Development of the TUP Model - Evaluating Educational Software

Roman Bednarik, Petri Gerdt, Ramin Miraftabi, Markku Tukiainen
Department of Computer Science
University of Joensuu, Finland
{roman.bednarik, petri.gerdt, ramin.miraftabi, markku.tukiainen}@cs.joensuu.fi

Abstract

Usability evaluation is a crucial step in the iterative software development life-cycle, leading into successful usage of systems. However, most of the usability evaluation methods and tools do not consider all aspects of educational environments. These lacks materialize as unusable results that lead to failures in educational software. Often these results are not comparable and credible, or easily accessible to educators selecting the proper systems for use in their settings. The Technology, Usability, Pedagogy (TUP) evaluation model equally concentrates on the technological, usability, and instructional aspects of educational environments, leading to complete evaluations. In this paper we present the TUP model with the use scenario included and our current WWW prototype of evaluation system based upon it.

1. Introduction

Undoubtedly, computing and the use of technology currently play key roles in supporting educational processes. Due to the increasing availability and diversity of educational environments, educators face the difficult task of finding and selecting the proper environment for their own courses and classes. The tasks of evaluating educational environments as well as finding and comparing the evaluations are difficult for teachers. We assert that the problem is rooted in the lack of a coherent approach to the evaluation of educational environments. We use "educational environment" to mean any software or electronic material that is used in an educational setting.

The role of usability issues in educational software is to contribute towards the achievement of educational goals. Therefore, usability evaluation is not only a crucial step during the software development life-cycle, but it is also important for assessing the quality of released systems. Although a vast number of evaluation methods have been developed in the past, only a few of them can be applied to educational environments. This is caused by the fact that educational settings introduce a complex set of elements, processes, and relations between them. A method which allows for comprehensive analysis and

evaluation of all the involved factors has yet to be developed.

In this paper, we first present our proposal for an evaluation method for educational environments. We then proceed to describe the design of our web-based prototype evaluation system which uses the TUP model. After outlining some initial experiences with the prototype we end our paper with discussion about the future of the TUP.

2. The TUP model

The TUP model is an acronym derived from the words technology, usability, and pedagogy [5], an evaluation scheme which equally concentrates on three aspects of educational environments: The technological aspects focus on issues such as the dependencies and interactions between the environment and surrounding software and hardware equipment, issues concerning security and privacy, material sharing and reuse. The usability aspects in educational environments concern into some extent the traditional usability issues as known from [6] and [7], or motor and perceptual factors [4]. The pedagogical aspects refer to the need for assessing the instructional qualities of educational environments. Thus, the issues such as the context of learning, the roles of participants, the motivation or progress tracking and assessment are concerned.

The use scenario is an integral part of the TUP evaluation scheme. In addition to providing information related to technology, usability, and pedagogy, the evaluator-reviewer also submits the context in which the environment has been used. We argue that the integration of the context of use into the evaluation scheme satisfies the needs of the professional teachers when searching for appropriate software for their classes. The teachers know the settings of the courses they plan and can query the system in order to obtain the reviews of the materials or software whose use scenarios match their preference.

Fig. 1 illustrates how the three aspects and the use scenario are interrelated in the TUP. Both usability and pedagogy build upon the foundation of the technological aspects. The use scenario intersects all of the other categories: the context determines whether a certain feature is applicable.
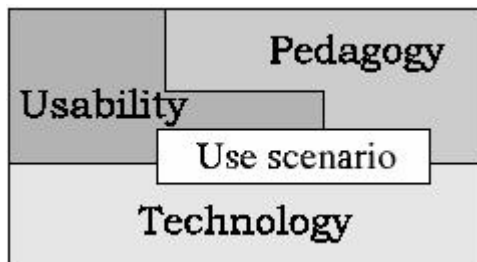
Figure 1. The relations of technology, usability, pedagogy, and the use scenario in the TUP model.

Checklists as a usability inspection method are one of the most used approaches in evaluating educational environments ([8], [10]). A checklist based evaluation guides evaluators and prevents them from unintentionally omitting some part of the evaluation process. The usage of checklists also brings an ease of performing, collecting, processing, and maintaining evaluations. However, if the questions contained in a checklist are too general, the evaluators might have problems relating them to the reviewed environment. This is especially true in educational settings. The teachers in the role of evaluators are experts in education, but they are rather inexperienced in evaluating software environments. We, however, feel it is possible to develop an evaluation method for educational environments based on the use of a checklist.

We have developed a checklist [1], which follows the taxonomy established by the TUP model, thus it consists of consequent parts devoted to technology, usability, and pedagogy, in this order.

3. The TUP-online prototype

With a view to support our evaluation checklist, we have developed an on-line evaluation service that allows users to share their (peer-) evaluations of educational environments. The evaluation within the TUP evaluation service is called a review. A review in our tool includes detailed description of settings and requirements in which the environment is supposed to be used, as for instance the operating system and platform, media, target users, main interface language and so on. This way we are able to incorporate the additional details about the context of use into the evaluation. The system also maintains a database of reviewers containing their educational background, the role in the learning process, and reviews completed within the TUP service.

The TUP-online prototype is a web-based evaluation service which utilizes the TUP model. The prototype was designed with high accessibility in

mind; it is accessible from all over the Internet through a standard web browser. Anybody is allowed to create an account, and submit reviews of educational materials. Users can add opinions to an existing review made by peers - the data about a certain educational application is stored only once into the database while several reviews contain the evaluations made by the users.

