Report on
Usability Evaluation of Web-based Learning Sites

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Abstract
Web-based learning provides the flexibility for knowledge acquisition without the limit of place, time and the availability of teacher. It is less resource demanding as compared with traditional method and learners have the full control on the pace of studying in order to suit their personal needs. However, self-learning has been criticized by its high dropping out rate due to the lacking of an encouraging environment and a number of other reasons, including the technical problem in using the learning kit. As such, it is hope that some usability criteria in form of a checklist can be worked out to assist the teacher-in-charge to fix the usability problems during the design stage or before the implementation of the web-based system. However, if the decision is to buy commercially available products, then the checklist can act as a guideline for making comparison amongst different kits and help to uncover any hidden usability problems before the final procurement decision is made.
# TABLE OF CONTENT

**ABSTRACT** ........................................................................................................................................................................................................................................... 1

**TABLE OF CONTENT** ................................................................................................................................................................................................................................. 2

1. **INTRODUCTION** ........................................................................................................................................................................................................ 4

2. **THE NEED FOR A USABILITY CHECKLIST** ................................................................................................................................................................................................. 4
   2.1 **FORMATIVE EVALUATION** .......................................................................................................................................................................................... 5
   2.2 **PROCUREMENT DECISION** ..................................................................................................................................................................................... 5

3. **THE INTERFACE USABILITY** .......................................................................................................................................................................................................... 6
   3.1 **CRITERIA EVOLVED FROM HEURISTICS (NIELSEN 1994)** .................................................................................................................................................................................................................. 6
      3.1.1 Visibility of System Status............................................................................................................................................................................................................. 6
      3.1.2 Match between system and the real world..................................................................................................................................................................................... 6
      3.1.3 User control and freedom......................................................................................................................................................................................................... 7
      3.1.4 Consistency and standards........................................................................................................................................................................................................ 7
      3.1.5 Error prevention, diagnosis, and recovery................................................................................................................................................................. 8
      3.1.6 Recognition rather than recall.................................................................................................................................................................................................... 9
      3.1.7 Flexibility and efficiency of use.................................................................................................................................................................................................. 9
      3.1.8 Aesthetic and minimalist design.................................................................................................................................................................................... 10
      3.1.9 Help and documentation.................................................................................................................................................................................................. 10
   3.2 **ADDITIONAL CRITERIA** ..................................................................................................................................................................................................... 10
      3.2.1 Readability of learning material........................................................................................................................................................................................... 10
      3.2.2 Effectiveness of multimedia as a dual-coding delivering tools........................................................................................................................................... 11

4. **OTHER USABILITY METRICS QUANTIFYING THE EFFECTIVENESS OF LEARNING MATERIALS** .................................................................................................................................................................................................. 12
   4.1 **THE INDEX PAGE** .................................................................................................................................................................................................. 12
   4.2 **THE CONTENT PAGE** .................................................................................................................................................................................................. 13
   4.3 **ASSESSMENT PAGE** ....................................................................................................................................................................................................... 13

5. **PEDAGOGICAL ISSUES IN RELATION TO USABILITY DESIGN** .................................................................................................................................................................................................. 13
   5.1 **APPROPRIATENESS OF CONTENT** .................................................................................................................................................................................................. 13
   5.2 **SOCIAL-CONSTRUCTIVIST OBJECTIVES** ................................................................................................................................................................................................ 14
      5.2.1 Complexity......................................................................................................................................................................................................................... 14
      5.2.2 Collaboration.................................................................................................................................................................................................................. 14
      5.2.3 Adaptation...................................................................................................................................................................................................................... 15

6. **FINAL CHECKLISTS FOR USABILITY** ....................................................................................................................................................................................................... 16
# 7. ON-LINE LEARNING SITES FOR EVALUATION

## 7.1 BRIEF INTRODUCTION TO THE SITES

1. **National Education Training Group (NETg)**
2. **IBM Learning Services Digital Video Library**
3. **Hong Kong Education City Limited (HkedCity)**
4. **Hong Kong Institute of Education (HKIED)**
5. **Sun Web Learning Center**

## 7.2 RESULTS AND DISCUSSION

## 8. CONCLUSION AND RECOMMENDATION

1. **Collaboration with Commercial Company or Educational Institute**
2. **Correlate Usability Metric with User Satisfaction**

