

Cast your Eyes on Moodle: An Eye Tracking Study investigating learning with Moodle

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Abstract

This work describes an eye tracking study of Moodle outlining how Moodle's components and teaching materials are 'seen' by Moodle users. In order to investigate navigation schemes, usability aspects as well as the learning process itself, Austrian students were eye-tracked during using Moodle. The study addressed objectives to find out about user's visual scanning of Moodle's environment identifying hereby core navigation strategies and components that highly affect exploration within Moodle's pages.

Discussion and analysis of the collected eye tracking data indicate some interesting results. For example, the investigation identified that the breadcrumb navigation and the "My courses"-block were most frequently used for navigation, but lots of students still use the browser's 'back'- button. Eye tracking results also demonstrated that some users had remarkable difficulties locating Moodle's logout button as well as their profile page.

The study also tried to draw conclusions for future development. Within this work recommendations are given contributing to development of an effective as well as intuitive user interface for Moodle 2.0. Implications are stated describing how users might use new navigation elements of Moodle 2.0 beta.

The major part of my presentation is to mediate how students actually 'see' and work with Moodle. For teachers (in particular) pointing out which elements are preferred during the learning process is highly relevant for efficient teaching. However, findings of this eye tracking study support not only teachers also developers and other Moodle users will benefit. Better understanding of Moodle's user interface and the learning process within Moodle might improve quality of use.

Keywords: Eye Tracking, Moodle, Usability Testing, e-Learning, User Interface Design.

1 Introduction and Related Work

In usability research various methods exist to investigate software interfaces focusing hereby on areas of interest and interaction. Questionnaires, mouse clicks, thinking aloud protocols etc. support improvement of user interfaces as giving information about users' thoughts, cognitive decision-making as well as navigation strategies. However, these methods cannot tell developers where users really look and what elements they are focusing on. Therefore the research method of eye tracking evolved to record users' eye movements.

The foundation for using eye tracking is the assumption that there is a relationship between eye movements and cognitive processes (Just and Carpenter 1976). This implies that those symbols or elements on the screen are fixated which attract the user's attention. From the observation of gaze the researcher can draw fairly valid conclusions on the user's thought processes. Various research fields benefit from the eye tracking method, for instance eye tracking is increasingly used in human-computer-interaction (HCI), usability research, marketing and investigation of consumer behavior (Jacob & Karn 2003, Kain 2007).

A special case in terms of eye tracking is e-learning software. Eye tracking seems to be especially appropriate to investigate the usability and pedagogical value of such software. As indicated, eye tracking has been used for quite a long time to study visual processes and has yielded some interesting results (see e.g. Rayner 1978, Goldstein 2002, Kain 2007). To a certain extent these research results can also be used as an input for eye tracking studies in the area of e-learning. There is some eye tracking research in e-learning, but many of the investigations rather concern the development of adaptive e-learning systems. Research dedicated to the investigation of learning processes using eye tracking seems to be scarce although there are still many questions which could be solved by adopting the eye tracking methodology. The study reported in this paper is a contribution in this area.

The following paper describes an eye tracking study of Moodle. The goal of this study was to investigate several learning variables such as the order of selecting learning material, the visual scanning of Moodle's interface as well as various usability aspects. The eye tracking analysis was supplemented with qualitative interviews carried out before and after the eye tracking sessions.

2 Description of the Study

2.1 Moodle Setup

The stimulus of this experiment is a newly configured instance of Moodle (version 1.9.4+) dealing with the general learning topic of 'privacy'. Five articles of three various fields (general introduction, theory and practical examples) were provided within different Moodle courses. Hereby, each course had a different amount of blocks, as differences in visual paths were expected. Also, media elements and the complexity of the articles systematically varied from one teaching material to another. This enables to investigate the influence of complexity during the learning process. Moreover, graphics' level of detail systematically varied among different teaching materials allowing researchers to study their role as well as importance within learning with Moodle.

2.2 Procedure of the Investigation

In this study the order of selecting learning items was not predefined, participants were allowed to determine freely which parts of Moodle they wanted to explore. Generally, test sessions lasted about one and a half hours (including interviews), although there were no temporal limitations set neither of eye tracking session nor interviews.

