A multidisciplinary tool for the evaluation of usability, pedagogical usability, accessibility and informational quality of web-based courses

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Abstract. Web-based learning environments have been extensively developed, adopted and in consequence a large amount of data has been collected from various web-based teaching experiments. Often platforms, web-based courses and web-based training services have been evaluated from rather narrow points of view. Further development of evaluation should to be based on a multidisciplinary framework right from piloting to the establishment of the web-based learning practices. A multidisciplinary evaluation framework is needed to define the factors critical in the implementation of training services for a given group of learners, as well as teachers and researchers of web-based courses. Researchers and teachers should pay attention to how the usability, accessibility and pedagogical appropriateness are taken into account in user interfaces and in the planning, designing and implementation of information content.

Because one evaluator (typically a teacher, designer or planner) can hardly be an expert in all the fields of science, a multidisciplinary evaluation framework has been created to help the evaluators to address the critical factors of quality of web-based learning. The purpose of this paper is to describe an evaluation tool based on the multidisciplinary evaluation framework of web-based learning. The evaluation tool was developed at the Hypermedia Laboratory of Tampere University of Technology (TUT) and the Virtual University of TUT in co-operation with the Finnish Virtual University. The framework and the tool systematically take into consideration the most important factors of usability, pedagogical usability, accessibility and informational qualities. The evaluation tool will help the evaluators to control the evaluation process, gather essential information and build course profiles. The evaluation framework and the prototype have been tested at TUT in the courses on Mathematical Modelling (a national network project coordinated by TUT). Later the evaluation tool will be integrated into the Education & Training Portal of the Finnish Virtual University.

Keywords: evaluation, web-based learning, usability, pedagogical usability, accessibility, informational quality

1. Introduction

The purpose of this paper is to describe an evaluation tool based on a multidisciplinary evaluation framework of web-based learning environments. Because one evaluator (typically a teacher, designer or planner) can hardly be an expert in all the fields of science needed in evaluation, the evaluation tool (with the multidisciplinary evaluation framework) has been created to help the evaluators to pay attention to the critical factors of quality of web-based learning environments. In this paper we consider web-based learning environments as a whole, which includes web pages which designed for educational use or platforms and contents as well as pedagogical and educational methods.

The evaluation tool was developed at the Hypermedia Laboratory of the Digital Media Institute (DMI) at TUT in co-operation with the Virtual University of TUT and with the Finnish Virtual University (FVU). The evaluation tool will be integrated into the Education & Training Portal of FVU (http://www.virtuaaliyliopisto.fi/arvo).

