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Evaluation of eye movements: How do students percieve teaching materials within Moodle?

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Abstract: *This paper outlines how teaching material is 'seen' within pages of Moodle. The underlying experiment was carried out as a eye tracking study conducted among Austrian students. The investigation addressed the following research questions:*

> *How do students perceive teaching materials within Moodle? Which type of elements do they fixate first? How do students perceive images compared to text elements? How does the complexity of a teaching material influence eye movements and subsequently the learning process with Moodle? To which extent does student's involvement influence eye movements during learning? ...*

Discussion and analysis of the collected eye tracking data indicate some interesting results. The investigation indentified for example that difficult texts generate higher fixations as well as intense eye movements, which in succession cause decreasing of student's reading rate. Moreover distinctive eye tracking fixation patterns were detected indicating complicate information–extraction of learning materials. As a further example, involvement measurements implied that learners with 'high' involvement tend to process teaching material uniformly, whereas participants of the category 'low' adopt noticeably irregular fixation-densities, due to intentional skipping of content or monotone reading. To sum up, all the findings are subsumed in 'Seven Recommendations' (see section 4) that support effective presenting of teaching material within Moodle.

Keywords: *Eye-tracking, Moodle, e-learning, teaching, complexity, involvement*

1 Introduction

Eye Tracking: The foundation for using eye tracking is the assumption that there is a relationship between eye movements and cognitive processes [3]. 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. Eye tracking has not been adopted for e-learning research to a large extent. However it has been used quite frequently in usability studies [2] [4] [5]. To certain extent usability research can also be used as an input for eye tracking studies in the area of e-learning. [4], for example, points out that text is usually fixated longer than pictures. She also indicates that involvement is an important factor in eye

tracking research. Higher involvement, based on [5] categorization, is correlated with longer duration of fixation and more intensive gaze paths.

Eye tracking parameters: This study focuses on the investigation of education materials using eye tracking analysis [1] as central method. Eye movements and visual attention are detected and evaluated to determine aspects of learning within Moodle.

In general, 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 teaching material's importance, distribution of visual attention or the grade of element's distraction) and s*can path* (visualizing spatial distribution, the sequence of recorded fixations and indicating design efficiency of interface components). Fixation duration as well as fixation frequency are illustrated by heat maps and statistical analyses, whereas scan paths are visualized by gaze plots.

2 Description of Investigation

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. The complexity of the articles systematically varied from one teaching material to another, enabling to investigate the influence of complexity during learning process. Also graphics' level of detail systematically varied among different teaching materials allowing researchers to study their role as well as importance within learning with Moodle.

Procedure: In this experiment the order of selecting learning items was not predefined, participants were allowed to determine freely which parts of Moodle they wanted to explore. To evaluate eye tracking results from a holistic perspective, further qualitative interviews were carried out, before and after each eye tracking session. A fundamental aspect of analysis was that eye tracking had to be always evaluated in combination with questionnaires' results.

Participants & Technology: Participants of this eye tracking investigation were ten students of various fields of studies. The Tobii T120 eye tracker (Fig. 1) was used to collect eye movement data measuring eye movements by two binocular infra-red cameras placed underneath the computer display. Moodle was displayed on the integrated 17" monitor of the eye tracking system. For gaze analysis, visualization and statistical evaluation Tobii Studio developed by Tobii Technology was utilized.

Fig. 1 Tobii T120 Eye Tracker

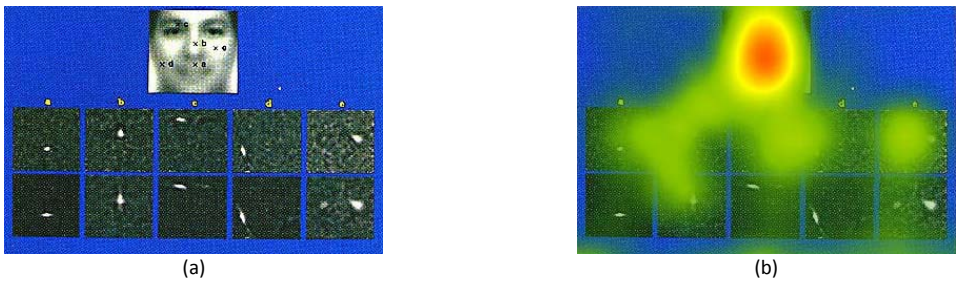
Hypotheses: The experiment addresses the following main research questions:

- → How do students perceive teaching materials within Moodle? How does complexity of a teaching material influence eye movements and subsequently the learning process with Moodle? Can unique scanning patterns be identified?
- → Do 'low' or 'high' involvement measurements affect processing Moodle? To which extent does involvement influence eye movements?
- → How do learners perceive text and images within Moodle? Specific investigations are undertaken to compare fixation-results of graphics and text blocks.
- → How do learners behave immediately after accessing Moodle? Which type of elements do they fixate first?