# REFERENCE
1. **Introduction**

With the popular usage of Internet as an everyday tool for information retrieval, leisure, transaction and communication, the development of learning kits running on the WWW platform is becoming more common to be adopted as a mainstream or supplementary teaching media by educational institutes at all levels. Web-based learning provides the inherent advantage of its capability to be delivered at any time, anywhere and solely at the learner own control. With the promotion on life-long learning by the Government and the issues about cost-effectiveness, web-based learning would be an alternative to traditional classroom teaching. The new mode of study helps to alleviate the resources demands and provides more flexibility to people with special personal needs. The latest communication technology also facilitates the delivery of material through interactive exercise and multimedia demonstration aiming at bringing the learners back to the virtual classroom.

However, the dark side of web-based learning has been criticized by its high dropping out rate. Self-learning is flexible but learner has to face with the difficulties of being lonely, lacking of motivation and any other matters including the technical problems arises from the studying tools. Web-based learning is promising and Educator is trying ensure that they are easy to use so that student can focus more on the learning content rather than the manipulation of the module interface. In fact, for a usable on-line learning site, the interface should look transparent. User can take up the control subconsciously with very short learning curve and be able to maneuver across different areas of the course module effectively.

2. **The need for a Usability Checklist**

Empirical evaluation is believed to be most accurate way of identifying usability problems. Representatives from the target audience are invited to test for the interface effectiveness and efficiency. This method, however, is not always used because of its nature of very resources demanding as sufficient number of users are required, their response during the trial have to be recorded. Questionnaire and a list of tasks have to be carefully designed and much effort is required for compilation and analysis after the test.
Predictive evaluation is considered to be more effective as the result is nearly immediate available and required much less human resources. This is done by checking the different aspects of usability issues against a list of heuristics as worked out by some usability experts. This heuristics provide the guidelines to work out the detailed usability criteria, which is specific to web-based learning. It is hope that this criteria which is in form of a checklist, could help to achieve the following objectives:

2.1 **Formative Evaluation**

It is becoming more common for educational institute to build up their own on-learning site through the assistance of in-house personnel or out-source. Owing to the limited budget, it is not always possible to hire another usability team to design and comment on the interface during the development process. The teacher-in-charge would likely be the personal to take up this job and so a readily available checklist can help them to identify most of the usability problem without much pain when the development team is there.

2.2 **Procurement Decision**

On-line learning modules are becoming more available commercially. Apart from the content and updating issues, the problem of usability would also affect the buying decision. The provision of this checklist helps to uncover the usability problem and make the comparison between different products easier.
3. The Interface Usability

3.1 Criteria evolved from Heuristics (Nielsen 1994)

The heuristics is adopted as the starting point to discuss the interface usability issue. The original wording is repeated followed by some elaboration focused on web-based learning environment:

3.1.1 Visibility of System Status:

“The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.”

For on-line learning, user has the freedom to surf around anywhere and an effective navigation system is of utmost importance. In order to make our learners to be at ease all the time, this navigation aid should be readily available on every page (Krug 2000) and presented in form of a recognizable metaphor such as navigation bar, tab, breadcrumbs or a hierarchical list of content. For the learner to know how far he has progressed or how much he will finish the current module, a persistent indication on his current location is required.

This heuristics emphasizes the need to inform users of the system status and progress. It is found that problem start to turn up before the actual learning process when users trying to download the materials from the server. There is always insufficient warning on the client side on the system requirements, such as the requisite external viewers, effect of cookie, version of browsers and size of bandwidth. In some cases, users are not sure whether request for online material has been successfully made, as there is no indication on whether the downloading process has been started.

3.1.2 Match between system and the real world

The system should speak the users’ language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.”
Learning materials should be delivered in user familiar language. They can easily digest and assimilate the idea without spending extra effort to guess the meanings of the original writer. The effect of different presentation style is unlikely to have much impact on usability provided that the style is consistent throughout the course of study.

3.1.3 User control and freedom

“Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.”

During the course of study, user may require to go backward to recapitulate what has learnt already or to clarify some issues before proceeding further. The action of moving to and fro is equivalent to the process of looking for something in the previous pages of a physical book. Taking this into account, the navigational tool should allow the learner to directly jump to a certain areas or the other topics within the module.