The purpose of the prototype is to further develop and validate the TUP model. We created a set of questions related to each of the categories in the TUP model. We have attempted to adopt the best state-of-art practices both from the predictive usability evaluation and from the modern views on learning. In the initial stages of the prototype development, we aim to create a vast number of checklist items to be reduced in the later phases.

The TUP on-line evaluation prototype ([11]) has been launched and tested, Fig. 2. The initial database of the prototype included data about several experimental educational environments. Then we opened the server and allowed a test group of experienced users to review the stored environments. The evaluations were made using the initial TUP checklist.
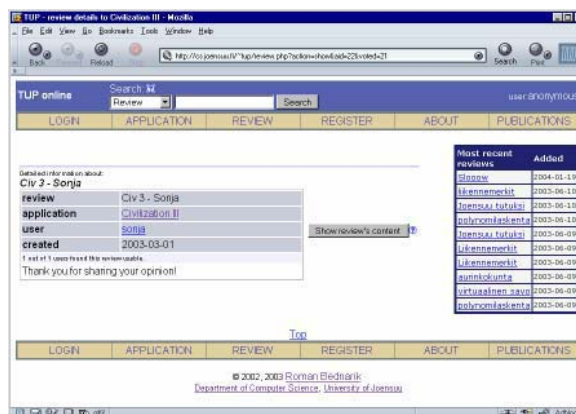

Figure 2. The TUP online screenshot.

4. Discussion

Our initial experiences with the TUP model and web-based prototype service and the results obtained from a small scale study show that although the level and coverage of the evaluation is adequate, the vast number of checklist questions needs to be reduced. We aim to create intelligent filtering of unrelevant or not-applicable items.

The usage of checklists as an evaluation tool brings several disadvantages and potential problems. In the educational setting, the checklist based usability evaluation methods were criticized by a few

researchers. For instance, Squires and Preece ([9], pp. 471) present several problems which occur in contemporary checklists. They argue that "it is difficult to indicate relative weightings for questions", "selection amongst educational software of the same type emphasizes similarities rather than differences", "the focus is on technical rather than educational issues", "it is not possible to cope with the evaluation of innovative software". We believe that the design of the TUP model and the evaluation tool considerably supersede these problems, especially the fact that the scenario use is incorporated into the evaluation. Squires and Preece further argue that "it is not possible to allow for different teaching strategies", "off-computer, teacher generated uses are not considered", "evaluation in different subject areas requires different sets of selection criteria". In the TUP model, the background of the teacher evaluating an environment, the intended purpose and subject matter of the environment are included into the evaluation. The whole review in the TUP service is thus constructed in a way which prevents the most of the problems pointed out by the critics of the checklists.

Recently, the research around user modeling concentrated on so called recommender systems. A recommender system is an agent-based system which guides the users in the process of making selection [3]. For the further development of the TUP we have decided to take on the social filtering mechanisms and adopt one of the central ideas of recommender systems, i.e. relying upon the opinions of the peers. The purpose of social filtering in the TUP is to help the user to find peers, who have similar educational and professional background. These peers are bound to encounter similar needs than the user and thus their experiences are more valuable to him/her than that of a layman or a specialist of some other field.

5. Conclusions

In this paper we introduced the TUP evaluation model for educational environments. The design issues of the evaluation checklist and on-line tool have been discussed. Our current work concentrates on implementing a socially sensitive layer for the TUP-online which will build on the ideas of social filtering. The field of educational environments favorably limits the variety of criteria which drive the recommendation and filtering agents and thus enables us to create more authoritative and authentic recommendations. These facts shall provide the users of the TUP online evaluation tool higher precision of the results, usefulness, and individualization of the system.

The next step in the development of the evaluation method is to create a system for automatic adaptation of the evaluation scheme to the certain types of educational environments. The feature will cut down the total number of questions needed to evaluate an environment and therefore shorten the time to complete the review. The prototype TUP online evaluation tool is now operational and it has to be validated in real use by a broad society of educators.

6. References

[1] Bednarik, R.: Evaluation of Educational Environments. The TUP Model. MSc. thesis, Department of Computer Science, University of Joensuu, 2002.

[2] Borsook, T. K., Higginbotham-Wheat, N.: Interactivity: What Is It and What It Can Do for Computer-Based Instruction? Educational Technology, 31 (10), pp. 11-17, 1991.

[3] Burke, R.: Hybrid Recommender Systems: Survey and Experiments. User Modeling and User-Adapted Interaction 12 (4), pp. 331-370, Nov 2002.

[4] Fitts, P. M.: The information capacity of the human motor system in controlling amplitude of movement. Journal of Experimental Psychology, 47, pp. 381-391, 1954.

[5] Gerdt, P., Miraftabi, R., Tukiainen, M.: Evaluating Educational Software Environments. In Kinshuk et al. (Eds.): International Conference on Computers in Education (ICCE) 2002, pp. 675-676, USA, 2002.

[6] Nielsen, J.: Usability Engineering. Morgan Kaufmann, San Francisco, 1994.

[7] Nielsen, J., Mack, R. L.: Usability Inspection Methods. John Wiley & Sons, New York, NY, 1994.

[8] Ravden S., Johnson, G. : Evaluating Usability of Human-Computer Interfaces, a practical method. Ellis Horwood Limited, Chichester, 1989.

[9] Squires D., Preece, J.: Predicting quality in educational software: Evaluating for learning, usability and the synergy between them. Interacting with Computers 11, 1999.

[10] SUMI: Software Usability Measurement Inventory. Available at: http://www.ucc.ie/hfrg/questionnaires/sumi/ (February 2003).

[11] TUP on-line: URL: http://cs.joensuu.fi/~tup/ (April 2004).