3 Results

Fixation results of text blocks and images: Text blocks and graphics had an important role during the learning process. Explicit comparison of these media types' eye tracking results indicate that images of higher detail-level were structuring visual attention remarkably and therefore had great impact upon the selecting order of learning material within Moodle. By contrast, images of low information density generated fewer fixations as they were processed superficially or were even completely ignored during learning.

An interesting outcome of the investigation is that participants' willingness of active information-extraction increases as they explore teaching materials that are made up of illustrative images, highly structured areas (such as enumerations or listings), personal aspects (for example faces, see Fig. 2) or unfamiliar or out-of-context objects. Eye tracking records and the qualitative interviews of this investigation clearly point out, that these elements enhance participants' level of attention and therefore their learning process itself. In regard of Moodle as well as the constructivist-learning theory they contribute to learning process by highly influencing exploration of teaching material. In conclusion content, which can't be missed, has to be 'highlighted' by informative images or by eye-catching structures.



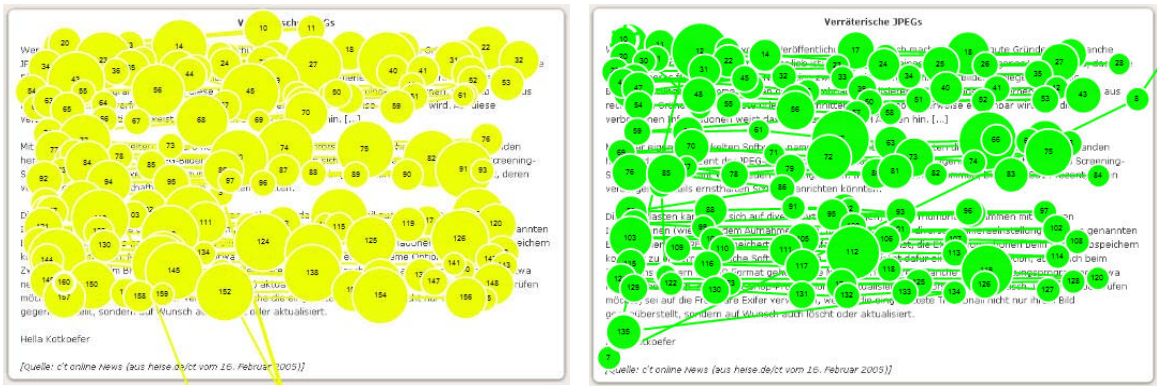
(a) (b)

Fig. 2 Willingness of information-extraction increases as personal aspects (such as faces) are displayed with education materials. This can be seen at red fixation intensity.

Furthermore the experiment also revealed that images were processed up to five times less (in relative to their spatial dimensions) than text blocks. Participants' fixation

results illustrate that text elements are ‘repository of knowledge’ however graphics and structuring elements (mentioned above) determine the path of visual attention.

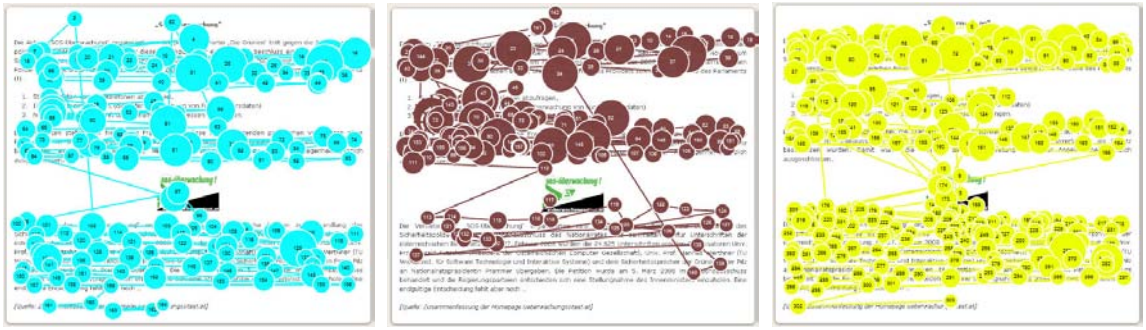
Complexity of teaching material: Investigation of text blocks indentified that difficult texts (or segments of text blocks) generate considerably higher fixation-densities. Furthermore duration of single fixations increase due to longer interpretation. Hereby statistical results point up, that participant’s reading rate significantly drops from 4.1 words per second to 2.9 w/s compared to ‘easy’ learning content. The reason for this distinctive effect is that ‘cognitive decoding’ respectively comparison with existing knowledge takes longer causing the eye to remain in a stable position. Also the amount of words detected with a single fixation drops (from 1.8 words per fixation to 1.3). Hereby participant’s visual focus decreases as efforts of high concentration were made. By the way it has to be stated that there is a high variance among participants as students facing difficulties have significantly different gaze plots (see Figure 3).



