Increasing Efficiency of Reading from Screen

Robert Pinter*, Sanja Maravić Ćišar* and Dragica Radosav**
* Name Subotica Tech-College of Applied Sciences, Subotica, Serbia
** Technical Faculty “Mihajlo Pupin”, Zrenjanin, Serbia
probi@vts.ac.rs, sanjam@vts.ac.rs, radosav@tf.ac.rs

Abstract In order to improve the learning process, an Adaptive Educational Hypermedia has to provide a personalized version of the learning material, as well as individual learning settings and environment. This work presents the efforts to find those factors which could mean some environment personalization in a learning process where those kinds of e-curricula are used, which are assembled mostly from pure text, without multimedia elements. The purpose of this work is also to define the factors for creating and providing a learning environment tailored to the learner’s specific needs connected with their learning styles, and which could improve reading from the screen.

1. INTRODUCTION

Nowadays every institution that practices some form of educational activities is making an effort to provide the so-called e-curricula besides the curricula in the classical form. This process by default sets out from the idea to use a lot of multimedia elements in the designing and assembling process of the curriculum. If the authors decide so, they can put in some new information technology (IT) features, which will add interactivity and stunning animations or simulation. But in the end, the issue of what the final form will be, as well as which technology will be used in the material mainly depends on financial issues. As a result of this, the Internet contains a wide range of e-curricula realized with different IT technologies, but most of them are created in the simplest (and cheapest) way, without multimedia feature, using only text, pictures and hyperlinks.

Much feedback from those users who study in this so-called computer based education system, deals with whether or not the users are satisfied with the quantity and variety of e-curricula, but not with the quality. That is why students mostly only spend a very short time with any of these e-materials.

The possible reason for this is explained by the fact that many authors who convert their curricula into e-curricula have not paid enough attention to the fact that the computer-based learning (CBL) is essentially a different learning environment from the classical frontal type of teaching setting [1].

When creating e-curricula every author also must keep in mind fact that each of his pages has to compete with hundreds of thousands of other similar pages for the user's attention (Nielsen J., 2005). If the design and the content cannot keep the student on this page, it is very likely that he/she will move on to other pages/curricula and try to pick the one which is the most appropriate for him/her.

There is some evidence [2] that very few e-curricula can overcome the negative effects which are likely to result from studying in an isolated and stand-alone environment. In most cases those so-called negative effects are connected with the lack of motivation. To sum it up, the following can be clearly stated: most people are not able to study independently. If the authors create expensive e-curricula with a lot of multimedia elements, it can decrease the students' impatience and could have positive on the learning process [3][4]. But as said before, this kind of content is difficult to design and to create, and the developing costs are the highest. However, the question arises concerning what to do when one cannot use interactive animations in creating e-curricula?

2. ADAPTIVE EDUCATION HYPERMEDIA

Today there is much talk about personalized learning materials and adaptive education hypermedia systems. These tools will help by incorporating the fact that every student has different requirements and goals for a given course. It is widely accepted that during the design and development of educational material attention must be focused on the learner’s characteristics and requirements [5][6].

Adaptive Hypermedia deals with issues including adaptation, user modeling and hypermedia. Hypermedia is a combination of “hypertext” and “multimedia”. The goal of adaptive hypermedia research is to improve the usability of the hypermedia application by making it personalized. A system which supports the adaptive hypermedia is called Adaptive hypermedia system (AHS). An AHS builds a model of the goals, preferences and knowledge for each user. Using this model AHS changes (adapts) the application to fit to the needs of the user. The creation of a user model is most often done by observing his/her browsing behavior, but there are applications which build the user profile with specially developed questionnaires.

Research has proven that using personalized e-learning curricula can result in successful and effective learning [7]. One possible method of personalization is the implementation of different learning styles [8] [9]. A learning style (LS) is defined as a unique collection of individual skills and preferences that affect how a student perceives and processes learning material [10]. Until now the psychology of cognitive styles still remains a poorly developed research field. In 2004, at Newcastle University, the researchers, led by Cowfield, found 71 different learning styles. Some of the more well-known styles include those identified by: Dunn & Dunn, Kolb’s, Honey & Mumford, Gregorc, Felder and Silverman etc. However, there are numberless other factors which influence the learning process. It is almost impossible to take into consideration each one of them. The application of the LS theory in education has boomed when the
learning process moved out of the classrooms and into cyberspace. In this new environment with the help of the Internet and computers it can be truly realized that all students can learn from individualized learning materials integrating different teaching and pedagogical styles.