Experiments were conducted throughout using equal scheduling for all participants. The procedure of each test-session was as follows. Before beginning the eye tracking tests partici-

pants' personal information were surveyed. Afterwards they were calibrated to the eye tracker and received essential instructions, such as admission data for accessing the learning environment. After logging in to Moodle (Fig. 1), participants were directed to the welcome page (Fig. 2), where they could process learning materials (Fig. 5) as well as the following four integrated tasks:

- Task 1: navigate to Moodle's learning activity 'survey' and take part in an on-line-poll (Fig. 4)
- Task 2: locate the environment's calendar and find the appropriate date of the investigation session (Fig. 3)
- Task 3: search and explore one's personal profile settings and adjust the e-mail address (Fig. 6)
- Task 4: log off the learning environment by locating adequate navigation elements.

Immediately after finishing the eye tracking session participants had to write down learning content they could remember and notable impressions they could recall. After a short break a guideline oriented interview was conducted investigating participants' experiences towards complexity, comprehensibility as well as difficulties caused by teaching materials, tasks or navigation. To evaluate eye tracking results from a holistic perspective, eye tracking results had always been evaluated in combination with the questionnaires' results.



Figure 1: Moodle's login page



Figure 2: course overview

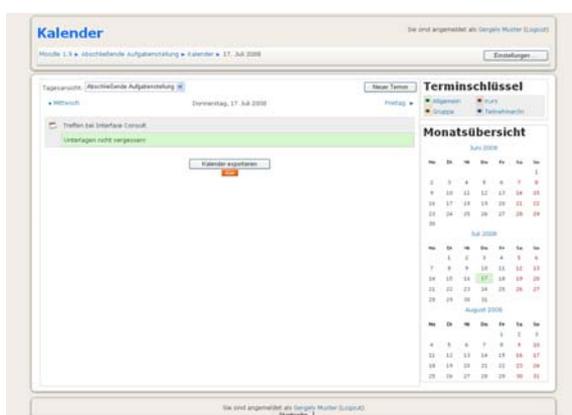


Figure 3: Moodle's calendar page



Figure 4: Moodle's poll tool

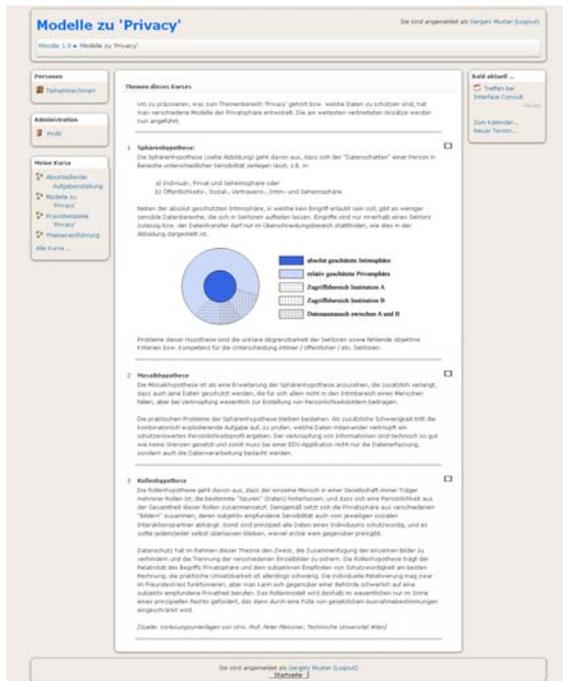


Figure 5: Exemplary article within Moodle

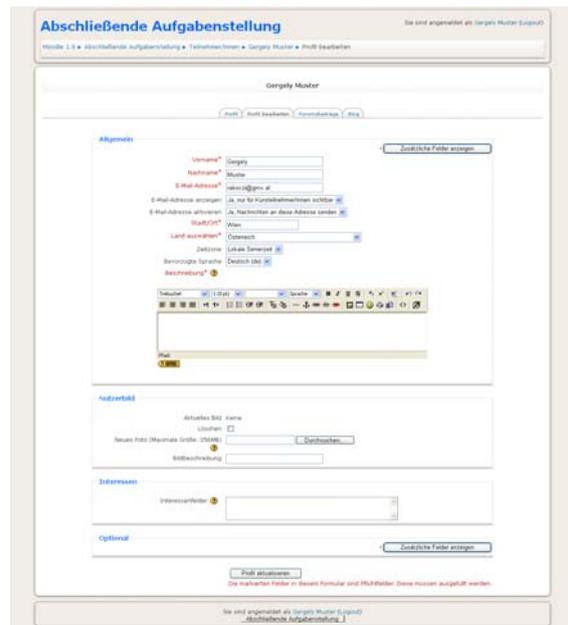


Figure 6: Moodle's profile page

2.3 Participants and Technology

Participants of this eye tracking investigation were ten students of various fields of studies (6 males and 4 females). Their ages ranged from 21 to 25. As it is unusual for eye tracking tests exclusionary demands had to be met. Only people, who didn't wear glasses or contact lenses, were eligible for the study due to limitations of eye tracking equipment. Furthermore participating students had to declare having no remarkable constraints concerning their physical condition during the eye tracking session. Moreover, all participants had to be at least regular computer users, having basic computer competence. First-year students were not allowed to take part and furthermore, participants were not allowed to have practical experience with Moodle.