2. Multidisciplinary framework of evaluation

The multidisciplinary framework of evaluation was based on earlier research on HCI (human-computer interaction), psychology and pedagogy as well as on evaluation research which has its roots in the theory of usefulness of computer systems. Usefulness of web-based learning environments includes usability and utility sections. The framework is needed to define the factors critical to the implementation of training and learning services for a given group of learners, as well as teachers and researchers of web-based courses. The main issues within this evaluation framework are usability, pedagogical usability and added value as well as accessibility and informational quality of web-based learning environments (Silius & Tervakari 2003).
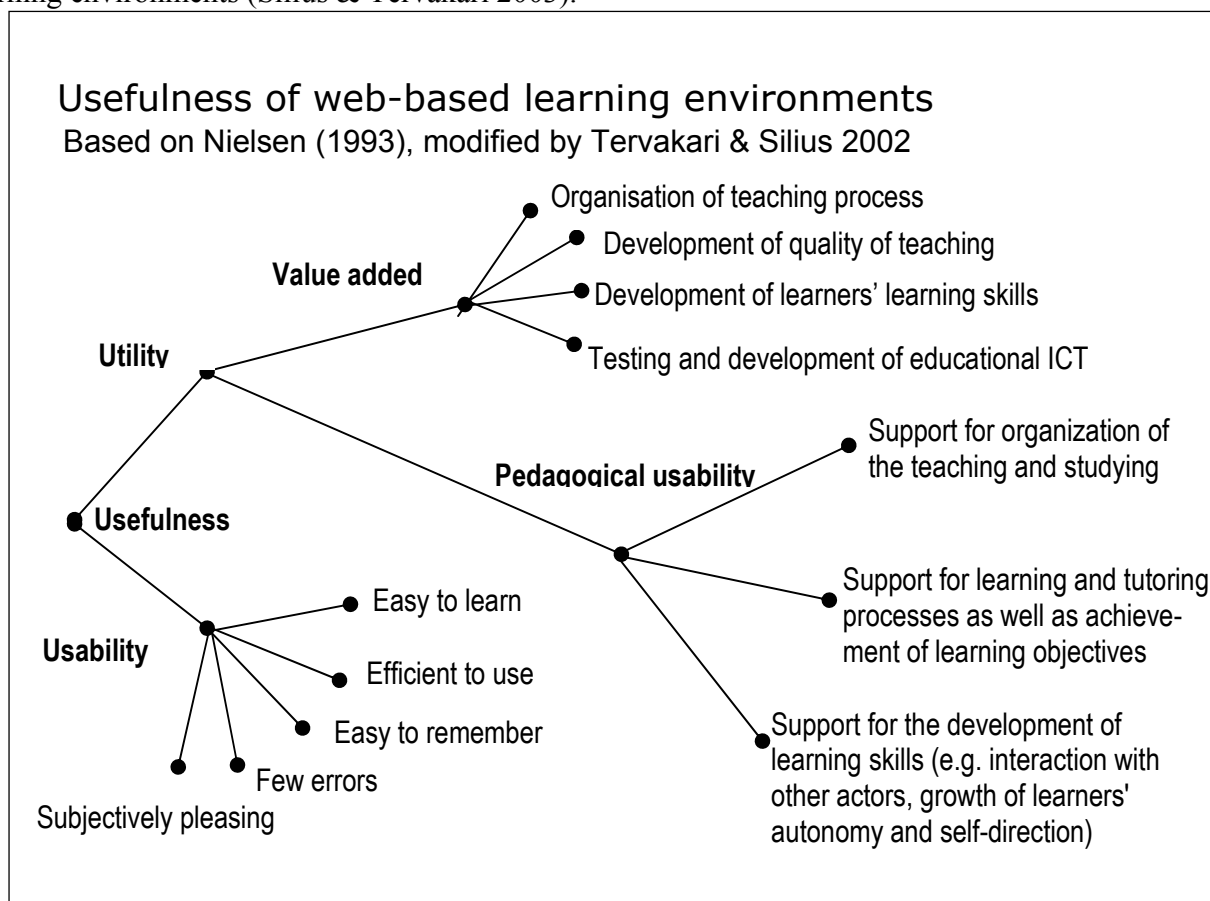
Usefulness of web-based learning environments
Based on Nielsen (1993), modified by Tervakari & Silius 2002

- Organisation of teaching process
- Development of quality of teaching
- Development of learners' learning skills
- Testing and development of educational ICT

Value added

Utility

Pedagogical usability

- Support for organization of the teaching and studying
- Support for learning and tutoring processes as well as achievement of learning objectives
- Support for the development of learning skills (e.g. interaction with other actors, growth of learners' autonomy and self-direction)

Usefulness

Usability
- Easy to learn
- Efficient to use
- Easy to remember
- Few errors
- Subjectively pleasing

Figure 1. Usefulness of web-based learning environment is a combination of its usability and utility. Utility can be divided into two categories: pedagogical usability and added value of web-based learning and teaching.

Usability is one aspect of the overall acceptability of a computer system. According to Nielsen (1993) the overall acceptability of a computer system is a combination of its social acceptability and its practical acceptability. Practical acceptability includes some traditional categories such as cost, support, reliability etc. and also usefulness. (Nielsen 1993.)

Software of any type should meet the basic standards for usability. The user interface of a web-based application must be easy and effective to use so that the user can concentrate on the information content instead of interface. When software is usable it is easy and efficient to use, easy to remember, has few errors and it is subjectively pleasing. (Nielsen 1993.)

