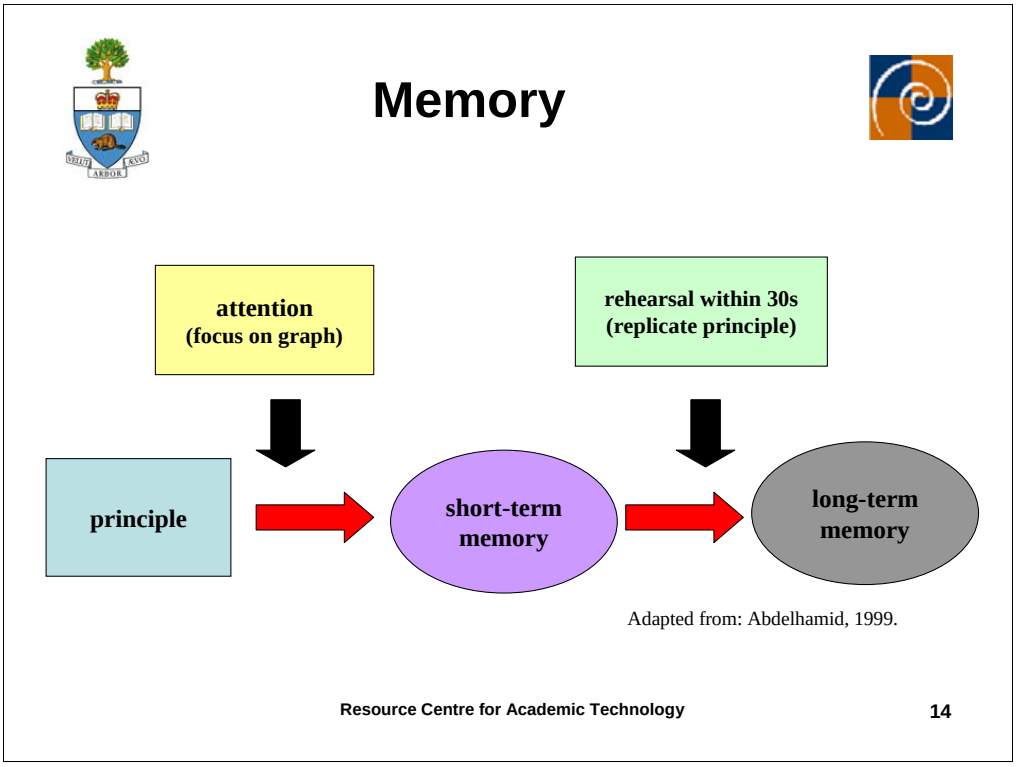
In the “Basic Principles” tab each principle is stated and then presented visually. At this point it is useful for learners to practice stating the principle. They may want to re-write the principle or attempt to put it into their own words.

The demonstrations illustrate how these rules can be used to explain, control and predict the effects of drug administration. The results are plotted in the “Blood Concentration Time Curve”.

The description that accompanies the animation explains the ‘whys’ of the principle.

The demonstrations refer to concepts (absorption, distribution, metabolism, and excretion of drugs) and terminology (physiology/ anatomy) that the learner may have previously acquired. During this phase, learners retrieve this prior knowledge in order to understand the principles.

Using the “Drug Options” tab the student can practice replicating the basic principles by selecting a range of patient variables, routes of administration and drug dosages. The learner begins by stating the principle they want to replicate.



As the learners experience the applications of the principles they are encouraged to focus their attention on the direction and magnitude of change which occurs in the 'blood concentration time curve' or area under curve (AUC) as a result of a variable being changed. Unless attention is given to this information it will be lost from memory.

1. After sufficient practice the student will be able to identify the features of the situation that suggest a particular principle is being applied and become proficient in correctly explaining, predicting and controlling the effect of these changes on the patient. In order to shift the principle that is being learned from short-term memory to long-term memory the steps which were taken to generate the principle must be rehearsed within 30 seconds.

Instructional Strategies

Inquiry Approach

- **Student randomly selects a range of variables**
- **tries to induce the principle which applies to that situation.**

Determine which concepts or variables are involved. Using trial and error, the student can randomly select a range of patient variables, routes of administration and drug dosages. In figure 5 the drug dosage has been increased from 10 to 20 mg (type 20 in the dose box and click on plot). The area underneath the blue curve and above the red curve represents the magnitude of the change caused by the increase in the dosage.

