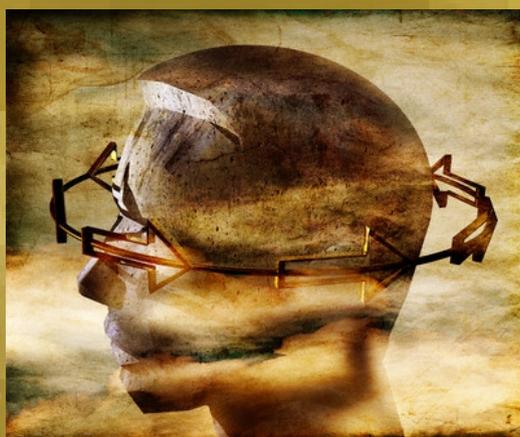


IADIS INTERNATIONAL CONFERENCE



CELDA

2009

COGNITION AND
EXPLORATORY LEARNING
IN DIGITAL AGE

20 - 22 NOVEMBER ■ ROME, ITALY

PROCEEDINGS

EDITED BY:
KINSHUK
DEMETRIOS G SAMPSON
J. MICHAEL SPECTOR
PEDRO ISAÍAS
DIRK IFENTHALER



iadis

international association for development of the information society

IADIS INTERNATIONAL CONFERENCE

on

**COGNITION AND
EXPLORATORY LEARNING IN
DIGITAL AGE
(CELDA 2009)**

**PROCEEDINGS OF THE
IADIS INTERNATIONAL CONFERENCE
on
COGNITION AND
EXPLORATORY LEARNING IN
DIGITAL AGE
(CELDA 2009)**

ROMA, ITALY

NOVEMBER 20-22, 2009

Organised by
IADIS

International Association for Development of the Information Society

Copyright 2009

IADIS Press

All rights reserved

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Permission for use must always be obtained from IADIS Press. Please contact secretariat@iadis.org

Edited by Kinshuk, Demetrios G Sampson, J. Michael Spector,
Pedro Isaías and Dirk Ifenthaler

Associate Editors: Luís Rodrigues and Patrícia Barbosa

ISBN: 978-972-8924-95-9

TABLE OF CONTENTS

FOREWORD	xiii
PROGRAM COMMITTEE	xv
KEYNOTE LECTURES	xix
INVITED SPEAKER	xxi
CONFERENCE TUTORIAL	xxii

FULL PAPERS

LDCAKE: A VISUAL EDITOR OF UNIT OF LEARNINGS <i>Telmo Zarraonandia, Esther Guerra, Paloma Díaz and Ignacio Aedo</i>	3
THE PLAYGROUND IN THE CLASSROOM – FRACTIONS AND ROBOT TECHNOLOGY <i>Gunver Majgaard</i>	10
ON THE DEVELOPMENT OF ROBOTIC ENHANCED LEARNING ENVIRONMENTS <i>Stassini Frangou and Kyparisia A. Papanikolaou</i>	18
CROSSING BOUNDARIES WITH GEODROMO: AN INTERACTIVE CROSS-MEDIA EXPERIENCE <i>José Bidarra and Olímpio Martins</i>	26
THE STUDY OF CONTENTS CONSTRUCTION & MECHANISM FOR E-LEARNING- FOCUSING ON “MODEL OF RHYTHM FOR UNDERSTANDING” <i>Naomi Nagata and Toshio Okamoto</i>	33
SEMANDIX: CONSTRUCTING A KNOWLEDGE BASE ACCORDING TO A TEXT COMPREHENSION MODEL <i>Panagiotis Blitsas, Maria Grigoriadou and Christos Mitsis</i>	41
BRIDGING THE GAP BETWEEN EXPERT-NOVICE DIFFERENCES: THE MODEL-BASED FEEDBACK APPROACH <i>Dirk Ifenthaler</i>	49
ANALYSIS AND DESIGN OF THE PORTAL OF WEBQUESTS IN PORTUGUESE LANGUAGE <i>João Batista Bottentuit Junior and Clara Pereira Coutinho</i>	61