Personalization of learning environment helps to provide the sense of ownership to user and motivate them to come back for the course. This includes the changing of color scheme to suit for personal need, the provision of a customized virtual desktop, audio control, automatic page forwarding, VIP registration, ...etc

For the interactive elements inside the learning module, users should be provided with the freedom to change the input user value or a re set function to start the process again. This is inline with what Nielsen mentioned Undo and Redo functions.

3.1.4 Consistency and standards

“Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.”
Learner would easily get frustrated if information is not delivered in consistent manner. During the course of study, the terminology used should be consistent in order to reduce the learner cognitive loading to interpret the meanings of different words. The page style, such as color and font should be kept the same unless they are designed for other purpose, such as the identification of different zones. Other well-known standard in regards of the web convention, such as the effect of roll-over, changing color of visited link, normal location of the navigational bar should also be followed to order that the user's familiarization time can be reduced.

3.1.5 Error prevention, diagnosis, and recovery

“Even better than good error messages is a careful design which prevents a problem from occurring in the first place.”

“Help users recognize, from errors
Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.”

During the course of interactive experiment, users are required to enter some trial figures to see how the phenomenon behaves. Error arises from the misunderstanding of the software system or the incorrect user model developed by the users. The system should prevent this from happening by restricting the range of values entered into the system. Sliding bar serves the purpose and provides an excellent metaphor for the change of user value.

For the error message to be helpful, the wordings should be in plain English and be specific to the concerned problem. Help function should also be provided at every pop-up error dialog box.

Designer should ensure that all the hyperlinks point to internal resources or external web sites are functioning. Dead-link not only makes learner frustrated, the creditability of the learning site would also be affected.
3.1.6 Recognition rather than recall

"Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate."

To reduce the cognitive loading of learner by recognition rather than recall, designers have to pay attention to the theory of what are so-called “knowledge in the world” and “knowledge in the head”. An intuitive pictorial certainly helps learner to guess the function of the icon button while the use of unambiguous wordings for the text link would help them to identify the way to go. However, it is not always possible to ensure that the icon buttons are recognizable, a rollover label would help to reduce the users memory loading.

3.1.7 Flexibility and efficiency of use

"Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions."

The study progress is entirely under the control of learner. When the other module is not yet completed and learner shall come back later, the system should allow a book marking of the latest learning page or simply a progress saved through the use of cookie. Some shortcut to facilitate repeat return would certainly welcome by user. Besides, for the delivery process to be flexible, server should have different version on the data format or media resolution to suit for different clients whose are running in different OS platform, different browser, varying external viewer, and different size of bandwidth.

After repeated visit, novices may familiar with the functioning and the system should allow for some direct command, which help them to complete some frequent process faster. The provision of keystroke commands, for instance, would increase the efficiency of advanced users.
3.1.8 Aesthetic and minimalist design

"Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility."

The design of the user interface should be neat and simple as far as possible. Learner should feel the interface transparent so that they can be more attentive to the delivery material rather than the manipulation of the user interface. Unlike other web-users, online learner is likely to read with more details and so a more comfortable color scheme and proper contrast would help to reduce their eye strain after prolong on-screen reading. Other unnecessary information, gratuitous animation and blinking effect should also be discarded.

3.1.9 Help and documentation

"Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large."

Although most of the learner would not refer to the documentation during the start of the online learning, the provision of this information is still necessary. Later on when user encountered problem in the installation process or the usage of the supplied tools, this document would be invaluable. A search function for the help topics or a list of FAQ would also be useful.

3.2 Additional Criteria

3.2.1 Readability of learning material

Unlike normal web sites where people don’t have the patience to read the content line by line (Krug 2000), people pursuing at the web-based learning sites is more likely to read everything in order not
to miss up any important thing during the learning trail. Reading from the display monitor is more fatigue than reading a book. Many tools are available to calculate the readability of document (Spool 1999). Amongst them, the Flesch Reading Ease (FRE) and the Flesch-Kincaid Grade Level (FGL) are employed to evaluate different learning sites in this project. They are chosen because of their availability in the common word processing software such as the Microsoft Word. The descriptions for these two scales as abstracted from Spool (1999) as follows:

“Flesch Reading Ease (FRE) is the average number of syllables per word and the words per sentence. Scores range from 0 to 100. The higher the score, the easier it is to understand the document.”