Try to determine the principle that explains the relationship between the concepts which apply to the variables you have chosen. Describe the effects that this might have on the patient.

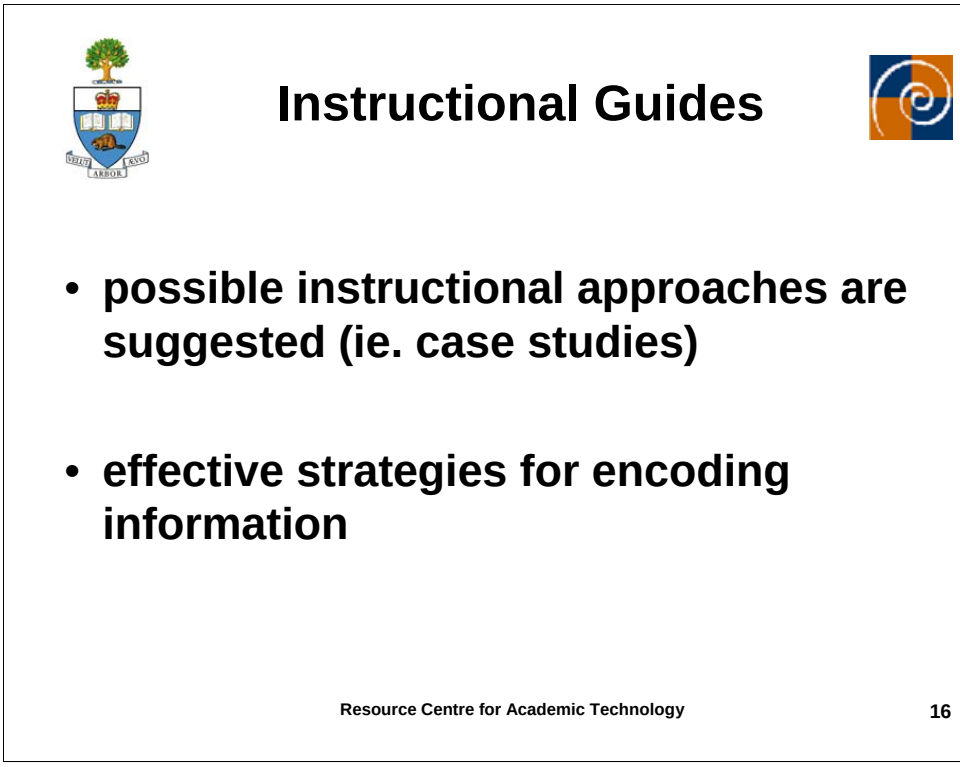
3. Recall the principle. If it is necessary the learner can return to the “Basic Principles” tab.

4. Determine which concept or variable has changed and the direction or magnitude of its change (i.e. increasing dose by 10 mg). By clicking the coloured numbers which appear next to the charted data the learner can review the patient variables that were selected for that example.

5. Determine which concept or variable has been affected (i.e. protein binding when phenytoin dose is increased).

6. Then determine the magnitude and direction of the effect (AUC) on the affected concept or variable

7. Confirm that the value is reasonable. Practice determining whether or not the principle has been correctly applied.



Guides include a description of the LO, learning objectives, target audience, pre-requisite knowledge and information on how the design of the LO supports the learning of pharmacokinetics.

Instructor Guide

use the learning object to make decisions about the administration of drugs referenced in the case study.

Student Guide

involves teaching learners the procedures of the strategy and when and where to apply it

Weinstein (1978) found that students who received direct instruction in strategy use outperformed students who were merely informed that the strategies would be helpful