In an educational context the evaluation of usability is not enough. It is also important to evaluate the pedagogical design of web-based learning. It has to be remembered that the evaluation of the pedagogical design should not replace usability inspection. A web-based learning environment may be usable but not pedagogically usable and vice versa, although there may be some overlap in the problems identified. (cf. Albion 1999; Labbate 1996; Quinn 1996; Squires 1997.) Tervakari et al. (2002) use the term "pedagogical usability" to denote whether the tools, content, interface and the tasks of the web-based learning environments support various learners to learn in various learning contexts according to selected pedagogical objectives.

The evaluation of pedagogical usability should moreover always be undertaken in relation to selected pedagogical objectives and the value added anticipated. Pedagogical objectives are influenced by learning objectives of substance as well as teaching and learning methods. In the evaluation of pedagogical usability attention should be paid to whether the pedagogical design of the learning environment is based on the appropriate educational theory and whether learners' unique skills (expertness of substance and web-learning skills) and needs like motivation, diversity and growth are taken into consideration (Silius & Tervakari 2003).

In addition to pedagogical usability the utility of web-based learning environments should include value added of web-based learning. Actually the combination of new teaching media (in this case the web) and the teaching method should produce some special value added for learners, teachers and organisations compared to traditional teaching. The best possible total benefits can be achieved if all partners can have special value added by using the web in teaching and learning. Added value in web-based learning and teaching can be broken down into categories: 1) organization of the teaching process 2) development of the quality of teaching 3) development of learners' learning skills 4) development and testing of educational information and communication technology. (Forsblom & Silius 2002a; 2002b.)

In the evaluation of added value of web-based learning and teaching should be paid attention to the attitudes, expectations and experiences of learners, teachers and other actors. The realization of value added is connected with an individual's context. That is why the same web-based learning environment may produce different kinds of value added for different individuals. E.g. for those students who are working while studying delivering learning material via the web can be significant value added. For students who participate in lectures on campus this is no value added at all. It has to be noted that the added value of web-based learning is not necessarily dependent on the usability or the pedagogical usability of the learning environment. E.g. learning material delivered via the web may have poor usability and poor pedagogical usability. Even though learning material in the web has some

weaknesses, be difficult to use, fail to take learners' different learning styles or different levels of knowledge into account, include content which does not support achievement of learning objectives etc., it still can produce some value added for certain individuals (Silius & Tervakari 2003).

An essential part of any web design today is designing for individuals with disabilities. Many governments and institutions nowadays require that web pages themselves should function with the assistive devices used by individuals with disabilities. Individuals with disabilities should also be able to access information and basic government services on the web. Accessibility is an important step toward the equality of citizens and independence for individuals with disabilities. The World Wide Web Consortium (W3C) has established guidelines for the design of accessibility (Web Content Accessibility Guidelines) and checklists to evaluate the accessibility of web pages. (Foley & Reagan 2002.)

It is also important to evaluate the informational quality of any web-based learning environment. To be of high quality the informational content of a web-based learning environment should meet the five main criteria: accuracy, authority, objectivity, currency and coverage. There are also some additional challenges presented by web resources e.g. instability of web pages, software requirements may limit access to information, web pages can be retrieved out of context, use on frames etc. (Alexander & Tate 1998.) From the viewpoint of pedagogical usability it is also important to ensure that the information as well as the presentation of the content is relevant and suitable for a given teaching context. (cf. Albion 1999; Liu 2001; Tergan 1998.)

3. Web-based evaluation tool

Because one evaluator (usually a teacher, designer or planner) can hardly be an expert in the many sciences needed in evaluation a multidisciplinary evaluation tool will be needed to help evaluators to address critical factors in the quality of web-based learning environments. The evaluation tool (in Finnish: http://www.virtuaaliyliopisto.tut.fi/arvo) helps the evaluators to control the evaluation process and gather essential information. The evaluation tool can be used over the Internet. The evaluator may use the tool at the same time as he or she is evaluating e.g. a course in the web.

