Improving student reading comprehension of learning materials using the analysis of Eye-Tracking data

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3 authors, including:

Michal Kohutek
University of Constantinus the Philosopher in Nitra - Univerzita Konstant'na Filoz…

Martin Magdin
University of Constantinus the Philosopher in Nitra - Univerzita Konstant'na Filoz…

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Improving student reading comprehension of learning materials using the analysis of Eye-Tracking data

M. Kohútek*, M. Turčáni* and M. Magdin*
*Department of Computer Science, Constantine the Philosopher University, Nitra, Slovakia
michal.kohutek@ukf.sk, mturcani@ukf.sk, mmagdin@ukf.sk

***Abstract*—The paper deals with the creation of effective e-learning courses, the task which in many cases is non-trivial. Many currently in use e-courses do not meet the principles of e-course creation, thus significantly reducing their effectiveness. In order of making it easier to identify deficiencies, we have decided to design an experiment using eye-tracking technology to pinpoint key areas in which it is necessary to enrich the e-courses with interactive multimedia elements, explanatory notes, etc. In the first part of the experiment, we will use a combination of questionnaires, personal interviews, and eye-tracking methods to identify gaps, or any suggested improvements to the content of the courses. Subsequently, we will adjust the e-courses created in this way according to the feedback received, following the principles of e-course creation described in the literature. We will verify the result with an experiment in which the control group will study using the original e-courses, while the new courses will be made available to the experimental group.**

***Index Terms*—e-learning, e-courses, eye-tracking, constructivism, LMS Moodle**

I. Introduction

In the past decade, learning through various e-learning courses has become ubiquitous. The implementation of educational ICT in both the developed and emerging countries has reached a level, where it is no longer a technological but rather didactic issue. In this article, we will summarize a number of experimentally validated e-course creation principles and propose an experiment to evaluate the courses we will have created using the eye-tracking method.

E-learning is ideologically based on constructivism theory. It is an approach to learning that is based on the idea that cognitive process (learning) is the result of "mental construction". Students learn by linking new information with the knowledge they already have. Constructivists believe that the process of learning is influenced by the context in which the idea is learned, as well as by the views and attitudes of the student. Constructivism, as a theory focuses on the learning process, and is largely based on the field of psychology, which explains how people acquire knowledge and learn. Two important schools of thought are based upon this idea of constructing knowledge. First school claims, that students are constructing new thoughts or opinions using that, which they already knew. Students bring along their past experiences and they influence the newly built knowledge resulting from new experiences. The second school of thought claims, that learning is a more active process, rather than a passive one. Students confront their previous experiences with what they observe in current situation. If what the students observe is not consistent with their previously gained knowledge, their understanding will adjust accordingly to incorporate new information. The students remain active during the whole process, they apply new experiences, take notes of relevant details from them and evaluate the consistency of older and newer information and based upon this evaluation, they adjust their knowledge [1]. Zhu [2] claims, that education by means of e-learning is not only conducted either objectivistically or constructivistically, as two contradictory theories, but through a combination of the two. Students collaborate online on assignments, in which every student contributes with their present knowledge and experience. The group members approach the information and theory together and construct their knowledge in process of online interaction. In other words, the knowledge is constructed and skills are developed through working together with e-learning materials. With the development of interactive technology and its widespread use, e-learning no longer serves as a transfer medium for information, but also encompasses collective learning, collaboration, asynchronous and synchronous interaction between students and teachers.

From technical point of view, e-learning is divided into several categories. Besides the traditional perception of e-learning as online learning, it encompasses all the educational activities, which are conducted by individuals or groups, online or offline, synchronously or asynchronously using personal computers and other electronic devices. M-learning is both technically and content-wise a very separate subcategory. It is a logical evolution of the idea of e-learning, taking full advantage of mobile devices. M-learning allows students to learn in various environments, while on the move without the need to spend time in their classrooms or sitting at their desks. E-learning and m-learning are also different in the design of courses and user interface. In e-learning, we are allowed to assume that the student is sitting comfortably at the desk, in front of a large screen and can use a computer mouse to navigate the interface. Therefore the courses can be more complex, consist of images and multiple paragraphs of text

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and take longer to go through. In contrast, while creating m-learning courses, we have to take into account the possibility, that students are reading them on the go, using a device with small screen, such as a smartphone and thus the courses need to be shorter, simpler and the lecture must be confined to a narrower context [3].

