Usability evaluation of web-based learning:

An essential ingredient for success

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Abstract: The use of the world wide web in the future is predicted to have more impact on learning than all the previous developments in instructional technology. The web offers many opportunities for e-learning and may be used both as a platform and as a delivery medium. Usability is a critical factor for the success of web-based learning material, which is often overlooked. This paper will give an overview of how standard usability evaluation methods can be used to evaluate and improve the usability of web-based learning.

Key words: web-based learning, usability, usability evaluation

1. INTRODUCTION

The growth of the internet and the world wide web since 1990 has been astonishing. It is said that the use of the web will probably have more impact on learning than all the developments in instructional technology of the past thirty years (Alessi and Trollip, 2001). The web offers many opportunities for teaching and learning and may be used as a platform, a delivery medium, a communication medium and as a methodology for learning. There are however, several critical factors for the success of web-based learning. These include technical issues such as speed, visual layout and navigation as well as educational issues such as accuracy of content, interactivity and active participation. What is often overlooked is the usability of the web-based learning material and how to determine this (Storey et al., 2000).

The original version of this chapter was revised: The copyright line was incorrect. This has been corrected. The Erratum to this chapter is available at DOI: [10.1007/978-0-387-35615-0_52](https://doi.org/10.1007/978-0-387-35615-0_52)

Developing usable web sites requires an in-depth knowledge of more than just the technologies involved. According to several web design experts, including Nielsen and Spool, "*Usability is often the most neglected aspect of web sites, yet in many respects it is the most important*" (Nielsen et al., 2001). To ensure usability requires a user-centred design approach together with an understanding of web design principles and guidelines (Lowe and Hall, 1999; Nielsen, 2000; Cato, 2001). The user-centred design approach is described in ISO 13407, which provides a framework for human-centred design and evaluation (ISO, 1999).

The model for design and development of instructional multimedia as proposed by Alessi and Trollip includes an iterative process of evaluation and design (Alessi and Trollip, 2001). The only evaluation technique discussed, however, is the use of an evaluation form. Within the field of human-computer interaction (HCI), several standard techniques exist for usability evaluation (Schneiderman, 1997; Dix et al., 1999, Faulkener, 2000). This paper will briefly review these and discuss how they can be used to evaluate the usability of web-based learning material.

2. WEB-BASED LEARNING

Web-based learning refers to interactive educational software that is offered through the medium of the internet. The web can be seen as both a delivery medium and an educational methodology (Alessi and Trollip, 2001). The vast majority of educational web sites are designed using the hypermedia methodology. Nevertheless, it is possible for a web site to include instructional multimedia such as tutorials, drills, simulations, games and any other methodology.

Within an educational web site, typical web design elements such as hyperlinks, tables and frame, can be used to structure course material, format display and provide learner control. Visual layout, navigation and interaction are key design issues, which can have a significant impact on whether the learner can achieve the desired learning objectives. These factors are also directly related to the usability of the web-based learning material.

3. USABILITY AND USER-CENTRED DESIGN

A detailed definition of usability is contained in the international standard ISO 9241, which defines usability as follows (ISO, 1997):

“Usability is the effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments; where Effectiveness is the accuracy and completeness with which specified users can achieve specified goals in particular environments; Efficiency is the resources expended in relation to the accuracy and completeness of goals achieved; and Satisfaction is the comfort and acceptability of the work system to its users and other people affected by its use”.

The usability of educational software can thus be defined as the extent to which the software can be used to achieve the specified learning outcomes effectively, efficiently and with user satisfaction within a specified learning context (Geisert and Futrell, 1995; Van Greunen and Wesson, 2002). According to a students’ assessment of web-based learning tools: *“If it [the tool] was functional and easy to use, I would be in favour of it”* (Storey et al., 2000).