The Tobii T120 eye tracker (Fig. 7) was used to collect eye movement data at the sample rate of 120 MHz. The learning environment was displayed on the integrated large scale monitor of the eye tracking system. Eye movements were measured by two binocular infra-red cameras placed underneath the computer display. The accuracy of eye tracking was about 0.5 degrees by a potential drift of <math><0.3</math> degrees. No chin rest was used due to enable freedom of head movements, however the equipment limited head movements to a scale of 30x22x30cm. For gaze analysis, visualization and statistical evaluation Tobii Studio developed by Tobii Technology was utilized.

There are three main eye tracking parameters used within this experiment: *fixation duration* (indicating difficulty of information extraction or interest towards elements), *fixation frequency* (counting the total number of fixations and providing magnitude towards interface element's importance, distribution of visual attention or the grade of element's distraction) and *scan path* (visualizing spatial distribution, the sequence of recorded fixations and indicating design efficiency of interface components). Fixation duration (as well as fixation frequency) is illustrated by heat maps and statistical analyses, whereas scan paths are visualized by gaze plots.



Figure 7: Tobii T120 Eye Tracker

2.4 Main Research Questions

This study was organised as giving answers to the following questions:

- How do users navigate within Moodle?
- How do learners behave after accessing single pages of the learning environment?
- Which type of elements do they fixate first? What elements are ignored?
- What components are among the highest fixated?

Furthermore, analysis of the recorded data should enable drawing general conclusions towards the following aspects:

- How can I create eye-catching teaching material?
- How will students 'see' Moodle 2.0's interface? Which elements or components should be changed for Moodle 2.0?

3 Fixation Results

This section summarizes analysis of the eye tracking data recorded during the sessions.

3.1 Where do Moodle users look?

Corresponding to the figures of section 2.2 (Fig. 1 to 6) eye tracking results are shown demonstrating participant's visual perception of Moodle's interface (Fig 8 to 13). The heat maps clearly visualize areas as well as components that highly attract users' attention. These figures also indicate areas of interactions as participants' mouse clicks are displayed as well.