Based on time synchronicity, e-learning is divided into synchronous and asynchronous. While synchronous s e-learning is dependent on time and based upon online chat, video-calls and real-time communication between students and teachers, asynchronous systems are time independent. These types of courses can be fully experienced while the teacher is offline. Communication is carried out via email and message boards, students go through the course independently and on their own time. The advantage here is the time flexibility, while the disadvantage is the somewhat isolated nature of learning in this manner and the missing interaction between students and teachers. An interesting combination is blended learning, which combines the traditional education with online courses. It takes advantage of the features of LMS[1] and mobile devices. Due to the ever increasing connectivity, people can create entire virtual classrooms, in which the whole communication is carried out online, using group videoconference calls. This concept breaks down geographic barriers and is called "Anywhere learning". The lectures can be recorded and are organized much faster than by traditional means. An extension of asynchronous learning is a so-called adaptive learning, which refers to automatic adaptation of e-learning materials to individual students, considering his unique skill-set and behaviour. Adaptive e-learning systems take note of students' activities and adjust it's operation based on this information. This adaptation can take several forms:

- adaptive aggregation of content - serving different content based upon simulation and games.
- adaptive presentation - presented information can be enriched with prerequisite knowledge or additional facts and explanations. The very same course lecture can look very different to different students.
- adaptive interface - the interface can adjust based on the needs of individual students [4].

Specific e-learning systems differ in their implementation, license and focus. Besides widely used systems such as Blackboard or LMS Moodle, there are specialized solutions, like AdeLE [2], e5Learning or iDict. iDict is an e-learning system designed for professional translators, which uses gaze tracking to show relevant hints or translations of difficult words and phrases. e5Learning allows teachers to set up restrictions, such as the length of time students are allowed to look at a single image or block of text. It's features include a rudimentary emotion recognition, recognizing the states of "high concentration", "incomprehension" and "fatigue" [5]. e5Learning consists of three main components - Monitor of Accessed Screen Areas, Contextual Content Generator and Emotion Recognizer. Using these three connected components, the researchers can analyse on which areas of selected e-course the students focus their attention, dynamically display related information based upon the gaze of the students and approximately recognize students' emotional states, their level of concentration, fatigue or to identify potential issues with understanding the current lecture. In that case, the system can display additional resources, explanations or if a pre-defined amount of time has passed, suggest the student takes a break. Similarly to other systems, e5Learning estimates the cognitive load based upon the blinking frequency, fixations and pupil dilatations [6].

[1]Learning Management System

[2]Adaptive e-Learning with Eye tracking

At the Constantine the Philosopher University in Nitra, we use the LMS Moodle to create and distribute e-learning study materials. Due to it's extensibility by various modules, it allows us to create logs of student logins, activities and other useful data. For example, in the area of student activity, we note that a significant proportion of all students (14 out of 25) have completed all the course activities, while only 4 students have completely ceased to be active in the course after the first few hours. The rest of the students sometimes did not fulfil a specific activity, but participated in most of the activities offered.

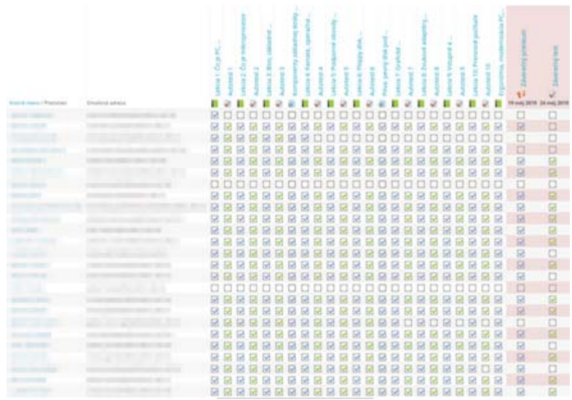

Fig. 1. Visualisation of student activities.

In contrast, we see great potential in improving the regularity of students accessing the e-courses. When looking at e-course access logs, we have to state that students show most interest in e-courses at the beginning of the semester and during the exam period. The space for improvement is therefore in the area of continuous student motivation, revising and practising throughout the semester.