The tool takes systematic account of the most important factors of accessibility, informational quality, usability and pedagogical usability. **The pedagogical usability section** in the first stage includes criteria to evaluate the support of the organization of the teaching and studying. In the second stage criteria will be developed to evaluate support of the learning and tutoring processes, achievement of learning objectives as well as support of the development of learning skills. **The usability section** includes sections to evaluate visual design, the use of multimedia elements, technical issues, support for online reading and navigation, error prevention and support for recovery from errors. All sections include around 4-12 criteria.
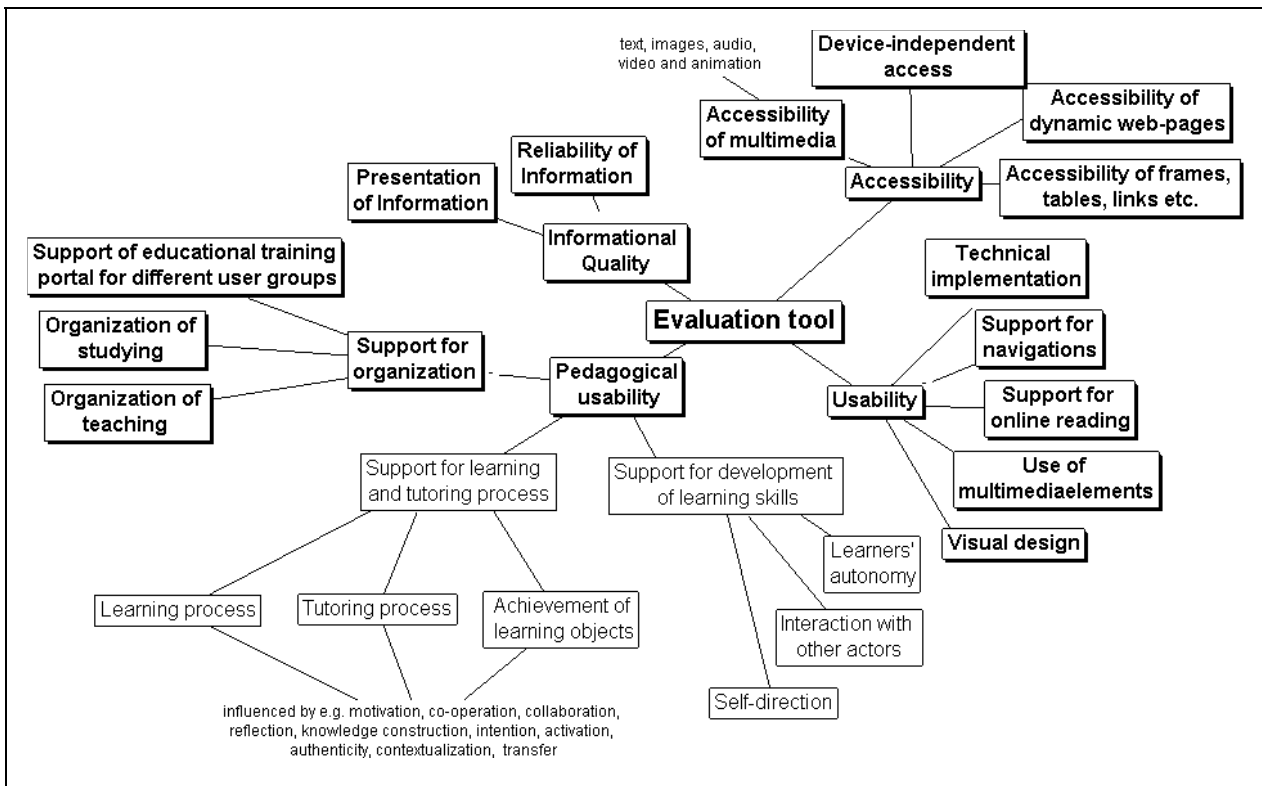
Figure 2: Sections of evaluation

To find out which degree a particular criterion has reached, the evaluator has to answer several (around 5-10) questions. The questions on each criterion are presented to the evaluator in a semi-intelligent form. It is possible for the evaluator to filter out questions which are irrelevant for certain web-based learning environments. For example, if there is no video or audio in the web-based learning environment, all the criteria and questions connected to these media elements will be excluded from the final evaluation form. Also, if the web-based learning environment has been created on purpose to support the organisation of the teaching and studying processes only, all the criteria and questions connected to other sections of pedagogical usability will be omitted from final evaluation form (See: Figure 3).