There are many learning style models. Some of them are better known others less so, but it holds true for all of them that it is very difficult to measure the outcome of using them. Most of these theories define/describe the learners’ profile and then make suggestions about the following:

- The preferred e-curricula’s structure and contents,
- How to effectively teach a pupil / student (person somebody) with a specific learning style,
- How to effectively learn with a specific learning style.

In this project the Felder and Silverman (FS) learning style model will be used, which is one of the most often cited model on the Web, a it can be easily applied in the electronic learning environment. According to the FS model a student’s learning style may be defined by the answers to four questions:

1. What type of information does the student preferentially perceive: sensory (sights, sounds, physical sensations) or intuitive (memories, thoughts, insights)? Sensing learners tend to be concrete, practical, methodical, and oriented toward facts and hands-on procedures. Intuitive learners are more comfortable with abstractions (theories, mathematical models) and are more likely to be rapid and innovative problem solvers. This is the sensory-intuitive dimension.

2. What type of sensory information is most effectively perceived: visual (pictures, diagrams, flow charts, presentations) or verbal (written and spoken explanations)? This is the Visual-Verbal dimension.

3. How does the student prefer to process information: actively (through engagement in physical activity or discussion) or reflectively (through introspection)? This is the Active-Reflective dimension.

4. How does the student characteristically progress towards understanding: sequentially (in a logical progression of incremental steps) or globally (in large “big picture” jumps)? Sequential learners tend to think in a linear manner and are able to function with only partial understanding of the material they have been taught. Global learners think in a systems-oriented manner, and may have trouble applying new material until they fully understand it and see how it relates to the material they already know about and understand. This is the Sequential-Global dimension.

The Index of learning styles (ILS) is a 44-question instrument designed to assess preferences on the four dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global) as defined based on the 4 types of questions of the FS model. These dimensions are like a continuum with one learning preference on the far left and the other on the far right. The score on one of those scales shows the preferences in the dimension, for example if the scores are:

- 1 or 3 on scale, shows fairly well balanced preferences on the two dimensions of that scale.
- 5 or 7 on scale, shows a moderate preference for one dimension of the scale and he/she will learn more easily in a teaching environment which favors that dimension.
- 9 or 11, means a very strong preference for one dimension of the scale. He/she may have real difficulty learning in an environment which does not support that preference.

Those AHS that have integrated the LS theory in some way based on the student’s model (which is comprised by progress in learning and test results, apart from the LS) are able to create individualized learning materials.

3. THE RESEARCH

The LS models do not provide precise directions on how to present only textual content for those for whom reading is not the most effectively information perceiving method. The aim of this research is to find answers found regarding what kind of reading motivating factors can be added to a predominantly textual curriculum in order to make it easy and effective to read for all students with different learning styles.

From the point of view of reading, the screen is a significantly different media compared with paper. The authors of this current paper will accept and use the results of Jakob Nielsen [11], who gives the following four plausible reasons for why 79 percent of Web users scan rather than read text on the screen:

- Reading from computer screens is tiring for the eyes and about 25 percent slower than reading from paper.
- The Web is a user-driven medium where users feel that they have to move on and click on things.
- Each page has to compete with hundreds of millions of other pages for the user’s attention. Users do not know whether this page is the one they need or whether some other page would be better: they are not willing to commit the investment of reading the page in the hope that it will be good. Most pages are in fact not worth the users’ time, so experience encourages them to rely on information foraging. Instead of spending a lot of time on a single page, users move between many pages and try to pick the tastiest segments of each.
- Modern life is hectic and people simply do not have time to work too hard for their information.

As a result, Web pages have to employ scannable text, using:

- highlighted keywords (hypertext links serve as one form of highlighting; typeface variations and color are others),
- meaningful sub-headings (not "clever" ones),
- bulleted lists,
- one idea per paragraph (users will skip any additional ideas if they are not included in the first few words in the paragraph),
- the inverted pyramid style, starting with the conclusion,
- half the word count (or less) compared to conventional writing.

Besides the above-mentioned structural and formatting aspects promoting reading, there are other options to
make reading more efficient. It is worth mentioning some earlier researches which have tried to find relations between reading speed and the color of the character or the background [12]. Further, researchers have attempted to define the impact of the font size [13], and distance from the text [14] on reading. And to mention newer research by [15], who examined the differences in struggling readers’ comprehension of storybooks according to the medium of presentation.

4. THE APPLICATION
For the collection of appropriate data a suitable application was needed. The authors have developed an application [16] with the aim of finding the factors that are of a motivating character on the reading process for learners with various learning styles. The application itself is a frame where different, already known effects are applied to the presented text. The application supports the following effects:
- altering the color of the characters and the background,
- altering the size of the characters (the font size 16 to 26 could be chosen),
- altering the background pattern,
- highlighting or selecting text in karaoke style,
- altering the speed of highlighting/selecting,
- altering the mode of highlighting/selecting: whole words or only character,
- randomly appearing interactive (Microsoft Office-like) assistant, whose task is to keep the user’s attention on the screen.

