USAGE AND USABILITY OF THE MATHEMATICAL WEB PAGES: An Example

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ABSTRACT

The main goal of this paper is to consider the usage and usability testing of a virtual mathematical interface. The main sections of the Laboratory of Applied Mathematics at Lappeenranta University of Technology new Web pages will be also introduced here.

The reason initiating the design of this interface was that, for some reason, the mathematical skills of new university students in Finland, as well as other countries, are not as good as one would expect. Students must revise high-school mathematics before starting their actual university studies, and computer-based study materials are one solution to this problem.

The primary intention of this project was to offer mathematically less skilled students basic material in an appropriate manner that they could use independently and that would help them grasp the basic concepts in mathematics studies, which they require later on in their studies.

In order to avoid reproducing, in the Internet already existing teaching material, the author decided to review the educational Web pages that had already been produced by other authors. Soon the author had found a sufficient amount of suitable educational Web pages for above-mentioned purposes. Finally, the Internet pages prepared here are ready to be checked, and usage as well as usability testing will be the methods used for testing.

1 Introduction

In 2001 the Eastern Finland Virtual University Network (ISVY) decided to grand funds for the distribution of basic-level mathematical material via the Internet.

First, several issues had to be taken into account before the new project could be initiated. One of these issues was related to the use of distributing educational material via the Internet, and below are some points that justify the use of the Internet as a medium for the dispersion of educational material [1]:

Material, which is on the Internet,

- is easy to reuse, transform and combine with other materials
- is fast to use at least with fast connections
- is accessible 24 hours a day
- can be accessed by many users.

After the material has been distributed and some kind of interface implemented to use this material, some questions remain to be answered. The usage and usability of this new interface are examples of such issues. Good usage roughly means that, for users, the pages are effective and pleasant to use. Pages are somewhat usable if the user is able to find exactly what they are looking for and immediately notice if the pages do not contain the necessary information. By good usability, we strive to achieve a user-oriented working environment. Usability is an important aspect in Web-based learning environments, since a poorly usable environment requires, of the user, a lot of time and effort which is away from the learning process.

This paper will shortly present an interface, which was implemented for the Lappeenranta University of Technology (LUT) and which uses a collection of materials [3]. This paper will also discuss the philosophy, the principles of planning, execution and future of this experiment. The core of the experiment consists of study packages based on hypertext, Web browsers, computer algebra systems and visualizations based on java applets. In addition to universities, the material delivered and categorized here can also be used as an additional reference at mathematically oriented schools. This paper will focus on mainly discussing the future of this project, which is strongly linked to the forthcoming usage and usability of the material.

2 Testing Usage and Usability

Why should usability be tested? One would expect that the content of pages, with good usability is easier and faster for students to adapt. The basic rules of usability state that Web pages have been well planned if they have: i) a consistent layout ii) a consistent design iii) a clear order of information iv) a clear way in which the information has been arranged v) been designed to allow easy and consistent navigation vi) been implemented in such a way that the pages and any graphics they contain are aesthetically comfortable [4].

Good usability can create better conditions for teaching, and improve the quality of learning. Of course good usability alone does not guarantee good learning results, since pages, which exhibit good usability, are only a tool for learning. Good teaching always supports the communication between the student and teacher, creates more interaction between students, supports active learning processes, provides accurate feedback, helps control the use of time, sets goals high enough, takes into account different talents and ways of learning. [5]. Obviously, a good learning procedure is such a complex area that no tool alone can guarantee it.

It is in any case good to estimate the usability of products in some way, since different usability tests will reveal the worst usability problems in an easy and effective way. Normally, usability tests also save a lot of money in the later phases of projects. There are mainly two approaches to usability testing. The first one is expert-oriented testing, i.e. the, so-called heuristic approach and the other end-user oriented approach.

2.1 Heuristic

An interface can be evaluated in a heuristic manner which means an expert-orientated evaluation, where an expert goes through an application from display to display, button to button and menu to menu using some well-known guidelines. The main advantage of this approach is that it is effective in relation to the time and money that it requires. The disadvantage of this method is that opinions normally do not come from the end-user, but from an expert.

The most well-known rules of usability evaluation for heuristics are perhaps Jacob Nielsen's ten rules [6]. This part of usability mainly shows how pages have been designed.

2.2 Usability Testing

Actual usability testing is a method which is intended for revealing the true problems experienced by the end user. It is preferable that usability testing be, to some extend performed already of the prototype phase of a project, which in this case, involved the author discussing the opinions of their colleagues and some students as to the design and contents of these pages. Real usability testing starts when the product is considered by an expert to be ready. The designer or expert user has to elaborate a list of the vital functions of the product as well as of some test operations with which to test these functions. The expert has to also perform pilot testing before end-user testing can actually begin.

Nielsen has written that *'Some people think that usability is very costly and complex and that user tests should be reserved for the rare web design project with a huge budget and a lavish time schedule. Not true. Elaborate usability tests are a waste of resources. The best results come from testing no more than 5 users and running as many small tests as you can afford.'* [7] and [8]. This is due to the fact that already the first test five users usually find as much as 85 % of usability problems. At this point, the designer is already bursting to fix these problems in redesign. After the new design has been prepared, tests needs to be run once again.