On the evaluation form each question is accompanied by rating scale (1=poor to 5= excellent; N/A "Not Applicable", "Don't know"). Evaluators are asked to rate the package of questions connected to each criterion e.g. visual design. The questions have been modified so that the evaluator does not have to think to what degree a particular criterion has been reached. The evaluator answers simple questions like "is it possible for a user to change the font size of the web page by using the browser settings". The alternative responses are "always", "often", "sometimes", "rarely" "never". Depending on the questions each alternative may have different scores e.g. "always" can be scored 1 or 5. Evaluators can also add relevant comments in the space provided (See: Figure 3).

After the evaluation the evaluator can have a report on the results of the evaluation. This report is composed of the overall profile of the web-based learning environment, a summary of the good features and guidelines on how to develop this particular learning environment. Guidelines are a detailed description for upgrading usability, pedagogical usability, accessibility and informational quality. E.g. to improve the accessibility of web pages one should provide a text equivalent for every non-text element via "alt" (See: Figure 3).
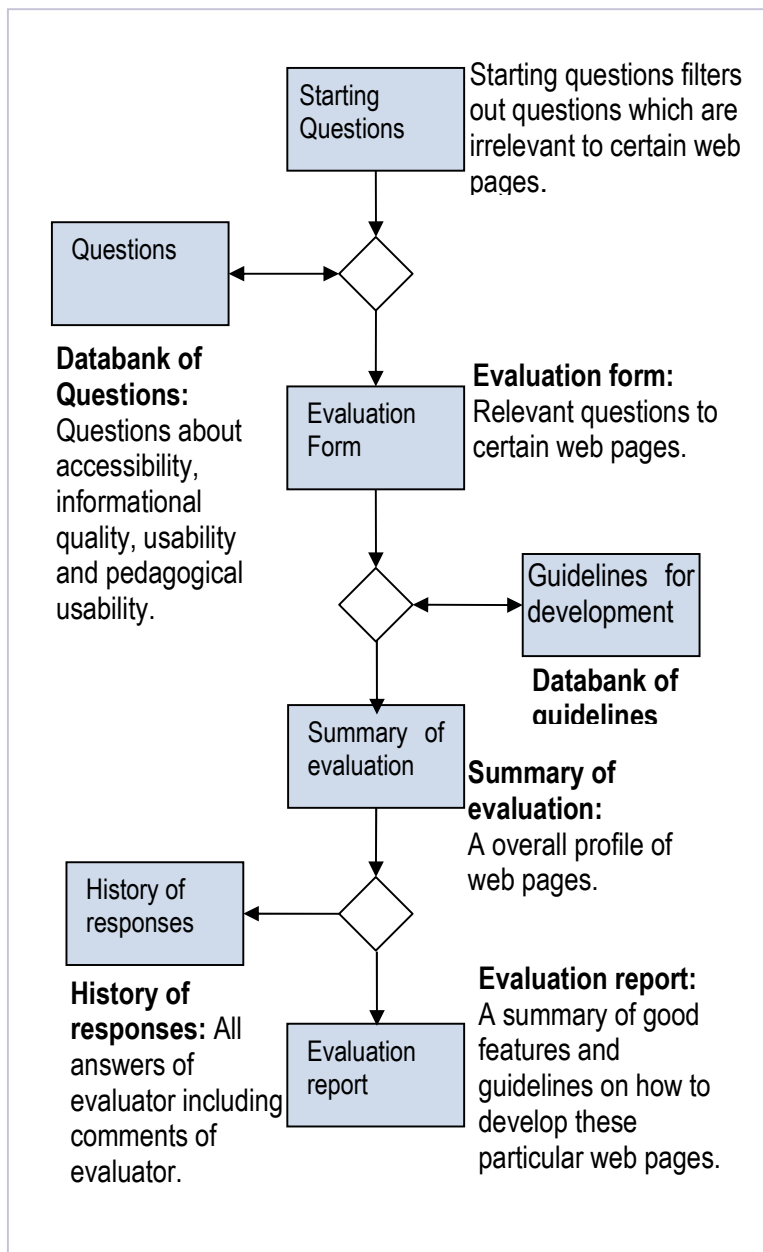