The purpose of this paper is to present a new approach in assessing the benefits in both the evaluation of current e-learning courses and by taking note of their shortcomings to create new, more effective e-courses. Therefore, in our research, we have raised the following research questions:

- **Q1** How to accurately identify the problematic sections of existing e-courses
- **Q2** Which methods described in the literature need to be used to design new e-learning courses in order to maximize knowledge retention?

- **Q3** How to experimentally verify whether the new courses brought the expected improvement in the results and interest of the students in the presented lectures?

II. Related Works

In our pedagogical research, we focus primarily on modifying existing and designing new e-learning courses based on the principles and methods that are explored and used by psychologists, didactics, and online marketers. Erich Petlak's work has proven to be an invaluable source of didactic knowledge. He describes the so-called "teaching principles" as the most general or fundamental requirements that determine the nature of the educational process in accordance with the objectives and its basic patterns. They determine that it should be appropriate, illustrative, systematic, etc. These principles include inter alia the principle of clarity and the principle of proportionality. It is these two principles that apply very well to the use of e-learning courses where we can illustrate phenomena and subjects with the use of multimedia and dynamically adapt the courses themselves to the students' biological and psychological abilities. We can also use Petlak's methodological recommendations as a template for e-courses - to highlight important things, to continuously test students, apply different methods of differentiated teaching [7].

The usefulness of multimedia in education is deeply addressed by Richard Mayer. He has published a number of articles, in which various aspects of multimedia and many generalized hypotheses and perspectives are discussed. The basic premise of his work is that people achieve a deeper understanding of the combination of words and images than just the words themselves. This assumption is also called the "multimedia hypothesis". What do we understand under multimedia education? To Mayer, multimedia means a way of communicating information via words (whether spoken or printed) and images (such as illustrations, photos, animations or video) at the same time. Such a broad definition encompasses various cases - multimedia encyclopaedias, online learning games or textbooks. Mayer demonstrates the added value of combining multiple media on an example. If the mechanism of the bicycle pump is described purely by words, students have little problem to remember individual processes and to repeat them at the exam (test of retention), but they do have problems in application of such knowledge in a test focused on problem solving skills (test of transfer). In contrast, an animated picture showing the movement of the pump's piston without any explanatory text wouldn't help the students in neither of the aforementioned situations. If we chain the animation with an verbal explanation, students do score better in both the tests of retention and transfer of knowledge. Mayer calls this effect the "multimedia principle".

There are two widespread explanations of this effect - quantitative and qualitative. The quantitative view is that if we present the information in two ways, the student de facto perceives the substance twice, just as on a two-lane road, twice as many cars can travel at the same time. Mayer rejects this view because of his incompleteness. He rejects the assumption that words and images are two equivalent ways of presenting an idea. In contrast, a qualitative perspective says that words and images are qualitatively different, but complementary and that human understanding is increased when students can mentally integrate visual and verbal representations of the same idea. The qualitative view assumes that these two media are not equivalent, and that words are useful for presenting a certain type of ideas, for example, ideas more abstract in nature, while images better present intuitive, harder to describe processes. Understanding occurs when students build meaningful links between verbal and visual representations. However, image materials are not all equally effective. Although current technologies make it possible to create excellent visualizations, this does not mean that all teachers are properly trained to create and use them. It is therefore necessary to carry out further research and education on how people learn from illustrations and texts and how to properly create multimedia materials [8].

Mayer further develops the principles of creating multimedia teaching materials and explains his model of multimedia learning. It is based on three principles of cognitive science: the dual channel principle, the principle of limited capacity and the principle of active processing.

- Dual channel principle - people have different processing channels for visual and verbal information.
- The principle of limited capacity - people can simultaneously handle only a few elements in each channel.
- The principle of active processing - significant learning occurs only when students actively process information

It is therefore important for teachers to create multimedia materials that encourage cognitive processes of selection, organization and integration, without overloading visual and verbal channels in memory.

To reduce unnecessary processing unrelated to the matter, Mayer lists five principles:

- Coherence principle - removal of excess material.
- Signalling principle - highlighting important material.
- The principle of redundancy - people learn better from images and interpretations than from images, interpretations and text.
- The principle of spatial context - Follow-up text should be placed near the corresponding part of the image.
- The principle of temporal context - Images and interpretation should be presented simultaneously [9].