A user-centred design approach is widely accepted as a necessary means to develop usable software evaluation (Schneiderman, 1997; Dix et al., 1999). User-centred design focuses on an understanding of the users’ goals and the tasks required to satisfy these goals. An essential element of user-centred design is an iterative cycle of design, evaluate and redesign (ISO, 1999). Usability evaluation is used to assist the design process and ensure user satisfaction prior to delivery. Within the context of interactive educational software, it is thus essential that feedback is elicited from ‘real’ users, that is, students (Storey et al., 2000).

4. USABILITY EVALUATION TECHNIQUES

Usability evaluation can be used both as a formative and as a summative evaluation tool (Faulkner, 2000). Formative evaluation can be done during design to detect potential usability problems. Summative evaluation can be done after implementation to determine actual usability problems. Different evaluation techniques are available to support these different types of evaluation. Analytical evaluation techniques are normally used during formative evaluation and empirical techniques during summative evaluation.

4.1 Analytical evaluation

Analytical evaluation techniques are typically used by design experts to determine usability problems during design (Faulkner, 2000). These techniques include heuristic evaluation, cognitive walk-through and keystroke-level analysis evaluation (Schneiderman, 1997; Dix et al., 1999).

Heuristic evaluation involves using a set of design heuristics or principles to evaluate the design and determine any possible usability problems. Several such lists of design heuristics exist, although the one most commonly used is the set of ten design principles as initially proposed by Nielsen (Dix et al., 1999). These are general design principles but have been adapted by several authors for use in different contexts, for example e-commerce (Nielsen, 2000). The outcome from a heuristic evaluation consists of a list of design problems, the severity of these problems and suggestions for design improvements.

Cognitive walk-through is an analytical technique that is used to assess the ease of learning and use of a system. A detailed task analysis is undertaken of the key tasks supported by the system. For each task, four questions are asked to predict the ease of use of the system. These questions are: *Is the goal clear at this stage? Is the appropriate action obvious? Is it clear that the appropriate action leads to the goal? What problems are there in performing the action?* (Faulkner, 2000).

A keystroke level analysis can be used to determine the efficiency of the user interaction and to compare different design solutions. Quantitative measures of time can be associated with each user action, for example, mouse clicks or text entry, and used to determine performance times for each task. These can be used to make choices about menu structure, mode of interaction and use of particular interaction objects.

4.2 Empirical evaluation

Empirical evaluation techniques are used to determine actual measures of efficiency, effectiveness and satisfaction (Faulkner, 2000). The available techniques include field tests, observations, interviews, questionnaires and formal usability testing. Empirical methods involve working with actual users and gathering data that has to be analysed. Empirical methods may involve substantially more time and money than analytical methods but can yield quantitative data on the actual usability of the system.

Formal usability testing involves the design of a controlled experiment that is normally conducted in a special-purpose usability laboratory (Rubin, 1994; Mayhew, 1999). Formal usability testing requires certain essential components: the experiment has to be carefully designed; research hypotheses identified; representative users selected; an appropriate task list produced; the evaluation conducted; data collected; and the results analysed. Use can also be made of pre- and post-test questionnaires to determine user profiles and user interaction satisfaction. Formal usability testing will produce actual measures of effectiveness in terms of task completion rates and efficiency in terms of task performance times.

5. USABILITY EVALUATION OF WEB-BASED LEARNING

A question is: to what extent can standard HCI methods of usability evaluation be used to evaluate the usability of web-based learning?

Analytical evaluation techniques can be introduced during the design phase of web-based learning to detect potential usability problems. A list of design principles for web-based learning could be used to conduct a heuristic evaluation of the web-based learning material. These design principles could be based on the general design principles as proposed by Nielsen (Dix et al., 1999), but would also need to include aspects specifically related to instructional multimedia (Alessi and Trollip, 2001). A recent study on evaluating the usability of web-based learning tools revealed that most of the tools evaluated did not adhere to general usability principles and that this had a negative impact on the students' attitude and performance (Storey et al., 2000).

A cognitive walk-through could be conducted to evaluate the ease of learning and use of the web-based learning material. The key goals need to be determined, for example, selecting a lesson or answering an on-line quiz, and an analysis done to see if learners can easily determine how the necessary tasks could be performed using the web-based user interface.