Benefits to Learner

- **learner control**
- **focus on engaging the learner**

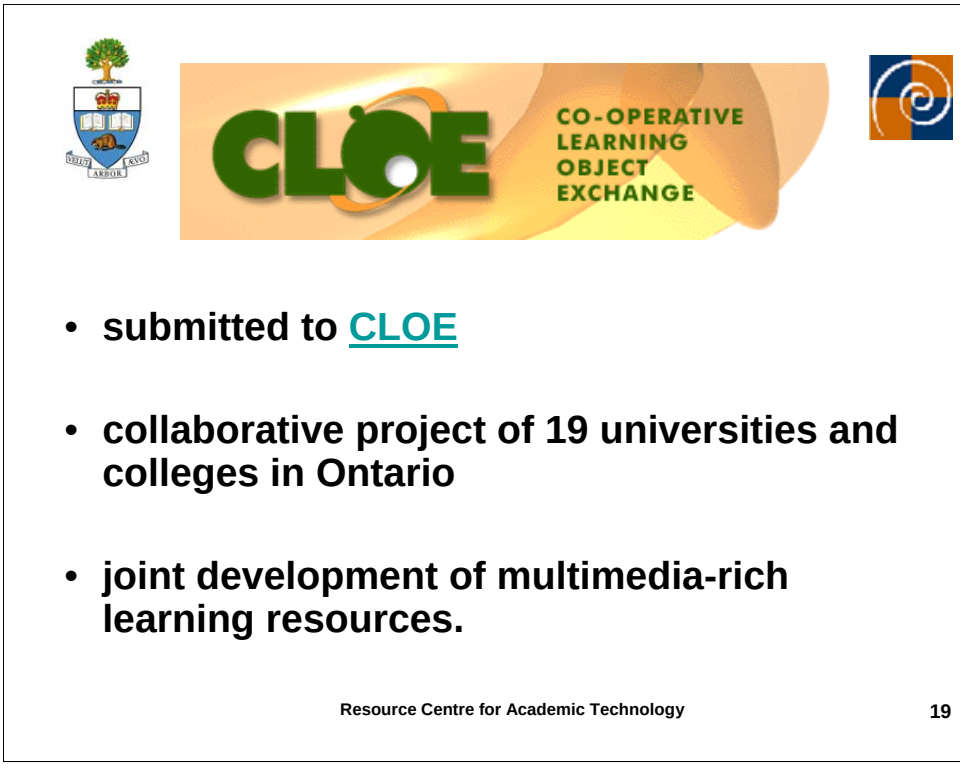
Content
Presentation
Learning rate
Study method

Relevance & motivation
Responsibility for learning outcomes

Benefits of Multimedia

- dynamic & interactive
- immediate feedback
- rapid retrieval of relevant information
- individualized instruction

Source: Nyhof-Young et. al



Edusource project

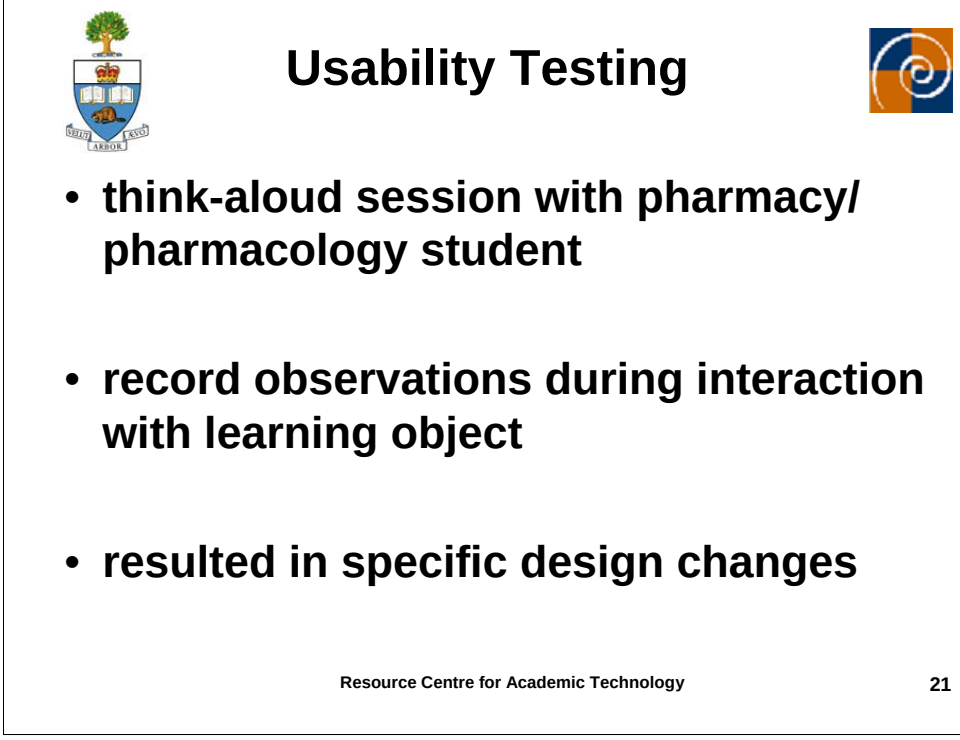
Promote the development of learning objects as a scholarly activity – hence peer review process

Learning object may be used by instructors in a range of related disciplines or by faculty at other institutions

Evaluation Methods

1. **Usability Testing**
2. **Peer Review**
3. **Learning Impact Study**

Goto http://ideas.blogs.com/lo/2004/01/learning_object.html for complete evaluation methodology



early in design stage

Student observation

It did not occur to the student that she could interact with the learning object to change the volume of distribution and dosage to affect the blood concentration time curve.