In [10], Mayer further explores the effects of following Mayer's multimedia principles in creating the lectures for medical students. His team has created two groups, a control group of 37 subjects, taught by teachers using pre-existing study materials. The second, experimental group, consisted of 43 students of the same year with the same matters presented, but with a presentation modified using Mayer's principles. In this presentation, the bulleted text has been replaced by a visual representation. In addition, all images and text not directly related to the content of the lecture have been removed. According to Mayer's signalling principle, all the important parts were highlighted in a different color and larger font. The graphs and the follow-up text were placed next to each other, according to the principle of spatial connection. Finally, based on the modality principle, the slides explaining the complex substance were replaced by visual representation and supplemented by spoken explanation. These adjustments reduced the number of slides from 35 to 28.

The students have been given a pre-test, an immediate post-test one hour after the lecture and delayed post-tests 1 and 4 weeks after the lecture. The tests were all identical and lasted 10 minutes. Students who missed one or more tests were discarded from the experiment and the final number of student subjects was reduced to 40 in the experimental group and 31 in the control group. The results of the experiment showed a significant improvement in the effectiveness of the lecture in the experimental group not only in the short term - test of retention, but also in the long-term application of knowledge - test of transfer [10].

No less important than the multimedia inclusion are the typographic properties of the text. The importance of text features such as font, spacing and so on was covered in [11]. Demir and Ceylan, among other things, describe the term font, as a word including all the features of the text, such as font character, style and size. It is therefore necessary to choose the correct font for readability and visual impression of the course. They claim that serif fonts are more readable than sans serifs and discourage combining serif and sans serif fonts in the same text category. The spaces between letters, words and lines are also important. Properly selected letter spacing is crucial for readability.

For qualitative assessments of e-learning systems and courses, many research teams have focused on modeling student behavior. Therefore, studies are conducted using questionnaires, various modules in e-learning systems and data mining. In [12], authors model user behaviour in e-learning based on interactive animations. The behaviour of the experimental group fulfilled expectations and showed that the addition of interactive animations to the e-learning course increased the frequency of course access. It is also interesting to note that the control group, which did not have access to interactive animations, was less attentive to the lessons learned, even though they had been given a written test. In addition, in the questionnaires, students included in the control group said they were often frustrated and irresponsible. However, the results also show a trend of decreasing these differences in both groups, which may be due to more similar e-courses containing interactive animations.

An important tool in exploring how students approach study materials is the eye-tracking method. It's use is mentioned in [13]. In a study aimed at distinguishing between the categories of learners - verbalizers and visualizers - using the eye-tracking method, the authors used the lengths and concentrations of fixations to create a map of transitions where the difference between these two categories is easily visible to a naked eye. Verbalizer fixations are mainly concentrated on the text of the lesson, while visualizers often skip from text to illustrations and back. Such a map of transitions can be very helpful in personalizing e-learning courses based on the learner category [14].

III. Material and Methods

The eye-tracking method itself is a historically well-researched method as it is much older than, for example, face detection. The first eye movement recording was created in 1901 using a photochronograph (Thomas Clinet). However, the eye-tracking method has improved over time, using mathematical algorithms to determine the pupil's position, it has become a modern technology that examines eye movements while reading or concentrating on a particular product (use in neuromarketing). The eye-tracking method allows the subject to read texts without interrupting the reader's pace [15], while providing valuable data regarding text observation, as it allows for continuous monitoring of movements and variations of pupils' size during reading. The movement of the eye is partly controlled from the middle brain, that is, it is not fully controlled by human consciousness. Therefore, the movement of the pupil is not influenced by the reading. In this respect, the eye-tracking method provides relatively accurate information about eye movement. The various movements that can be recorded via eye-tracking include tracking, shaking, circling, panning, fixation and saccades. The most important movements that are evaluated by the eye-tracking method are fixations and saccades. When reading or observing a particular situation, the eyes of the person do not move smoothly along the lines, but they "jump" along. While reading, it is the movement between the words when one can perceive 2-4 different words at the same time and therefore can read the text quickly. In the case of observing images, or watching a particular life situation, a person can focus on a particular point of interest in the situation. This stop is called fixation and the jumps (moving to another observation point) are called saccades.