Empirical evaluation techniques could also be used to determine actual measures of learner satisfaction, efficiency and effectiveness (Storey et al., 2000). Questionnaires could be used to evaluate the user interaction satisfaction. Formal usability testing can be used to identify any usability problems that learners may have with specific aspects of the web-based learning material. Such tests, however, will require a careful analysis of potential usability problems (for example, using a heuristic evaluation) and the construction of a specific list of tasks for the learners to perform.

6. FUTURE RESEARCH

While considerable research on usability evaluation has been conducted in the HCI domain, very little research has been done on usability evaluation of interactive educational software (Storey et al., 2000; Van Greunen and Wesson, 2002). There is no doubt, however, that standard usability evaluation methods can be used to evaluate the usability of such software. More empirical research is needed to determine the relative importance of usability for web-based learning. Additional research is also needed to determine the most applicable evaluation methods. This includes research

into design principles for web-based learning as well as appropriate evaluation metrics. The different types of educational software may also require different approaches. More standard evaluation instruments, such as different questionnaires, need to be developed.

7. CONCLUSIONS

The next few years will be evidenced by a substantial growth in the development and use of web-based learning. The usability of the web-based material can, however, have a significant impact on the success of web-based learning. Traditional models for the design and development of interactive educational software do not explicitly include usability evaluation. Standard usability evaluation methods such as heuristic evaluation, cognitive walk-through and formal usability testing can be used to determine the usability of web-based learning material and suggest design improvements.

REFERENCES

- Alessi, S.M. and Trollip, S.R. (2001) *Multimedia for Learning: Methods and Development*. Boston, MA: Allyn and Bacon
- Cato, J. (2001) *User-Centered web Design*. Reading, MA: Addison-Wesley
- Dix, E., Abowd, F. and Beale, J. (1999) *Human-Computer Interaction*, Second Edition. Reading, MA: Addison-Wesley
- Faulkner, X. (2000) *Usability Engineering*. Basingstoke: Macmillan Press
- Geisert, P.G. and Futrell, M.K. (1995). *Teachers, Computers and Curriculum*. Boston, MA: Allyn and Bacon
- ISO (1997) ISO 9241-1: Ergonomic requirements for office work with visual display terminals.
- ISO (1999) ISO 13407: Human-centred design processes for interactive systems.
- Lowe, D. and Hall, W. (1999) *Hypermedia and the web: An Engineering Approach*. New York: John Wiley and Sons
- Mayhew, D.J. (1999) *The Usability Engineering Lifecycle*. San Francisco, CA; Morgan Kaufmann Publishers Inc.
- Nielsen, J. (2000) *Designing web Usability*. Indianapolis: New Riders Publishing
- Nielsen, J., Coyne, K.P. and Tahir, M. (2001) *PC Magazine*.
- Rubin, J. (1994) *Handbook for Usability Testing*. New York: John Wiley and Sons Inc.
- Shneiderman, B. (1997) *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. Reading, MA: Addison-Wesley
- Storey, M.-A., Phillips, B., Maczewski, M. and Wang, M. (2000) *Evaluating the usability of web-based learning tools*. Proceedings of Educational Technology, Educational Technology Conference Series, University of Victoria, Canada.

Van Greunen, D. and Wesson, J.L. (2002) Formal Usability Testing of Interactive Educational Software: A Case Study. In J. Hammond, T. Gross and J. Wesson (eds.). *Usability: Creating a Competitive Edge*. Proceedings of the World Computer Congress (WCC 2002)

BIOGRAPHY

Janet Wesson is professor in the Department of Computer Science and Information Systems at the University of Port Elizabeth, South Africa, and head of the UPE Centre of Excellence in Distributed Multimedia Applications. Janet completed her Ph.D. on design methodologies for usability at UPE in 1997. Her current research areas include HCI design patterns, information visualisation, mobile computing, usability evaluation and web design