“Flesch-Kincaid Grade Level (FGL) is the average number of syllables per word and the words per sentence. The score indicates a grade level required reading the text. For example, a score of 7.0 means that a seventh-grader would understand the document.”

Moreover, for the content to be readable the font size of the text should preferably be adjustable and the text box containing them should be movable and re-sizable. This helps to reduce necessary vertical scrolling and overlapping with other necessary information on the screen. However, for horizontal scrolling, it is certainly annoying and unacceptable. Designer should avoid this all the time.

3.2.2 Effectiveness of multimedia as a dual-coding delivering tools

Multimedia in form of image, sound, video and animation provide an effective tool to deliver idea and concept in a more imaginable and realistic way. The enhanced representation helps to bring learner to the real world and reduce the thinking gap between the designer and user knowledge model. Besides, the dual channel delivery accounts for the effectiveness of multimedia for instructional media. This has been proved by the dual-coding theory (Paivio 1986) and the Model of Working Memory (Baddeley 1999) in Cognitive Science. However, for the delivery process to be effective, the following principles have to be paid attention during the design process. It is
reported that student shall perform better in the aspect of knowledge retention if the delivery of multimedia follow these rules. These principles (Mayer 2001) shall be adopted as additional criteria:

"a) Spatial Contiguity Principle: Corresponding Words and Pictures are presented near rather than far from each other on the page or screen.
b) Temporal Contiguity Principle: Corresponding Words and Pictures are presented simultaneously rather than successively.
c) The coherence principle 1: Learning is hurt when interesting but irrelevant words and pictures are added
d) The coherence principle 2: Learning is hurt when interesting but irrelevant sound and music are added.
e) The coherence principle 3: Learning is improved when unneeded words are eliminated.
f) Modality Principle: Learning is improved from animation and narration than from animation and on-screen text. (i.e. Spoken text is better than printed text)
g) Redundancy Principle: Learning is improved from animation and narration than animation, narration, and text. (As visual channel become overloaded)"

4. Other Usability Metrics quantifying the effectiveness of Learning Materials

A review on the some well-developed on-line learning sites reveals that their main structure comprises of an Index Page, Content Page and the Assessment Page.

4.1 The Index Page

The index page provides an overview on the site architecture and content of material to be delivered. The index may be a linear list or a hierarchy of topic items. The effective design on the index page helps learner to keep track his progress and his approximate location inside the module. Study on Cognitive Science shows that human being is more likely to retain information in form of chunks, probably 5 to 7 pieces of data. This suggests that if there are not more than 7
branches of sub-item within every level at the index page, learner is more likely to keep the picture on what the current module contains. This helps them to reflect their current location with respect to the structure of the site.

4.2 The Content Page
The primary concern about the content page is the quality itself. Other factors, including its quantity, updating and suitability to the target audience, are valid points to be considered. The length of the content page should not be too long. The number of page within one content module should be limit to 10, otherwise users may easy get frustrated and discouraged as they think it still to have a long way ahead before the check point. Internal hyperlinks can help to shorten the content and provide the choice for different learners to explore the topic further. In order that learner will not easily get lost, the content page should limit the internal hyperlink to less than two deeper levels.

4.3 Assessment Page
To give recognition and motivation, an assessment test should be provided at the appropriate checkpoint. Balance should be made as to how frequent the test to be conducted. The end of the course, is a checkpoint and a long content page, which require more than 30 minutes to complete, also need a checkpoint in between. The test itself should not be too long and require not more than 10 percentage of previous learning time to complete.

5. Pedagogical Issues in relation to Usability Design
5.1 Appropriateness of Content
The primary focus on the usability of on-learning material is whether the content of the module fit the curriculum in term of scope and level of difficulties. Whether the material is up-to-date and free from the writer's personal bias are important points to be considered. During the start of the learning process, the objective of every module should be clearly stated. Sufficient and appropriate amount of learner activities helps to achieve the goal of learning by doing and provide the necessary tools for self-evaluation.
5.2 Social-Constructivist Objectives

The evaluation of usability by a checklist is considered not exhaustive (Squires, D., Preece, J. 1999) because the heuristics fail to consider the learning issue from the social-constructivist point of view. The latest web-based learning kit is developing in a more innovative way to support learner-centered and collaborative learning. In general, people studying through the mode of interactive learning can be categorized into behaviourist and the cognitive (Atkins 1993). The former would go along the study path in a more or less linear way and accept the knowledge passively. They are content-centric.