LEARNING THROUGH EMERGING TECHNOLOGIES AND KNOWLEDGE BASED INTERACTIONS <i>Jorge Ferreira Franco and Roseli de Deus Lopes</i>	439
CONSTRUCTIVISM IN NURSING EDUCATION <i>Julia Greenawalt and Dolores Brzycki</i>	443
A COURSE ON PROGRAMMING FOR BEHAVIORAL SCIENCES STUDENTS <i>Rachel Or-Bach</i>	447
SOCIAL MEDIA AND SOCIAL LEARNING: A PERFECT FIT OR A CLOSE ENCOUNTER? <i>Nada Dabbagh and Rick Reo</i>	453
STUDYING ENGINEERING ETHICS USING AN ONLINE ENVIRONMENT: EMBEDDED AND QUESTION LINKS <i>Rose M Marra, David H. Jonassen, Demei Shen, Jenny Lo and Vinod Lohani</i>	457
AN APPROACH FOR DYNAMIC STUDENT MODELLING OF LEARNING STYLES <i>Sabine Graf and Kinshuk</i>	462
EYE TRACKING STUDY OF THE E-LEARNING ENVIRONMENT MOODLE: INVESTIGATION OF USER-BEHAVIOR <i>Gergely Rákóczi and Margit Pohl</i>	466
ENCOURAGING REFLECTION IN SIMULATION GAMES <i>Xin Bai</i>	470

REFLECTION PAPERS

SEVENTH GRADE STUDENTS' CONCEPTUAL AND PROCEDURAL KNOWLEDGE ABOUT RATIO AND PROPORTION <i>Zeynep Sonay Polat, Feride Özyıldırım, Oylum Akkuş İspir, Sema İpek and Berna Aygün</i>	477
THE DEVELOPMENT OF MODEL OF SUSTAINABLE DISTANCE LEARNING MANAGEMENT IN LITHUANIA <i>Arturas Kaklauskas, Natalija Lepkova and Silva Rimkuviene</i>	480
MENTAL CHARACTERISTICS IMPLEMENTATION OF THE SOFTWARE AGENTS IN THE TUTORIAL SYSTEM <i>Oleg Fedyayev and Tatyana Zhabskaya</i>	482
COGNITIVE LOAD THEORY AND WEB 2.0 <i>Steve Bennett</i>	484
DESIGNING ONLINE EDUCATIONAL GAMES FOR THE NE(X)T GENERATION <i>Sofia Mysirlaki and Fotini Paraskeva</i>	486
EXPLORING A BLENDED LEARNING ECOSYSTEM IN THE ACADEMIC ENVIRONMENT <i>M. Nikolaidou, Cr. Sofianopoulou, N. Alexopoulou, K. Abeliotis, V. Detsis, Ch. Chalkias, K. Lazaridi and D. Anagnostopoulos</i>	489

EYE TRACKING STUDY OF THE E-LEARNING ENVIRONMENT MOODLE: INVESTIGATION OF USER-BEHAVIOR

Gergely Rákóczi

*E-Learning Center, Vienna University of Technology
Gußhausstraße 28, A-1040 Vienna, Austria*

Margit Pohl

*Institute for Design and Assessment of Technology, Vienna University of Technology
Favoritenstraße 9-11, A-1040 Vienna, Austria*

ABSTRACT

This work describes an eye tracking study of the e-learning system Moodle outlining how Moodle's learning materials are explored, selected and processed. The goal of this study was to investigate several cognitive variables and the exploratory learning processes itself. The experiment addressed research objectives such as the individual order of selecting learning material, the visual scanning of Moodle's environment, the importance of "Gestalt laws" respectively rules of pre-attentive perception, the influence of the involvement-factor as well as usability aspects.

Discussion and analysis of the collected survey data indicate some interesting results. The investigation identified that first fixations of a Moodle page basically reveal a sort of 'inventory' of informative elements and that visual perception-rules highly structure participant's exploration. Moreover 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.

KEYWORDS

Eye-tracking, e-learning, user-behavior, Gestalt laws, Moodle, usability.

1. INTRODUCTION

Eye tracking is being used increasingly in HCI and usability research (Jacob & Karn 2003). Such research has been adopted to link eye tracking data to cognitive processes. In this way, researchers try to get insights into the perceptual and thought process software users engage in. The following paper describes an eye tracking study of the e-learning system Moodle. Moodle is based on a constructivist learning approach and supports exploratory learning processes. To do this study, an experimental e-learning system was developed, which systematically varies different variables aiming to investigate cognitive variables on the basis of hypotheses, described in section 3.4.