Subsequent design change

An animation showing how to change the volume of distribution and dosage to affect the blood concentration time curve was included in the demonstration of a basic principle.

Peer Review

- **2 Health science faculty (Brock, UOIT)**
- **established rating instrument**
- **assess LO in 8 categories using 5pt scale**

Resource Centre for Academic Technology 22

Belfer, K., Nesbit, J.C., Archambault, A., & Vargo, J. (2002) Learning object review instrument (LORI). Version 1.4. http://elera.matchbox.surrey.sfu.ca/eLera/Home

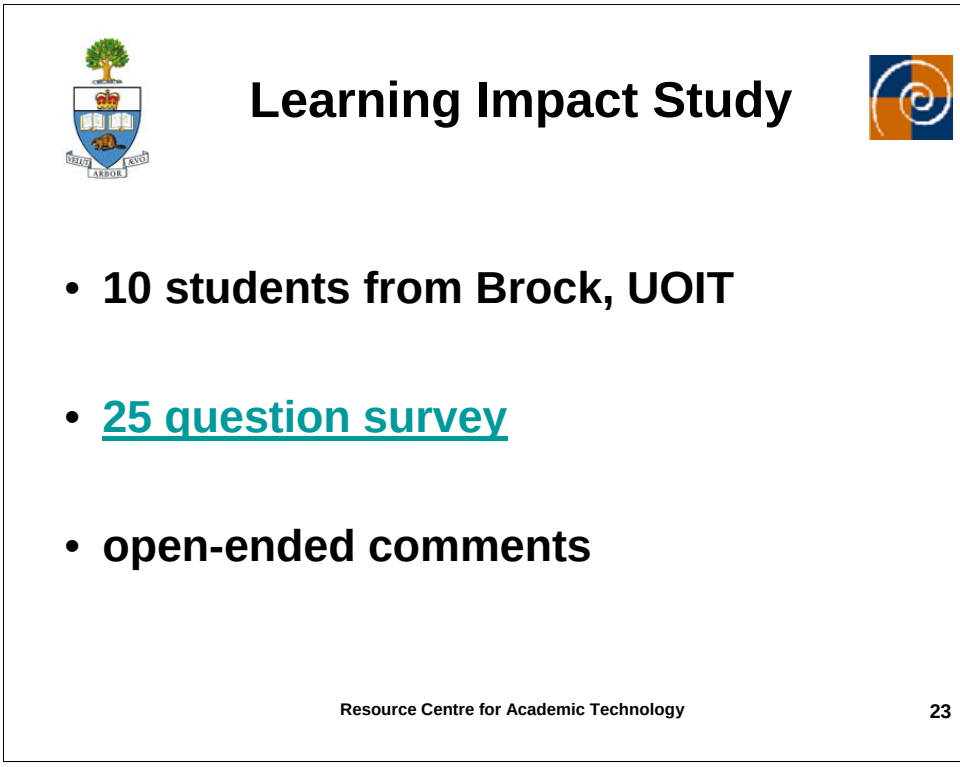
Goto evaluation results http://icarus.med.utoronto.ca/LO/eval/instruct_results.htm

The results indicate that the learning object scored high in the categories of content quality, motivation and instructor/ student guides.

It also rated very good to high in learning goal alignment, presentation design and reusability.

Interaction/ usability and feedback/ adaptation received the lowest scores.