On the other side, the cognitive tend to study in social-constructivist approach (Solway et al. 1996). They emphasized the benefit of knowledge acquisition through collaboration with other people having some common interest and practice.

Constructivists are active, constructive and learner-centered. They are capable to reflect past experience before incorporating new idea and knowledge to construct concept and idea which is meaningful and applicable to real life situation.

Characteristics of Social-constructivism

5.2.1 Complexity (Squires, D., Preece, J. 1999)

Learner builds up the knowledge representation model by himself. The learning path and depth versus breadth aspect is totally within own control. The linear and prescribed way of material delivery is considered appropriate for behaviorist but not for constructivist. Constructivist always tries to investigate problem from different perspectives and look for multi-representations or multi-solutions for a given problem.

5.2.2 Collaboration

Knowledge construction is achieved by exploration of different perspective through discussion with other learners. This would involve the process of disagreement, acceptance, reflection, evaluation and finally integration. The interactive nature of the web could provide a suitable environment for this kind of view exchange. Email and discussion forum provides an asynchronous means of communication
between learners who may not be available at the same time. Online chat provides synchronous means of idea exchange, which would be more challenging to require an immediate feedback.

5.2.3 Adaptation (Brailsford 2002)

At different stage, learner may require different scope of material for his cognitive process. To cater for different abilities and academic levels achieved, the delivering system should be able to vary the type and amount of material in accordance with the profile of the learner. Some new user model such as the WHURLE is capable to examine the current user profile and vary the learning material to be delivered for the purpose of adaptive learning.
6. Final Checklists for Usability

Based on the previous argument, an initial list of usability criteria for different aspects is worked out and applied to the on-line learning site. During the course of testing, it is found that the initial list may not be detail enough to describe the revealed problem and more guideline would be added on cumulatively until all the selected sites have been gone through.

i). Navigation

- Navigational aid is provided throughout the whole course of learning
- Metaphor of navigational aid is recognizable
- The location of navigational aid follows prevailing web convention
- Every page is given a title
- A course map or learning trail is provided
- Direct access to user-specified area within the learning module
- Index to topics is provided
- Search function for topics is provided

ii) Downloading of Learning Material

- User informed of the system requirements, installation time and bandwidth requirement for the installation process
- The server side provides automatic check on the status of the client's side browser.
- Direct link to acquire the necessary external applications is provided
- Clear status indicator for the process of material delivery and installation process at the learner's side.

iii). User control

- The freedom to go backward or forward within a training module
- The freedom to do directly to a certain topics or areas within the module.
- Delivered in user-spoken language
- User allow to change or to reset the input value during an
interactive training

- Appropriate and controllable widgets for the interactive experience
- Utilities provided for personalization of the online environment, such as changing color scheme, changing font sizes, automatic page forwarding,...etc.

iv) Consistent way of presenting information

- Delivered in user-spoken language
- Consistent languages, terminology
- Layout, font and style for every page is consistent
- Follow the usual convention of the web, such as changing color for visited link, location of navigation bar

v) Error Prevention

- Effective bound for user input value
- Presence of dead-link
- Error message expressed in comprehensible and simple term
- Help function provided during every pop-up error dialog box, preferably to be specific to the problem
- Searchable index for help manual
- Provision of guide tour, online tutorial
- Provision of FAQ or full documentation for the functions and running of the learning module

vi) Recognition rather than recall

- Semantic meaning of text link is unambiguous
- The use of metaphor for the graphic icon is predictable by user.
- Label is provided for every graphical icons.