Figure 8: Heat map of Moodle's login page



Figure 9: Heat map of the course overview



Figure 10: Heat map of Moodle's calendar



Figure 11: Heat map of Moodle's poll tool



Figure 12: Heat map of the exemplary article

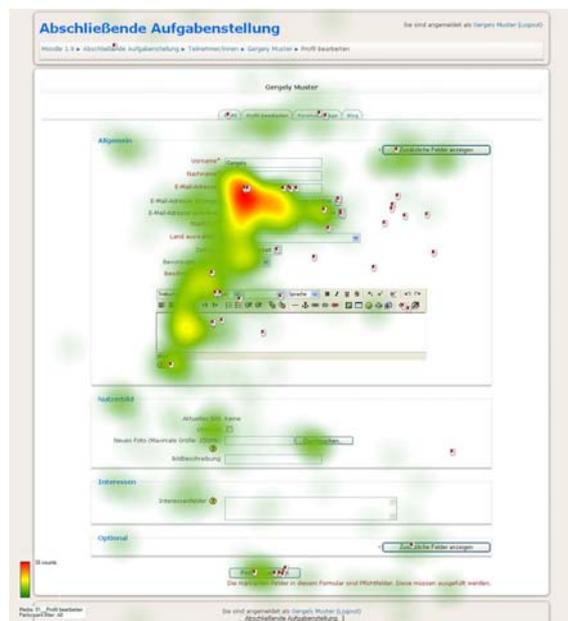


Figure 13: Heat map of one's profile page

3.2 Navigation within Moodle

As investigating navigation, eye tracking fixations revealed that students generally navigated with three different elements. The breadcrumb navigation bar (see for instance in Fig. 10), the 'My courses'-block (Fig. 12) and the browser's Back-button were most frequently fixated as well as used for navigating through Moodle's contents. Interviews identified that students preferred the breadcrumb navigation over the 'My courses'-block due to its fixed and central position as well as hierarchical structure. However, it has to be said that, some students were cognitively overextended, as having various short fixations at visually processing this navigation element. On the contrary, eye movements also show that still most students still use the browser's 'back'- button. Interviews reveal that they saw and also know other navigation elements, however they are used to navigate with the browser's 'back'-button. Therefore as a recommendation for the Moodle developers in terms of future Moodle releases, highlighting and visually enhancing of the breadcrumb navigation bar is of great importance. Indicating the breadcrumb bar as central element of navigation will contribute to improve Moodle's usability.

Eye tracking results also demonstrated that some users had remarkable difficulties locating Moodle's logout button as well as their profile page. This 'status bar' (Fig. 14) caused difficulties for the majority of the students. The 'name' (link to personal profile page) and the 'logout' button were identically color-coded and were positioned next to each other. Although these elements were equally displayed, they had different functions. The study's participants assumed (as revealed in interviews), equal semantic purpose for the buttons, because of their equal visual appearance. Analyses revealed, however that students were highly disoriented, because of the unexpected functionality.



Figure 14: Identical color-coding and grouping suggest equal semantic purpose

Results also indicate high fixation intensities (fixation durations up to 2 seconds!) for Moodle's bottom navigation element that redirects to higher navigation levels (see Fig. 15). One reason for this aspect is, that this button's caption changes as different pages are viewed, confusing hereby Moodle users. The majority of the study's participants reported difficulties of understanding the purpose of this element. Therefore as a solution, developers should entitle identical functions with (universally) similar captions on all Moodle pages. Different functionalities of one element contribute to cognitive overload, so there element's purpose should be designed clear without ambiguity.



Figure 15: Changing captions confuse users

Within this eye tracking study it could be detected, that users tend to overlook buttons at the bottom of pages. Especially demonstrative in this respect is the ‘Update profile’ button on users’ profile pages. 4 out of 10 participants have not saved their changes as missing to click ‘Update profile’. Figure 13 shows hardly any yellow or red areas (indicating fixations) covering this button. Interviews and statistical analysis of the investigations’ data reveal that especially novice users oversee this user interface element.

One another element causing high fixation values is Moodle’s element for folding topics (Fig. 16). Various users visually focused on this element for a long time by one long fixation. This effect suggests unclear functionality of the element. During interviews students reported that they had difficulties interpreting this element’s purpose. Some students assumed that this element is for opening documents. On the contrary, others presumed that it is for checking of finished assignments. Possible reasons for this element’s strong visual distraction is that it is relatively in the centre of the screen and that this item is not (closely) surrounded by other elements. This gap causes visual accentuation enhancing hereby the element’s importance. Therefore as a recommendation for future Moodle developments, designing ‘floating’ elements in the middle of the screen should be done carefully, as they highly attract users’ attention.



Figure 16: Moodle’s element for folding topics suggests unclear functionality

The study also indicated that there is quite a significant variance among participants’ eye tracking measurements. Moodle pages (and also its’ elements) were explored remarkably randomly, even among 10 participants. This implies highly different exploration strategies making it difficult to draw general conclusions towards computer supported learning.

Furthermore gaze plots also indicate that many students were exploring Moodle’s interface for a specific button that leads to the next teaching material. As Moodle’s general structure is not based upon step-by-step concept, some participants criticised lack of continuous learning within Moodle.

Moreover ‘precautious navigation’ could be detected at some of the eye tracking sessions. Hereby users move their mouse cursor to the intended link and just before clicking it, they explore the whole page with various rapid single fixations to ensure that none other link fits better.

3.3 Accessing Moodle

To investigate initial gaze, media elements of each article were categorized by areas of interest (text blocks, captions, images and navigation elements). Afterwards, these areas were evaluated by the parameter ‘time to first fixation’ to determine the sequence of visual fixation. Hereby, analysis of measurements was always evaluated in relation to categories’ spatial dimension.