Based on previous studies, there is a consistent link between human fixation and cognitive processes [16]. Mapping the content of where and how long a person is looking at reading is a graphical technique [17] which seeks to illustrate the understanding of the content of the learning material provided by students. The result of such mapping is a graphical conceptual map that can help researchers understand how students work with the provided learning materials, while summarizing and synchronizing knowledge [18].

There are several types and price categories of eye-trackers on the market. in [19], authors compare several parameters of the Pupil Labs eye-tracker and a much more expensive EyeLink 1000. In the calibration, although more expensive equipment was more accurate, both devices were comparably good. Pupil Labs lost calibration more quickly and had to be recalibrated to ensure maximum recording accuracy. However, in general, the accuracy of the Pupil Labs recording lags behind the significantly more expensive EyeLink 1000, especially in the tasks where the so-called micro-saccades have been measured. Pupil Labs eye-tracker also often failed to detect blinking.

When measuring the contractions of the pupils, there were differences in the measured values, measuring a larger area in case of either Pupil Labs, or EyeLink 1000. This was different in various participants and within the group this effect may be lost. Therefore, both devices are suitable for measuring variations in pupil size [20].

However, this does not disqualify Pupil Labs from use in our experiment, although it is necessary to take into account the greater tolerance in the size of so-called Region of Interest (ROI). That being said, Pupil Labs is almost unusable for experiments where it is necessary to record micro-saccades as it captures only 55% of them. Head movements also have a very negative impact on measurement accuracy, which is true for every eye tracking device. The software supplied with the Pupil headset also has other, useful features for our experiment. We can use the so-called chessboard markers to generate maps of interest (heatmaps), that show which parts of the course the students are most interested in. In addition, it uses the ZeroMQ framework for interprocess communication, allowing additional programs to connect to it. In this way, we can record a lot of data, such as the size of pupils, blink occurrences, as well as the detailed position of the pupil with respect to the user's head, but also the text he is looking at.

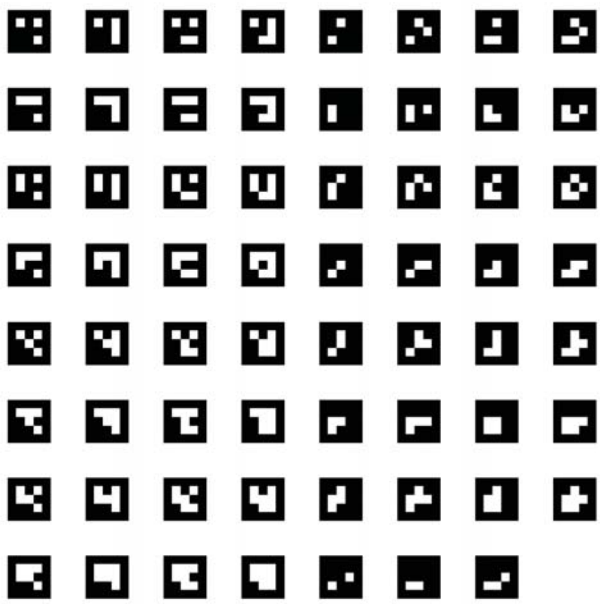

Fig. 2. Chessboard markers generated and used by Pupil Labs.

Changes in pupil size over time also indicate changes in cognitive load. Similar to e5Learning, in our experiment, we assume that we will be able to use a pattern that increase in the blinking frequency and the frequency of fixation, or an increase in the radius of the pupil, indicates that the user has experienced a section of increased concentration or misunderstanding. In [20], authors build on the work done in creating the e5learning system, aimed at detecting and analyzing emotional states while studying e-courses. The participants of the experiment were tasked with solving tasks requiring knowledge of the Pythagorean theorem. Tasks fell into three categories of difficulty: Easy, difficult, and unsolvable. The participants dealt with tasks one by one and were instructed to speak out their thoughts aloud. Due to this, it was possible to match changes in eye behaviour with specific phrases during task solving. The results of the experiment reinforced the theory that the size of the pupil represents the function of cognitive load and mental effort. However, as dilatation is also dependent on external influences, e.g. on the intensity of illumination, pulses, etc., other parameters such as fixation lengths, saccades, and blink rate, as well as other indicators, such as mouse movement and clicks, must be considered. Using the provided Pupil Headset and EmoSense, a data aggregation application created at Constantine the Philosopher University, we can record and visualise, among other parameters, changes in pupil diameter throughout various experiments.