vii) Flexibility and Efficiency of Use

- User can saved up the latest learning progress
- Support different browser and different viewers
- Option for different bandwidth for the downloading of multimedia material.
- Provision of short-cut for advanced users
viii) Aesthetic and minimalist design
- Neat and simple design
- Color and graphic are used aesthetically, comfortably and match the learning topics
- Proper contrast between text (or graph) and background
- Free from distraction and unnecessary information

ix) Readability of text
- Suitable font size
- Movable and Re-sizeable text box
- Excessive vertical scrolling
- Presence of horizontal scrolling
- Flesch Reading Ease (FRE) Scoring
- Flesch-Kincaid Grade Level (FGL) Rating

tax) Use of multimedia
- User control on the delivery of audio and video clips (Pause, forward and backward, replay, audio on/off)
- Spatial Contiguity Principle
- Temporal Contiguity Principle
- The coherence principle 1
- The coherence principle 2
- The coherence principle 3
- Modality Principle
- Redundancy Principle

xi) Usability metrics for the delivery process
- Number of subsidiary links from one node at the Index Page
- Average number of topics/modules in one course
- Average number of pages for one topic/module
- Time taken to complete one topic/module
- Average number of evaluation question for one topic/module

xii) Pedagogical Aspect
- Content is appropriate in terms of scope and level of difficulties
- Content is free from personal bias
- The objective of every module is clearly stated
- Appropriate and sufficient amount of learner activities and self-evaluation tools
- Support non-linear or holistic delivery of online material
- Support collaboration through asynchronous and synchronous communication with tutor and fellow learners.
- The system support multiple representation or solutions
- The system support variation in the delivered content through adaptation to the user profile.
7. On-line Learning Sites for Evaluation
7.1 Brief Introduction to the sites
7.1.1 National Education Training Group (NETg)

Course: Operating System Fundamental
(Provided through Cyber Learning Centre Plus, Civil Services Training and Development Institute, Hong Kong Government)
http://www.clcplus.cstdt.gov.hk

The training course is delivered in multimedia with narration, picture and text. It distinguishes from other learning site by having a familiar pull down menu. Persistent navigation tool and a course map are provided. Users are able to go directly to a certain topic using the search function.

![Navigation Window of A+ Certification Course for Operating System Fundamental (NETg)](image)

**Figure 1.** Navigation Window of A+ Certification Course for Operating System Fundamental (NETg)
Figure 2. Playable Narration together with the Text Box (NETg)
7.1.2 IBM Learning Services Digital Video Library

Course: Introduction to Shell Variables for Unix


IBM makes use of streaming video technology to deliver tutorial as if you were attending class. The narration is combined with the presentation of slide. Learners have full control on the pace of delivery, to rewind the video or to go back to previous slide by using the persistent navigation bar on the bottom. As the delivery process would be a little bit technology demanding, the server would provide a client check-up to see if the learner’s browser is capable of receiving this multimedia material.
Figure 4. Remote Check on the Client Browser for the necessary software (IBM Learning Services)
7.1.3 **Hong Kong Education City Limited (HkedCity)**

Course: Application of IT in Teaching

[http://www.hkedcity.net/learning/](http://www.hkedcity.net/learning/)

![Figure 5. Navigation Window (HkedCity)](image)

The learning material is arranged in modular approach where student can completed the course sequentially.

![Figure 6. New Window for Individual Module. (HkedCity)](image)

### Overview of this course

This course is designed by Yeung King Sing. The aim of this course is to want to have a Paradigm shift in both teaching and evaluation.

This is an interactive Maths lessons about **Probability** including some comprehensive learning modules that includes examples, diagrams, summaries and exercises. The target users are Form 3 students. The syllabus cover are only cover
7.1.4 Hong Kong Institute of Education (HKIED)

Course: Mathematical Theory

http://www.ied.edu.hk/has/maths/i-maths.htm

Figure 7. The Home page for the On-line learning Module "Mathematics Theory (HKIED)"
7.1.5 Sun Web Learning Center

Course: Using the Sun ONE Studio 4

https://tmn.sun.com/WLC/StudentCurriculum?cmd=list

Figure 8. Home Page of Topic for for Sun ONE Studio 4 (Sun Microsystems)
7.2 Results and Discussion

7.2.1 Results from the checklist indicate no obvious usability problem on the user interface although the “Mathematical Theory” Site of HKIED needs some improvements in the navigation. There is no exit or home button on the content pages and user has to make use of the back button to go to the main page.

7.2.2 Result of usability metrics for all the web sites indicates that the average number of topics/module within one course is 6.3. The number of pages within one module has a large variation, ranging from maximum 77 to minimum 2. The average is 24.2. Besides, it is interesting to learn that the time spent for one content page is around 1 minutes.