First fixations of a Moodle page basically reveal a sort of ‘inventory’ of informative elements. Initial fixations generally target text elements. Hereby participants attempt to estimate the amount (and complexity) of the learning material as interviews revealed. Gaze plots indicate that afterwards headlines and titles are captured to determine the page’s topic and its key aspects. Simultaneously pictures of high information density are located, enabling learners to directly confront with key issues of the teaching material. Moreover, analyses imply that throughout the experiment high detail graphics tend to be fixated earlier than images with low information-density. Finally (just before leaving the page) navigation elements are recognized. Hereby participants begin searching on the left hand side due to local clockwise reading direction.

4 How to Create Eye-catching Teaching Material?

In this section ‘Seven Recommendations’ are presented evolving from the conducted eye tracking study. These aspects should help (especially Moodle teachers and course creators) to develop more eye-catching resources facilitating students’ learning process:

1. Use enumerations, numerical listings for emphasizing important parts of the education material!
2. If you want to educate with difficult text, break them apart in small ‘bites’! This relieves visual perception and processing of information.
3. Make students curious to increase their involvement! Results shows that students of high (thematic) involvement tend to process teaching elements in greater depth and significantly higher fixation intensities.
4. Use borders to visually pre-segment your education material. Students’ eye movements will focus on parts of your choice! Remember that segmentations guide eye movements unknowingly!
5. Use text blocks always in combination with high-detail pictures to encourage interpretation potentials!
6. Use word-wrapping in continuous text to facilitate visual processing!
7. Use different colours for different semantic approaches and be consistent!

5 Conclusions for Moodle 2.0

As this paper tries to contribute to development of an effective as well as intuitive user interface for Moodle 2.0, implications are stated describing how users might fixate new navigation elements of Moodle 2.0 beta’s start screen as well as course page.

Firstly, when investigating Moodle 2.0's start page it has to be stated, that the breadcrumb navigation bar is still missing. To get users used to this important element it should be displayed from the beginning on. Therefore, any eye movement will cover the area represented with [A] in Figure 17.

Secondly, listing of courses should always have borders around. The Moodle installation of this paper had borders that were barely visible (similar to the borders in Figure 17 area [B]), this provoked that on the large eye tracking display there is a big gap between the titles and descriptions. Gaze plots of various students showed that they processed titles and their descriptions separately having hereby numerous jumps between the elements. Therefore it is recommended to border semantic elements, even stronger than in Figure 17 (area [B]).

Thirdly, the calendar block (see in Figure 17 area [C]) will have lots of early fixations after accessing the Moodle page as it is consisting of lots of small items. Eye tracking results of this paper showed that groups of small elements highly attract user's visual attention.

At last, don't forget to display your corporate identity or user's personal profile pictures! This study found out, that representative images with high information densities strongly attract user's attention! Furthermore, they are generating interest and contribute to users' involvement as well as mood.

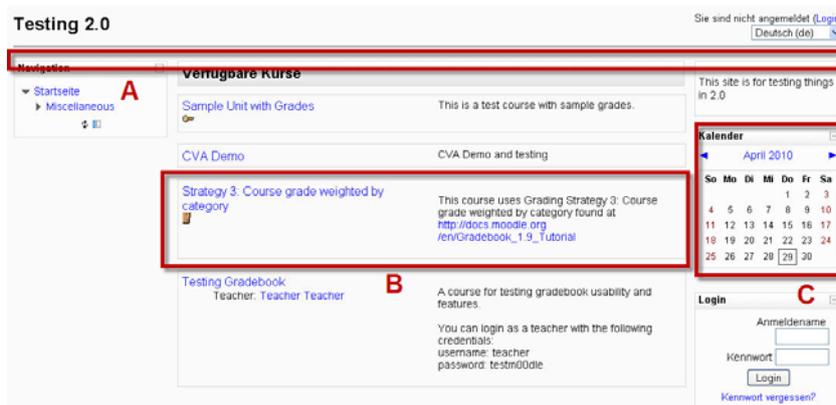


Figure 17: Moodle 2.0's welcome page



Figure 18: Moodle 2.0's new navigation

The visual focus of Moodle 2.0 will be probably the new Course navigation element enabling to display, navigate and fold topics (Fig. 18). Due to its interactive character, layout of small items and optimal navigation position in the top left corner, this element will highly attract users' attention. However, there are some concerns. Topics' captions have to stay visually distinguishable having hereby optimal font size, colours and sufficient gaps. If not, users' eye movements will increase as cognitive processing is handicapped.

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Author Portrait



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Function: Development of E-Learning and Usability

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