Rating instrument was accompanied by instructor survey - provide faculty with an opportunity to suggest modifications for improvement



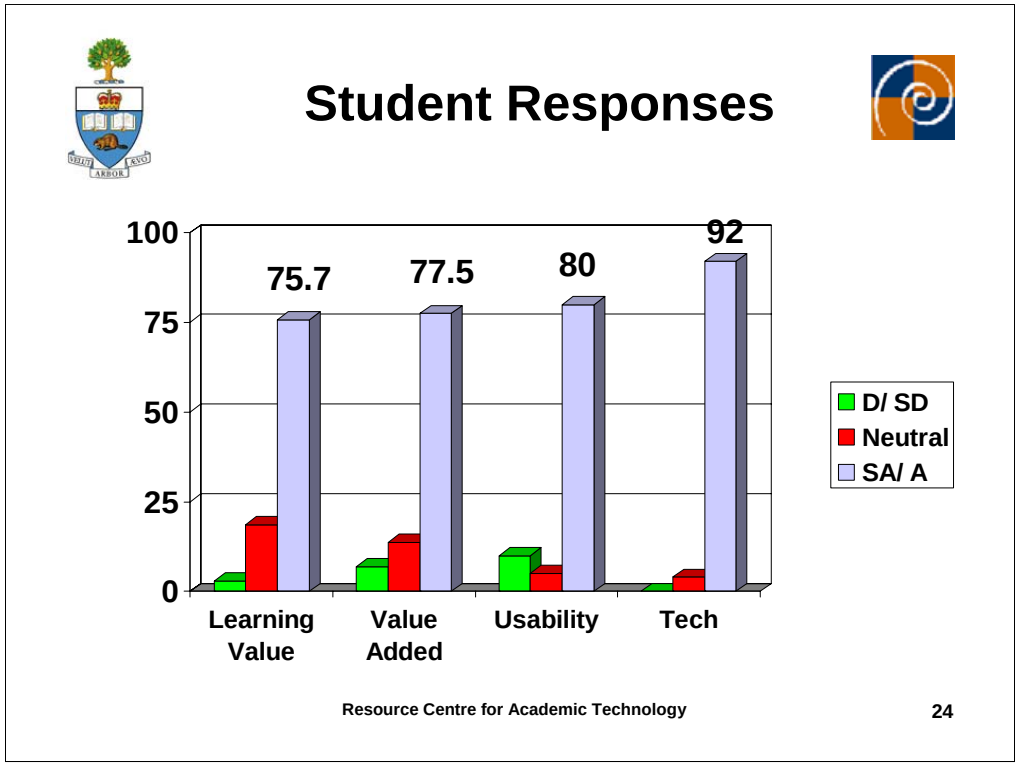
Goto http://icarus.med.utoronto.ca/LO/eval/subscales.htm for survey questions

Surveys developed by Dawn Leeder (2003) of the Universities' Collaboration in eLearning retrieved from http://www.ucel.ac.uk/resources/dev_pack.html

Student questionnaire items were combined into four sub-scales Learning Value; Value Added by the Learning Object; Usability of Learning Object; Usability of Technology (adapted from Rose, 2003).

This allowed the presentation of student perceptions related to these aspects of the learning object.

A section for open-ended comments was included in the survey so that students could qualify any of their ratings with a statement.



Sample Questions

Learning Value

The images and animations were valuable components of the LO

The LO was interesting and engaging

The activity was appropriate and aided my understanding

Value Added by Learning Object

The LO encouraged me to reflect on the material

I am confident that I will be able to use the knowledge gained from this LO in future practice