(a) (b)

Fig. 3 Size of dots indicates fixation duration. Students having difficulties (a) significantly have longer single fixations and fewer gaps between fixations.

Impact of Involvement: Evaluation of this factor was carried out in two categories ‘low’ and ‘high’. Participants were categorized based on their attitude towards ‘privacy’ that was surveyed during the interviews. Gaze plots of each category were summarized and compared (Figure 4).



(a) (b) (c)

Fig. 4: Highly involved participants (a) have uniform density and variance of fixation. Students of low involvement (b) and (c) have greater gaps and monotone or highly irregular fixations.

The results point out, that learners with 'high' involvement tend to generate uniformly distributed gaze plots. By contrast, participants of the category 'low' cause gaze plots that have noticeably irregular densities and also there is high variance between single fixations. Furthermore scan paths have either greater gaps among fixations, this indicates intentional skipping of content, or monotone minimal distances between fixations. Qualitative interviews revealed that participants of 'low' involvement could not reproduce contents of these articles. These participants processed teaching material with monotonous eye movements. Hereby, information extraction was rather visually than cognitively.

First Fixations: To investigate initial gaze, media elements of each article were categorized by four areas of interest (text blocks, captions, images and navigation elements). Afterwards, the areas were evaluated by the parameter *'time to first fixation'* to determine the sequence of visual fixation.

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 Seven Recommendations

In this part seven recommendations are presented evolving from the conducted eye tracking study. These aspects should help Moodle teachers or 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 reception of information.
3. Make students curious to increase their involvement!
4. Use borders to visually pre-segment your education material. Students' eye movements will focus on parts of your choice!
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 colors for different semantic approaches and be consistent!

5 Conclusion

This paper describes how learning materials are 'seen' within Moodle. It points out which elements are seen first as well as which of them are preferred during students' learning process. Furthermore it introduces seven recommendations enabling Moodle teachers to educate and present materials more effectively within Moodle. Moreover this paper's results contribute to better understanding how students work and learn within Moodle courses.

Strategies were introduced that help teachers producing educational material that is eye-catching and facilitates student's learning process within Moodle. The experiment also revealed how teaching material's complexity and student's involvement influences learning in Moodle. Hereby, fixation patterns could be detected that signalizes complicated information-extraction. Further utilization of these findings might be used to improve existing monitoring systems that automatically recognize learning difficulties.

References

1. Duchowski, A.T., 2003. *Eye Tracking Methodology: Theory and Practice.* Springer-Verlag, London, United Kingdom.
2. Jacob, R.J.K. and Karn, K.S., 2003. Eye Tracking in Human-Computer Interaction and Usability Research: Ready to Deliver the Promises. In: J. Hyona, R.R. Radach, H. Deubel (eds.), *The Mind's Eye. Cognitive and Applied Aspects of Eye Movement Research.* Oxford: Elsevier, pp. 572-605.
3. Just, M.A. and Carpenter, P.A., 1976. Eye Fixations and Cognitive Processes. *In Journal of Cognitive Psychology* Vol. 8, pp. 441-480.
4. Kain, S., 2007. *Erfassung der Aufmerksamkeitsverteilung auf Webseiten.* VDM Verlag Dr. Müller, Saarbrücken.
5. Rayner, K., 1978. Eye movements in reading and information processing. *In Psychological Bulletin*, Vol. 85, pp. 618-660.
6. Zaichkowsky, J.L., 1985. Measuring the involvement concept. *In Journal of Consumer Research*, Vol. 12, No. 3, pp. 341-352.

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