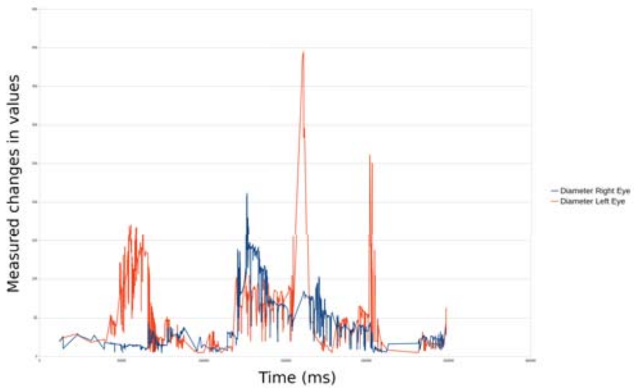

Fig. 3. Changes in pupil diameter during the pre-experiment

In [21], eye-tracking has been used to explore the influence of various types of pictures on the reading speed. It's been shown, that people read the selected text slower, when there were relevant images added to it. This phenomenon can be explained by people spending more time and effort identifying the relation between the text and the picture. In contrast, when confronted with pictures unrelated to the text, for example advertisements, the reader often got distracted and a greater degree of regressions and repeated readings have has been observed. That being said, there was no link between the content of the images and information retention [21].

Conversely, in [22], eye-tracking has been used in the pilot study to evaluate the user interface design of the proprietary Blackboard e-learning platform. Users were asked to browse through different pages and use different tools available in Blackboard. In analyzing the data obtained, researchers concentrated on fixations, transitions and dilatation of the pupils. The choice of these investigated variables was based on the fact that by combining the areas of fixations and the dilatation rate of the pupils, it is possible to identify places of interest and at the same time to determine cognitive load.

At the outset of the present research experiment, it will be necessary, from a pedagogical point of view, to take the necessary steps to assess the quality of the currently available e-learning study materials in the Computer Architecture course. Since students studying the e-course are graduates from different types of secondary schools and thus have different initial levels of knowledge, it is necessary to assess how they read and understand the study materials provided by us. Based on this, we will follow these steps:

1) Divide the students into control and experimental groups
2) Provide enough study time for studying to each group.
3) Provide students with the opportunity to give feedback on the current quality of study materials provided.
4) Evaluate the results obtained from the questionnaires.
5) Identify the problematic sections in the e-learning courses and the teaching approach.
6) Utilize the personal interview method

The experimental group will consist of 20 students, whose eye movements will be captured using the Pupil Labs headset. The control group will also consist of 20 students, who will study the courses without eye-tracking supervision. Both groups will be given a questionnaire, in which they will describe the quality of supplemented e-courses on a 9-point scale. We will be including these information in the questionnaire, to take into account the variables, which could affect the perception of the learning materials:

- sex,
- age,
- type of secondary school,
- relationship to computer science,

At the same time, the questionnaire will include questions describing the quality of learning materials:

- clarity of the structure of the study material,
- sufficient readability of the course,
- interactivity of the included multimedia and the course itself,
- wealth of provided information,
- attractiveness of education delivered in this way

Since students can unconsciously provide misleading answers in a questionnaire, or to tell only a partial truth, we will be utilising the personal interview in addition to the questionnaire. We assume, that by applying this method we will gain relevant answers to our questions and concurrently these answers can be compared with the answers given in the questionnaire. From our already conducted pre-experiment, we have already gained technical insight on the conditions necessary for successful execution of our suggested experiment:

- The experiment must be conducted in a well-lit room,
- The computer screen must be placed perpendicularly to the windows,
- The text of the course needs to be adjusted so that it always fits on the screen,
- The ROI must be bordered by the chessboard markers,
- The student must be told not to move head if not absolutely necessary,
- After 5-10 minutes, the Pupil Labs headset must be recalibrated.