Figure 3: The evaluation tool helps evaluators to control the evaluation process and gather essential information for further development.

4. How does the evaluation tool help teachers to develop their web-based courses?

As a part of the activities of Finnish Virtual University, the Department of Mathematics at Tampere University of Technology is coordinating a national network project on mathematical modelling. The activities and results of the project are described by Pohjolainen, Suomela and Häkkinen (2003). The purpose of the project is to develop Web-based learning and teaching methods, to support content production in mathematical modelling and to develop the administrative measures needed to support web-based learning and teaching. Ten universities and research institutes are participating in the project and the teachers of the universities are responsible for certain parts of the courses and for producing the corresponding courseware. Students from different universities can study mathematical modelling both individually and collaboratively.

The learning environment used in teaching mathematical modelling, in other words the A&O platform with its tools including the learning material, were evaluated using the evaluation tool. The planners and teachers of mathematical modelling courses were provided with a report of evaluation. The evaluation report includes sections on reliability of information, presentation of information, visual design, support for online reading and navigation, technical realisation and use of multimedia elements and accessibility. Pedagogical usability was evaluated from the viewpoint of the organization of teaching and learning. The planners and teachers appreciated the advice guidelines which help them to pay attention to those sections of the learning material that can be improved. The guidelines are references from the research, so the reasons to develop learning environment and learning material were easily accepted after the evaluation.

In the opinion of the planners and teachers of the mathematical modelling courses the evaluation tool helped the evaluators to review numerous details of usability, accessibility and informational quality in the design of web-based learning material. It is difficult to remember so many details and even professional web designers might forget some. The evaluation of the mathematical modelling courses pointed out some details to be improved. For example, more course information should be available on the web, the accessibility of the learning material should be improved, likewise many details in the multimedia elements, some overall usability details and some detail of navigation should be improved.

The evaluation is partly subjective. The evaluator is not infallible and some important details may go unnoticed. The better the evaluator knows the substance, learning material and learning environment the better the evaluation will be. On the other hand many students may face the same problems as an evaluator who is totally unaware of the substance and learning environment. The best solution to evaluate each learning environment would be for real users, evaluator and designers to take part in the evaluation process.

5. Conclusions

We consider it is important that the tool enables teachers and planners of courses to evaluate their courses themselves. The evaluation tool (questions, advances, interface etc.) has been designed so that it is easy to answer the questions and understand the guidelines provided without being an expert in usability, accessibility or pedagogical usability. The evaluation tool can be also used as a "designing tool" as some teachers have done. In the near future the evaluation tool will be developed with special references to pedagogical usability. The next step is to add criteria and guidelines to supporting tutoring and learning processes in the web and the development of learning skills in the web.

We consider that it is most important to develop this evaluation tool so that user-oriented factors and factors concerning learning tasks, objectives and contexts collected from real users of the learning environment (learners, teachers and assistants) can be included in the tool. In the future the tool will help to match data collected from evaluators and real users. To enable the successful further development of web-based learning and teaching the Hypermedia Laboratory and the Virtual University of TUT are conducting joint research to identify the best practices and the conception of added value by investigating the advantages and disadvantages of web-based learning in various contexts. The data will be collected in the pilots of the Hypermedia Laboratory and the Virtual University of TUT and will be used to develop the evaluation further.

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