2. RELATED WORK

Eye tracking has not been adopted for e-learning research to a large extent. Jacob and Karn (2003) distinguish between two different areas of eye tracking research in usability studies – analyzing interfaces on the one hand and eye tracking as a kind of medium of control. Eye tracking as a medium of control implies that the computer reacts to the users' actions based on eye tracking data. This distinction can also be observed in e-learning research, although some of the investigation combine both. Pivec et al (2006), for example, report an ongoing study about using eye tracking research as a basis for the development of an adaptive e-learning system, that monitor learners' behavior.

Eye tracking has been used frequently in usability studies (for an overview see e.g. Kain 2007). She indicates that involvement is an important factor in eye tracking research. Higher involvement, based on Zaichkowsky's (1985) categorization, is correlated with longer duration of fixation and intensive gaze paths.

More general research from the area of HCI is also relevant for eye tracking research subsequently for the area of e-learning. Nielsen (2001) reports research concerning the sequence of scanning screen-objects. He assumes that headlines are examined first, then pictures as well as diagrams followed finally by text. This assumption is also tested in our study. Ware (2000) describe the Gestalt laws of perception as well as pre-attentive factors and their influence on human information extraction and for learning processes.

Beymer et al (2007) found out that pictures of high information density slow down reading. They assume that this is due to the readers making an effort to relate the pictures to the text.

In general, there is some eye tracking research in e-learning, but many of the reported 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 eye tracking. The study reported in this paper is a contribution in this area.

3. DESCRIPTION OF INVESTIGATION

3.1 Learning Environment

The subject matter of this experiment is an instance of Moodle. Moodle is an open source LCMS application (learning content management system) based on the didactic principle of constructivism. In Moodle learners construct their individual learning situation by interacting with educational material provided by teachers.

The general topic of the learning environment was about 'privacy'. Four tasks and five articles of three various fields were provided within Moodle courses. Each educational material was presented with a headline and included text blocks and graphics. Graphics' level of detail systematically varied among different articles allowing researchers to study their role within learning. The investigation's outcomes were not limited to simple reading of the articles, but rather the learning environment was studied as a whole.

3.2 Methodologies

This non-repeated single study focuses on the investigation of user-behavior using eye tracking analysis (Duchowski, 2003) as central method. There are three main eye tracking parameters used within this experiment: *fixation duration*, *fixation frequency* and *scan*. Fixation parameters are illustrated by heat maps and statistical analyses, whereas scan paths are visualized by gaze plots.

Eye tracking outcomes were always evaluated in combination with interviews' results. Firstly, immediately before beginning the eye tracking tests, participants were questioned based on the method of 'partly standardized qualitative interview' (Flick, 2005) about their learning behavior and computer skills. Immediately after finishing the eye tracking session participants had to jot down content they could remember and impressions of their experience gained during working with the learning environment in sequence, as recollected. This process should identify areas, that had crucial impact upon each participant. Afterwards a guideline-oriented interview took place, investigating participants' experiences towards comprehensibility, involvement to privacy and difficulties caused by teaching materials, tasks or navigation.

3.3 Experiment

Participants of this study were students of various fields of studies. A total of 10 participants, 6 males and 4 females, were recruited and their ages ranged from 21 to 25. Exclusionary demands had to be met: Firstly, participants were not allowed to have practical experience with MOODLE, secondly all participants had to be at least regular computer users, having basic computer competence and thirdly only people, who didn't wear glasses or contact lenses, were eligible for the study due to limitations of eye tracking equipment.

The Tobii T120 eye tracker was used to collect eye movement data. 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. No chin rest was used due to enable freedom of head movements. For gaze analysis and statistical evaluation Tobii Studio was utilized.

3.4 Hypotheses

The experiment addresses the following main research questions: How do learners behave immediately after accessing single pages of the learning environment? Which type of elements do they fixate first? Do pictures' information density influence their exploration or their learning-behavior? Can specific eye fixation patterns be found by analysis of rules of 'pre-attentive perception' or 'Gestalt laws'? Do 'low' or 'high' involvement affect processing Moodle? To which extent does involvement influence eye movements?

4. RESULTS

Accessing the learning environment: To investigate initial fixations, 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.

Influence of perception laws: Evaluation of eye tracking results clearly demonstrated that visual perception rules structure participant's exploration and have apparent influence towards selecting Moodle's elements.