7.2.3 The average number of questions in the evaluation test after the completion of one module is 2.2

7.2.4 It seems to have some correlation between the Flesch Reading Ease (FRE) Scoring and Flesch-Kincaid Grade Level (FGL) Rating. The lower the Reading Ease Scoring, the higher is the required Grade Level of the student to read the content.

7.2.5 Even though the Virtual Classroom developed by the IBM Learning Services is innovative, there is some time lag between the narration from the video and the highlighting on presentation slide. This fails to meet the temporal contiguity principle on the use of multimedia.

7.2.6 It appears that the error message and help function for the sites under evaluation are not well developed. This may be due to the lacking of interactive activities provided to learners.
7.2.7 Summary on Results of Usability Evaluation on Web-based Learning Sites

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>NETg</th>
<th>HkedCity</th>
<th>HKIED</th>
<th>IBM</th>
<th>Sun</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(i) Navigation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Persistent navigation aid</td>
<td>✔</td>
<td>✔</td>
<td>X</td>
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<td>- Metaphor recognizable</td>
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<td>X</td>
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</tr>
<tr>
<td>- Location of navigation aid follows web convention</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>- Every page is given a title</td>
<td>X</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>- Course map/trail</td>
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<tr>
<td>- Direct access to user-specified area</td>
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<td>X</td>
<td>X</td>
<td>✔</td>
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<tr>
<td>- Index to topics</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>- Search function for topics</td>
<td>✔</td>
<td>X</td>
<td>X</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>(ii) Downloading/Installation of Learning Material</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- User informed of the system requirements, timing and bandwidth</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>✔</td>
</tr>
<tr>
<td>- Remote check-up on the status of the client’s side browser</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>✔</td>
<td>X</td>
</tr>
<tr>
<td>- Direct link to external software applications</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>- Clear progress indicator</td>
<td>X</td>
<td>X</td>
<td>✔</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>(iii) User control</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Freedom to go backward or forward</td>
<td>✔</td>
<td>✔</td>
<td>X</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>- Freedom to go directly to a certain areas/topics</td>
<td>✔</td>
<td>✔</td>
<td>X</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>- Change or reset of input value</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>N.A.</td>
</tr>
<tr>
<td>- Appropriate control widgets for the interactive experience</td>
<td>✔</td>
<td>X</td>
<td>X</td>
<td>✔</td>
<td>N.A.</td>
</tr>
<tr>
<td>- Personalization such as color scheme, font sizes, automatic page forwarding...etc.</td>
<td>✔</td>
<td>✔</td>
<td>X</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>(iv) Consistent way of presenting information</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Delivered in user-spoken language</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>- Consistent languages, terminology</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>- Consistent Layout and style</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td><strong>(v) Error Prevention</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Effective bounds for user input values</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>- Absence of dead link</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>N.A.</td>
<td>✔</td>
</tr>
<tr>
<td>- Error message in comprehensible and simple terms</td>
<td>N.A.</td>
<td>N.A</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>vi) Recognition Rather than Recall</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>- Semantic meaning of text link is unambiguous</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- The use of recognizable metaphor for the graphic icon</td>
<td>✓</td>
<td>✓</td>
<td>N.A.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Label provided for graphical icons.</td>
<td>X</td>
<td>X</td>
<td>N.A.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>vii) Flexibility and Efficiency of Use</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Saved function for learning progress</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Support different browsers/viewers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Option for different bandwidth for the downloading</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>- Short-cut for advanced users</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>viii) Aesthetic and minimalist design</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Neat and simple design</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Aesthetic colour and graphic, match the learning topics</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Proper contrast between text (or graph) and background</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Free from distraction and unnecessary information</td>
<td>X</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ix) Readability of text</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Suitable font size</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Movable/Re-sizable text box</td>
<td>✓</td>
<td>✓</td>
<td>N.A.</td>
<td>✓</td>
<td>N.A.</td>
</tr>
<tr>
<td>- Avoid excessive vertical scrolling</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Absence of horizontal scrolling</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Flesch Reading Ease (FRE) Scoring (0–100, the higher the score, the more easier to read)</td>
<td>27.5</td>
<td>69.9</td>
<td>N.A.</td>
<td>N.A.</td>
<td>57.4</td>
</tr>
<tr>
<td>- Flesch-Kincaid Grade Level (FGL) Rating (To be read by student at the grade of)</td>
<td>12</td>
<td>7.9</td>
<td>N.A.</td>
<td>N.A.</td>
<td>8.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>x) Use of multimedia</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Full control on the playing process</td>
<td>✓</td>
<td>N.A.</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Spatial Contiguity Principle (Word close to Picture)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- Temporal Contiguity Principle (Narration/Word and Picture presented simultaneously)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>N.A.</td>
</tr>
<tr>
<td>- The coherence principle 1 (Avoid interesting but irrelevant word/picture)</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>- The coherence principle 2 (Avoid interesting but irrelevant audio/video clips)</td>
<td>✓</td>
<td>✓</td>
<td>N.A.</td>
<td>✓</td>
<td>N.A.</td>
</tr>
</tbody>
</table>
- The coherence principle (Eliminate unnecessary words) | ✓ | ✓ | X | ✓ | ✓
- Modality Principle (Use animation + narrative instead of animation + text) | ✓ | N.A. | N.A. | ✓ | ✓
- Redundancy Principle (Avoid visual overloading, i.e. narration, animation and text simultaneously) | X | N.A. | N.A. | X | ✓