The case discussed here involves different categories of teachers and students at the university, which requires two different test series to be run. Nielsen recommends that between three and four users from each category be selected for testing when there are two categories. As a result, in each test case. As a result, in each test case, there will be between three and six participants. A normal test situation is videotaped and the participants speak as freely as possible while proceeding through the key sections of the interface. It is important that the supervisor of the tests not help the participants once the test has started, since the purpose of these tests is to study problems in the usability of the interface. Once the test has been completed, there is closing discussion in which possible problems in the product are revised as well as which suggestions for improvement or comment as to the appearance of the product from users are collected. It is however, the most essential for notes to be made as to how the user is actually using the product [9]. Finally, the test supervisor prepares a written report as the basis of the test results, considers the results and implements possible changes before initiating a new round of tests.

3 Realization of Virtual Mathematical Web Pages

The author, at first thought about using a design approach called the Mud-Throwing Theory of Usability which has recently become popular for the design at new websites and innovative Internet services with the idea of throwing a design at the wall and seeing if it sticks. The assumption is that speed is everything. If the initial design has weaknesses (i.e., drops off the wall), these weaknesses can always be fixed in redesign [10].

Actually, it is the author's opinion that in mathematical non-commercial web-design, speed is indeed not such an important matter. This is due the facts that

1. the information contents do not change radically over time,
2. students are very critical customers and if a design is bad, they will not come back to use the interface when its design has been improved. As Nielsen states, *'Once a user has had a bad experience on a website, it is very difficult to convince him or her to come back.'*,
3. while speed is not everything, customer (in our case student and teacher) satisfaction is [10],
4. launching a bad site with poor usability is a guaranteed way to waste money, since it will have to be redesigned more or less immediately [10].

According to the usability theory [7] it is only necessary to test with very few users in order to gain the vast majority of insights into the usability of a design. Usability feedback can be obtained at a very early stage of the design when nothing has been implemented yet and there are nothing but a few sketches of the proposed new service. Testing does not therefore need to delay implementation. In fact, testing with an early prototype of a future site will sometimes speed up a project and save time as the designer discovers that certain features are unnecessary or that things should be done in simpler ways than originally thought.

The basic philosophy of this project was to give the student an open study environment, which consists of information on mathematics, problems to be solved, computational tools, guidance, general help (both technical and mathematical) and visualizations. The student can study what they feel to be the most interesting. Students will hopefully begin to do their own research and form a view of mathematics. Thus, the view of the learning process is constructivist. In principle, the criterion of learning is the ability to solve given problems. On the other hand, students are not graded. The purpose is only to give them a study environment that will be interesting enough to make them study mathematics at their own pace. The design principles were set as follows:

- To create a mostly hypertext-based mathematical forum with visualizations, animations etc.
- The system has to work smoothly.
- Students should receive feedback and be able to submit it as well.
- The material has to be well organized.
- The material has to be relevant for students,.
- The distribution of the most important content of the material should be free.
- Request permissions for the usage of material in all cases.

Once the material is complete it is important that

- The content of the new interactive pages is ordered in a pedagogically meaningful manner.
- All the material is in order in the sense that all the authors have been notified and licenses requested for the use of their material.
- The system be verified to ensure that it functions as required.
- The opinions of other's as to the new pages (co-workers, students) be requested in addition to recommendations for improvements.
- Any required changes be made and the system verified once again.

4 Main Functions of the Interface

All the pages have a feedback form, which is intended for students to use to send the designers any information as to what they require of the pages. The pages, in the final outlay, consist of the following main parts:

4.1 Main Page

- Main pages in Finnish[3].
- Main pages in English[11].

Both these sets of pages have various links and their main mathematical features are shown below.

4.1.1 Introduction to University-Level Mathematics

By clicking this link [12], the student can find links to

1. The basics of mathematics [13].
2. The basics of high-school level mathematics [14].
3. Quizzes and games prepared by Franz Embacher [15].

All of these pages include a lot of mathematical theory, exercises, visualizations, quizzes and games for students.

4.1.2 Ordinary Differential Equations

This section consists of material [16] prepared by Simo Kivelä and his working group and includes theory, visualizations, exercises and examples of ordinary differential equations.

4.1.3 Virtual Mathematics

By clicking this link [17], the student can find links to

1. Examples [18] which include a lot of useful examples on java coding and mathematics.
2. Sorted applets [19] which will help visualize mathematics.
3. Ready material [20] which includes all kinds of useful mathematical material, such as the previously mentioned pages by Franz Embacher [15].

It should be mentioned that this is just the main part of the materials what we have placed on our pages.

5 Future

So far, the following items have been noticed as features that should be corrected in order to improve the functioning of the system.

- Improve categorization by, mainly changing some names of the menus.
- The feedback form should be altered.
- A chat and/or bulletin board should be added on to our pages in order to provide users with more interaction with the teacher.

The author will also use these pages in the second basic mathematics course which he will start lecturing on March. The author will implement a small interface for the needs of this specific course, collect data from the students while they use the interface and run usability tests for the students. The author will also run tests for mathematics teachers. After analyzing the results oh these usability tests, the author will make the necessary changes to the interface and run further tests. Finally the following actions will be taken:

- Active advertising of these pages will be initiated.
- When the package is used via the web, students will be able to send their answers to problems to the server. Here, the answers will be checked, some feedback given and statistics is collected. Thus, it will be possible to send the student a survey of the work done during several sessions (which problems have been solved, how many correct and incorrect answer were given, etc). It must be emphasized that the idea is not to grade the student, but to provide feedback for self-evaluation. On the other hand, the data collected in this way can be used for further developing the system.
- The aim is to develop a system for collecting data on work of students and to analyze the data.
- These pages will be maintained constantly.
- The materials used in mathematics courses will be linked and used here.
- Even more co-operation will be undertaken with other universities, high-schools etc.

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