Due to the Gestalt Law of 'Shared Region' and the pre-attentive factor of 'Enclosure' tool boxes generated blobs of fixations. As qualitative interviews revealed this clustering effect eased remembering, locating and memorizing of Moodle's elements. Numberings, listings and enumerations were the highest fixated elements of Moodle (Figure 1). The combination of the Gestalt Laws 'Proximity' and 'Common Fate' respectively the pre-attentive rules of 'Shape' and 'Spatial Position' unconsciously influenced user's attention. As interviews revealed most participants could reflect all elements of the enumeration.

By contrast to these examples, also misleading use of visual perception rules could be detected within Moodle. For example, difficulties on Moodle's welcome page were detected. Teaching materials and their descriptions were illogically grouped by Gestalt Law of 'Proximity'. Eye movements revealed that students processed learning materials and their descriptions independently. Gaze plots show a remarkably high amount of jumps between these elements. Hereby inefficient grouping caused noticeable usability 'disorientation'.



Figure 1. Heat map analyses (a) illustrate that enumerations (b) were fixated highest within Moodle pages. Numerical listings have clearly emerged as most 'structuring' elements and as an effective way of presenting content to learners.

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

guideline oriented interview. Gaze plots of each categories were summarized and compared (Figure 2). 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 the variance of fixations is significantly higher. Furthermore scan paths have either greater gaps among single fixations (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.

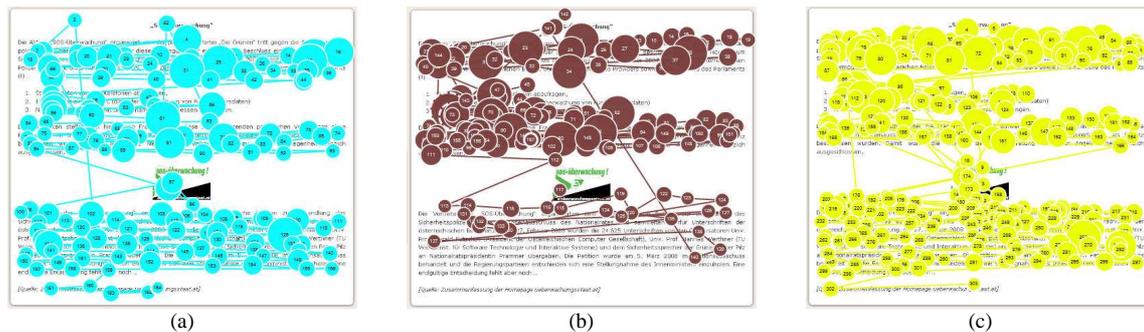


Figure 2. Gaze plots of highly involved participants (a) are characterized by uniform density and variance of fixation duration (size of dots). By contrast, 'low' involvement has greater gaps, monotone and/or highly irregular fixations (b,c).

5. CONCLUSION

This work outlines how learning materials are 'seen' within Moodle. It points out which elements are seen first as well as which of them are preferred during the learning process. A possible application of this work's results could be a summarized catalogue of usability improvements that could contribute to the Moodle community. As a result students and teachers can operate more effectively in Moodle. In addition this work reveals the importance of perception rules that highly structure exploration within learning environments. 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 student's involvement influences learning in Moodle. These findings can be used in future work to improve existing monitoring systems that automatically recognize learning difficulties.

REFERENCES

- Beymer, D., et al, 2007. An Eye Tracking Study of How Pictures Influence Online Reading. *Proceedings of the INTERACT 2007 conference*, Rio de Janeiro, Brasil, pp. 456-460.
- Duchowski, A.T., 2003. *Eye Tracking Methodology: Theory and Practice*. Springer-Verlag, London, United Kingdom.
- Flick, U., 2005. *Qualitative Sozialforschung*. Rowohlt-Taschenbuch-Verlag, Hamburg, Germany.
- 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.
- Kain, S., 2007. *Erfassung der Aufmerksamkeitsverteilung auf Webseiten*. VDM Verlag Dr. Müller, Saarbrücken.
- Nielsen, J., 2001. *Designing Web Usability*. Markt+Technik Verlag, München, Germany.
- Pivec, M., et al, 2006. Eye Tracking Adaptable e-Learning and Content Authoring Support. In *Informatica*, Vol. 30, pp. 83-86.
- Ware, C., 2000. *Information Visualization. Perception for Design*. Morgan Kaufman, San Francisco, USA.
- Zaichkowsky, J.L, 1985. Measuring the involvement concept. In *Journal of Consumer Research*, Vol. 12, No. 3, pp. 341-352.