**xi) Usability Metrics for the delivery process**
- Number of subsidiary links from one node at the Index page | 4 | 5 | 8 | 5 | 6
- Average number of topic/modules in one course | 8 | 8 | 5 | 6 | 4
- Average number of pages for one topic/module | 77 | 15 | 5 | 2 | 22
- Average time to complete a one topic/module in minutes | 90 | 15 | 4 | 5 | 25
- Average number of evaluation questions for one topic/module | 5 | 1 | 0 | 0.8 | 4

**xii) Pedagogical Aspect**
- Content is appropriate in terms of scope and level of difficulties
  - Not Test
  - Not Test
  - Not Test
  - Not Test
  - Not Test
- Content is free from personal bias
  - Not Test
  - Not Test
  - Not Test
  - Not Test
  - Not Test
- The objective of every module is clearly stated
  - ✓ | ✓ | X | ✓ | ✓ | ✓
- Appropriate and sufficient amount of learner activities and self-evaluation tools
  - ✓ | X | ✓ | X | ✓ | ✓
- Support non-linear or holistic delivery
  - X | X | X | X | X
- Support collaboration with tutor and fellow learners.
  - ✓ | ✓ | X | X | ✓
- Support multi-representation or solutions
  - X | X | X | X | X
- Support adaptation to the different user profile.
8. Conclusion and Recommendation
After the literature review and a trial test on some web-based learning sites, a detailed checklists covering the aspects of User Interface, Usability Metrics and Pedagogical issues have been worked out. The results of the checklist have uncovered some usability problems and designers of the on-line learning sites may consider incorporating the findings to further enhance their web sites for maximum usability and learnability. However, the criteria were only tested against a few numbers of web sites, which cannot proved to be conclusive.

On the other hand, this project has uncovered some interesting aspects, which are worthwhile for further study and so the recommendations are:

8.1 Collaboration with Commercial Company or Educational Institute
The web sites under testing are either free web sites or demonstration web sites created by commercial company. They are unlikely to be well-developed learning sites to be adopted for formal and academic purposes. Negotiation should therefore be made with other education institution to continue this study in a collaborative basis. Most of the existing cyber-learning sites are restricted to outsiders and permission should be sought for a trial walk-through to see if there should be some fine-tuning on the criteria checklist. The teacher in-charge, as a layman, should also try to make use of the checklist to see if they really understand the wording and intention of the criteria.

8.2 Correlate Usability Metric with User Satisfaction
Metrics data provides some standards and objective measures for usability. Throughout the course of this study, some interesting data are worked out. They are incomplete in describing the unique environment of web-based learning and further study to dig out more relevant metric data is required. It is suggested to visit more learning sites and to conduct testing to verify the assumption made on the metric data and their relationship with the subjective user satisfaction level.
Reference

Atkins, M.J.(1993) Theories of Learning and Multimedia Applications: An Overview, Research Papers In Education 8(2) 251-271