Usability

The LO was easy to navigate. I felt in control

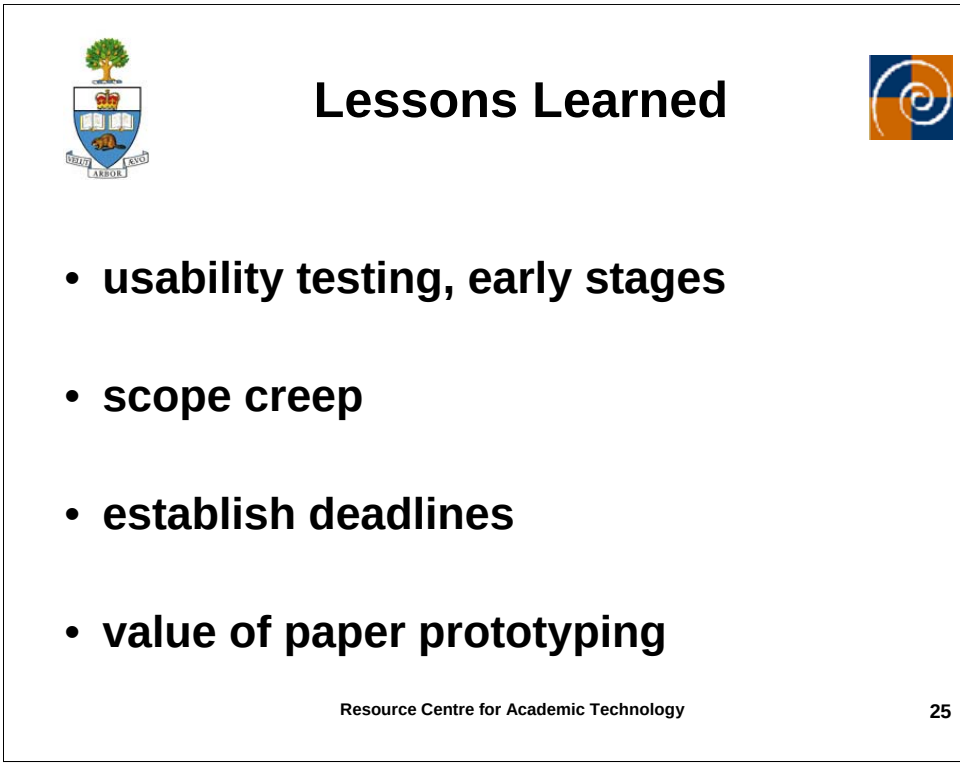
The LO was well structured and easy to follow

Technology

I use the web regularly to support my studies

I like the idea that I can access this LO whenever I need to

The results of the 'learning impact lite' studies provided important evaluation data related to the students' use of the learning object. These results show that 75.7% and 77.5% of the possible responses within the Learning Value subscale and the Value Added subscales, respectively, were in the Agree and Strongly Agree categories (blue bar). The responses for Usability of the Learning Objects and Usability of the Technology were in the Agree and Strongly Agree categories 80.0% and 92.0% of the time, respectively.



The more work invested in the design stage the more time/ money saved in development stage

Clearly articulated design leads to effective learning

Learning Design Websites

IDEAS: Instructional Design for Elearning ApproacheS
http://ideas.blogs.com

Instructional Strategies
http://ideas.blogs.com/lo/instructional_design/index.html

Peer Review Evaluation
http://ideas.blogs.com/lo/2004/01/evaluation_resu.html

Pharmacology Learning Object
http://icarus.med.utoronto.ca/lo

RCAT Links

McGraw-Hill Ryerson Teaching Technology Integration Fund

Instructional Technology Courseware Development Fund

Teaching Online Group **(TOG)**

Funds may be used for:

* hiring technical staff (faculty release time is not eligible)
* specialized training or consulting required to complete the project
* hardware/software/texts or other materials specifically required to complete the project

TOG is an opportunity for faculty to informally share ideas and techniques they have used in their online courses as well as a place to learn new strategies for web-based instruction.

References

Ally, M. (2004). Foundations of Educational Theory for Online Learning. In Elloumi, F. & Anderson. T. (Eds). Online Learning Handbook. Athabasca University.

Abdelhamid, T. (1999). The multidimensional learning model: A novel cognitive psychology-based model for computer assisted instruction in order to improve learning in medical students. Med Educ Online, 1(1), 1-8.

Abdelhamid, T. (1997). An application of cognitive psychology in medical education using a specific educational program. Tarek's integrated system for learning and memory (TISLM): An evaluation of its effectiveness in improving learning and memory. Master of Literature-education University of Auckland.

References

Clark, D. (1995). Introduction to Instructional System Design. Available: http://www.nwlink.com/~donclark/hrd/sat1.html.

Nyhof-Young, J., Walsh, L., Stewart, P. (2002, June). Let's ask the users! Development and implementation of an evaluation strategy for multimedia teaching software. Paper presented at the International Slice of Life conference, University of Toronto, ON.

Rose (2003). CLOE Learning Impact Studies Lite: Evaluating Learning Objects In Nine Ontario University Courses. Report presented to the Office of Learning Technologies Human Resources Development Canada. http://lt3.uwaterloo.ca/CLOE/MERLOTConferencePaper10.doc

Weinstein, C. E. (1978). Elaboration skills as a learning strategy. In H. F. O'Neil (Ed.), Learning Strategies (pp. 31-55). New York: Academic Press.

Think pair share discussion.

Identify instructional challenges – how might technology address the challenge

Barriers/ challenges in designing online instruction

Lessons learned in designing online instruction