The reader/learner can switch off or manually change some of these options in the toolbar. In order to motivate readers to change these options and to dislodge them from the “local minimum”, the application always starts with a randomly set fore- and back color, highlighting effect, effect speed and assistant. In this way, it can detect which settings are preferred by the user (he/she will set them) and which are not (he/she will change them). Furthermore, it can be traced which highlighting/selecting effect was used most often by the user, which is his/her preferred font size on the screen, etc.

The application is part of a Content Management System (CMS) whose primary task is to deliver e-curricula for three computer science courses (Object-oriented programming, Java and Multimedia) to the students. This CMS has a module which can determine the user’s learning style, with a Index of Learning Styles questionnaire.

The users are obliged to fill in a questionnaire when registering to the system. The CMS has also advanced user activity tracking capabilities: it can track and save information to the database about user behavior in the system; as well as which previously described options he/she used and in which settings. In the phase of data analysis the aim is to detect correlations between the most often used options and learning style profiles.

5. THE EXPERIMENT AND ANALYSIS
Data acquisition was done at Subotica Tech - College of Applied Sciences. It involved the second year students from Computer Science (CS) undergraduate program. The number of participants was 38, and the group consisted of 9 female (23%) and 29 male (77%) students. Every participant was between 19 and 22 years old.

The students’ profiles based on the ILS are as follows:

![Students’ LS profile distribution on Active-Reflective dimension](image1)

![Students’ LS profile distribution on Sensory-Intuitive dimension](image2)

![Students’ LS profile distribution on Visual-Verbal dimension](image3)

![Students’ LS profile distribution on Sequential-Global dimension](image4)
The text to be read was taken from the Introduction chapter of the book about algorithms used in the course of Object-oriented programming. Thus it is a rather “dry” text containing historical facts. In about 45 minutes, the students have tried every option and effect offered by the application. After that, they filled in the questionnaire with 17 questions, in which they described their opinion about those options and effects of the application that are likely to “improve reading”. The questionnaire contained 14 questions that they could rate with marks from 1 to 5, and for the remaining 3 questions they had to provide textual answers. The mark “5” denoted the options and effects which, in their opinion, they found very helpful in the reading process. The mark “4” was for the options which were helpful, but in a moderate manner. The mark “3” was used for indifferent options. The mark “2” was given for the options that somewhat hindered the reading process, and finally the mark “1” denoted those option which absolutely hindered the reading.

With textual answers students presented their opinion about what their preferred text color on white background was, as well as what their preferred text and background color combination was. Also, they could make suggestions regarding how to extend the application, which options or effects to add. The effect that refers to the speed of selection was also marked “1” to “5”. The method of converting speed setting to mark will be discussed in a later section of this paper.

The following figures present how students rated “reading helping” options and effects:

The answers to the question “Can highlighting effects help in your reading process?” were given in the following distribution: 8% of the students expressed that they were very helpful, 47% said that they might help, 34% felt that they would neither help nor hinder the process, only 5% expressed that highlighting effects are hindering, and the remaining 5% were absolutely sure that this particular feature did not help them in the reading process.

Processing of data from the questionnaire was followed by data analysis in order to detect the relationship between learning style profiles and the marks given to the specific effects. This was done based on the following concept: in every of the 4 dimension of the LS
model 6 groups were defined, according to the level of preferences: the “1-3 group”, the “5-7 group” and the “9-11 group”. Altogether this means 24 groups. It was calculated how a given group (e.g. “verbal 1-3”) evaluates all the “reading helping” options of the application. The result are equal to the average of the marks given by all students belonging to that group. The results from one group was compared, with the results of other groups on the same dimension.

Data processing was made easier by the fact that the profiles defined by the FS LS model did not show a very heterogeneous structure (see the Figures 1 to 4). Not all dimensions had 6 groups, but even so there were 266 (19 groups * 14 questions) pieces of information to be analyzed. For example, on the Visual-Verbal dimension there were only 4 groups (see Fig. 3).

The scope and topic of this article allows the authors only to present the results attained from the Visual-Verbal dimension. In the opinion of the authors the remaining three dimensions show a weak connection with reading only text from the screen. For example, the Sensory-Intuitive dimension (what type of information does the student preferentially perceive: sights, sounds, physical sensations or memories, thoughts, insights) is not likely to be realized when reading. But the Sequential-Global dimension may also be mentioned (how does the student characteristically progress toward understanding: in a logical progression of incremental steps or in large “big picture” jumps), which is rather dependent on the complete structure of the electronic textbook and its use.