From technical point of view, our pre-experiment has followed a similar approach to the one we describe for our suggested long-term experiment. Firstly, we've selected a chapter of an e-learning course, such that it would take a subject between 5 and 10 minutes to read, to lessen the negative influence of decreasing headset calibration and reduced accuracy of the recording. After that, we've divided the chapter into four parts so, that each part could fit on a computer screen while adding the aforementioned chessboard markers around the text . After calibrating the headset, we've instructed the subject to avoid significant movements, changes in head position, distance from screen and to ensure that after changing the page of the chapter, all the tracking markers stay visible. We have repeated this pre-experiment on a group of 25 students, none of which has read the chapter before, nor have been part of any similar experiment. The pre-experiment has given us an insight into possible future uses of eye-tracking in educations. As the pupil headset can recognize combinations of the generated chessboard markers, it provides near limitless possibilities of tracking surfaces. For example, the markers could be used to mark areas of a classroom and allow researchers and teachers to discover various sources of distractions, to which the student's gaze might gravitate.

Using the open source software supplied along with the Pupil Headset we can generate heatmaps, visualising the time the subject's gaze spent on an area. Using default settings, the generated heatmap (Fig. 4) has low granularity, which has high informative value in terms of depicting the concentration of the gaze in wide areas, for example to identify distracting effects, or to better align the navigation and control elements.

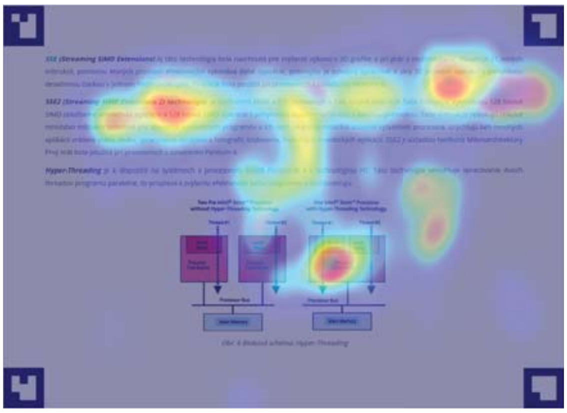

Fig. 4. Low granularity heatmap generated by the Pupil Headset.

Such heatmaps do not, however, provide precision to a singular words, which we are in need of for this experiment. By adjusting the parameters of the heatmap generating plug-in, we were able to gain 10x increase in fixation depiction granularity, which allowed us to pinpoint the fixation tracking to individual words and even syllables.

Fig. 5. High granularity heatmap generated by the Pupil Headset.

These heatmaps were subsequently merged together and by using the graphical editor GIMP[3], we have filtered out short-term and less intensive fixations, represented by the blue and green color. Fig. 6 shows a composite of 25 heatmaps retaining only the most intensive and long-lasting fixations.

Fig. 6. Composite heatmap.

By manually analysing the composite heatmap, we have been able to create a word cloud representation of the most fixated-upon words and phrases (Fig. 7). Such representation can be further utilised while devising the questionnaire supplementing the data gathering of the future experiment.

Fig. 7. Composite heatmap.

[3]GNU Image Manipulation Program

IV. Discussion and Conclusion

Based on our pre-experiments and related works, we assume that the data obtained from the proposed experimental group will help us to identify shortcomings and possible improvements in the content and form of the current Computer Architecture e-course. After analyzing and editing the e-course, we also propose an experiment in which we will reuse two groups - experimental and control, to verify the effect of the changes. The new control group will continue to study with the established learning materials in the e-learning course, while the experimental group will study the already modified course. Subsequently, we will compare the study results of both groups and analyze the new data obtained by the eye-tracking method.

The preliminary experiment gave us valuable insights into the appropriate procedure to be applied in the experiment itself. It has also generated the first output data in the form of video recordings and heatmaps created. Using such maps and careful observation of the acquired gaze-tracking records, we were able to identify the words that students were most focused on while studying the submitted study text. In case of the first page of our experimental text, the most fixated upon words and phrases were: Central Processing Unit, programmable, ALU, control unit, registers, addressing, instruction channels, internal cache memory, memory access time, etc. However, since such fixation clusters have also occurred in the case of general words and phrases, it is appropriate to ask whether the students paused at those words because of the lack of understanding, increased interest in the notion or due to an unusual syntax of the sentence in which these words occurred. Among other things, it is necessary to note that a number of words with pre-existing explanatory notes did not arouse the interest of the students despite their technical nature, the context of the text and the strong color coding. As one of the questions of the follow-up questionnaires and personal interviews, we should ask whether these words were insufficiently marked, or if they were uninteresting to the students or they had already known them.

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