The rating of the effects according to the groups of Visual-Verbal dimension:

![Figure 9. Students' opinion about questions No. 1 and 2.](image)

![Figure 10. Students' opinion about questions No. 3 to 6.](image)

![Figure 11. Students' opinion about questions No. 7 to 9.](image)

![Figure 12. Students' opinion about questions No. 10 to 13.](image)

The figures presented the following relationships between LS profiles and effects:

Figure 9: All three groups of the Visual dimension and one from the Verbal dimension gave a mark of 4 to the option when highlighting refers to the whole line at once. Students with this profile rated the option of highlighting one character at a time poorly. The situation with the groups in the other dimensions portrays a similar picture. Those data are not presented in this work.

Figure 10: All three groups of the Visual dimension, as well as one of the groups of the Verbal dimension rated the option highlighting with bold effect similarly, while they gave different and lower ratings to other options. It is worth mentioning that the least and most visual groups (groups “1-3” and “9-11”) felt most strongly about the differences in highlighting. The Visual groups 1-3 and Verbal 1-3 mostly rated the efficiency of effects in a similar manner.

Figure 11: the Visual groups 1-3 recognized the difference between whether highlighting refers to only one word or the entire text. The group of Moderate and Strong visual preference along with the Verbal 1-3 group saw a minimal difference between these two effects. The Verbal rated these effects with marks below the average.

Figure 12: From the above-average marks (around 3.5) it can be seen that the options of the background color were important to all groups. The highest marks were given by the Strong visual group. The option of speed of highlighting was not found to be significantly useful by the groups; the majority gave a mark 3. The authors feel that this may not portray the real picture, because the speed of effects could be set from “very slow” to “very fast”, and during the experiment it was discovered that the two extreme values, and values near them, were not usable, because they were too slow or extremely fast. Thus for most students the preferred values were around the middle of the scale. The process of conversion happened by dividing the speed scale into five parts, and the resulting segments were represented.
with a mark (mark “1” for the values 0% to 19% of the scale, mark “2” for 20% to 39% etc.). This means that the settings around the central values became the marks 3 or 4, thus the truly individualized settings were lost. In the planned redesign of the application the scope of settings will be much smaller.

Analyzing the values globally it can be stated that the four diagrams do not always show that there was a significant difference between how the groups of the FS-model based Visual-Verbal dimension evaluated the “reading helping” effects. Therefore if the effects were found to be useful, then the average marks also showed similar values. This makes it a reasonable suggestion that the marks of the groups should not be represented by average marks but in another manner. Further, in order to attain more accurate data it is advisable to repeat the ILS test to rule out the case that the student did not answer the questionnaire completely truthfully for some subjective reasons so that they were not placed into the correct profile. The authors plan to conduct an experience with students outside the field of engineering, as well, which will provide heterogeneous LS profiles.

6. CONCLUSION

In today’s modern world people acquire the majority of information by watching or reading the screen, either the screen of a computer or any other electronic communication device. This inevitable leads to a change in the users’ reading habits and preferences. Often the user does not so much read the text as they scan it. Texts that do not contain highlighted words, expressions, or some lists are often not even read. In modern life people simply do not have time to work too hard for their information.

This work is trying to find the answer to the question of how to motivate and help the reading process for those electronic textual contents that do not contain multimedia elements. To determine these motivating factors 38 students were involved in the experiment. A special application was developed for this purpose, which enables the students to, through experimentation; determine the parameters that make the best reading environment for them individually, including the parameters of front and background color, highlighting effects and their different types. The results have shown that the majority of students (55%) have the need for some type of mechanism that makes reading easier, and only a small percentage of the students (10%) feel that such mechanisms are more likely to hinder them in the reading process. The research results have also portrayed that there are specific highlighting effects that are suitable for most students, while there are other effects and settings that can be eliminated from further research (Figures from 9 to 12).

Besides the elements helping and motivating reading, the research tracked the students’ answers regarding their learning styles. The data collected from the students is connected with their learning style profile. Based on that information a collection of rules adaptivity can be defined, for promoting the reading of the text-only electronic learning materials for learners with different learning styles. Hence, if the reading environment settings and effects are suitable and convenient for one student, then it is probably also suitable and convenient for somebody else with the same learning style profile, and applying those settings could also promote reading on screen.

Considering the role that text-only electronic learning materials play in e-learning, further research into the promotion of reading will contribute to the general aim of increasing the efficiency of electronic learning materials.

7. REFERENCES