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COMPUTER TOOLS IN ENGINEERING EDUCATION – EXAMPLE ON MACROMEDIA FLASH

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Abstract: The purpose of this study is to investigate the potential benefits of using computer tools in engineering education. Animations, visual cueing, and their combination in a multimedia environment are designed to support learners' acquisition and retention of scientific concepts and processes. The software used in the development of the animations is Macromedia Flash, a tool that allows very small vectorial graphics files to be created, thus facilitating their electronic transmission to any user connected to the network. The research was conducted on 75 students of the first year at the Faculty of Civil Construction Management of the Union "Nikola Tesla" University, Belgrade, Serbia. The course was followed by a 3-year study to assess the acceptance of the computer tools and multimedia animations for learning mathematics. This research clearly showed that students were highly interested in this way of teaching and learning.
Keywords: computer tools, Macromedia Flash, animation, Engineering education

INTRODUCTION

Today, Internet has established a new model for providing information and services to all users throughout the world [30]. Thus, the decision to use web technologies such as HTML, XML, Java and Flash is obvious [27]. FLASH is a very powerful graphics and animation development system that was introduced by Macromedia (now a subsidiary of Adobe Systems) in 1997. Over the past decade, it has become the de-facto standard for animation, gaming and multimedia applications on the World Wide Web. Many companies have web page that include animations created with Macromedia Flash, due mainly to the two most important characteristics of this application: creation of vectorial graphics and interaction of it user with the animations. We should add that Flash allows the user to interact with the animation being displayed, thus the user can control the visualization of the film, take decisions, write, press buttons, move, drag, etc.

The contribution made by Flash is clear: animation + interactivity, and we should remember that interactivity is the greatest advantage that multimedia contributes to teaching [11]. It is only necessary to select the content correctly and insert them properly in the program. In most cases, Flash animations have become teaching aids [4] that are now common in many courses and universities and this represents a notable advance in teaching innovation achieved in recent years.

In the literature, there is of course no shortage of studies about the effects and the benefits of computer tools and animations in classroom instruction. Author [26] studied such effects long before the modern animations tools were introduced. Authors [11], [27], [3] and [19] discussed the use of interactive graphical tools in applications such as engineering education, computer science education and ecology. Authors [12] presented a study of the psychology of student interaction with animations. Authors [24] described some important concepts in the interactive learning process, such as the design principles of an interactive learning environment, the technology needed for gauging human performance, etc. Authors [13][14] published an extensive study of the cognitive and psychological aspects of multimedia learning. Authors [21] pointed out that multimedia applications have

slowly transformed the typical university communication network to an education delivery system. Author [25] argued in a short article for the first time that the Macromedia Flash development system can be a serious instructional authoring tool (this is the view shared by the present author).

Authors [10][9][16][17][18] and recently [6] demonstrated some specific Flash examples for mathematics teaching.

MATERIAL AND METHODS

Overview of the experiment

One purpose of the current study was to investigate whether animations were more effective than static graphics to promote learning. Animations have the potential to facilitate knowledge construction with this type of learning content [7][22][29]. Therefore, we hypothesized that animations enhance retention of both concepts and processes. The study also investigated the potential cognitive benefits of adding visual cues to visualizations to enhance science learning in a multimedia environment. Based on the literature reviewed in previous section, we hypothesized that visual cueing is effective to enhance learning. In addition to learning, cognitive load and motivation were also investigated. By providing learner control over animations, the transitory nature of animations could be overcome. Therefore, we expected that when comparing animations to static graphics, animations would reduce extraneous load and consequently foster germane load. We also expected visual cueing to reduce extraneous load in multimedia learning environment, which is in line with [15] and [28]. Only a few studies have investigated learners' motivation in multimedia learning, e.g., motivation in an agent-based environment [20], and in an online animation-based environment [23]. As motivation impacts learning [5][8], this study explored the potential effects of animations and visual cueing on learners' intrinsic motivation in the multimedia environment.

Participants and questions of the Research

The research was conducted on 75 students (tree generations as per 25 of the first year students) at the Faculty of Civil Construction Management of the UNION University, Belgrade, Serbia. The course was followed by a 3-year study (2010, 2011. and 2012.) to assess the acceptance of the computer tools and multimedia - Flash animations for learning mathematics. In addition to the statistics collected about the test scores, the students who were tutored with the new techniques were also asked directly two questions after the conclusion of the study:

(1) 'Do you agree that the Flash animations contributed significantly to *lecturing* mathematics: I disagree, I agree, I totally agree?' and

(2) 'Do you agree that the Flash animations contributed significantly to *learning* mathematics: I disagree, I agree, I totally agree?'

Computer-based learning environment of mathematics. Example

Lectures of the mathematics courses included exactly the same information i.e. axioms, theorems, examples and tasks like on the traditional class of math, but the main information source was software created in Macromedia Flash 10.0, which is proven to be very successful and illustrative for creating multimedia applications in mathematics lectures [2]. Our multimedia lecturing material was created in accordance with methodical approach, i.e. cognitive theory of multimedia learning [13][14], as well as with principles of multimedia teaching and design based on researches in the field of teaching mathematics [1]. This material includes large number of dynamic and graphic presentations of definitions, theorems, characteristics, examples and tests from the area of mathematical geometry and analyses based on step-by-step method with accent on visualisation. Important quality of making one's own multimedia lectures is possibility of creating combination of traditional lecture and multimedia support.
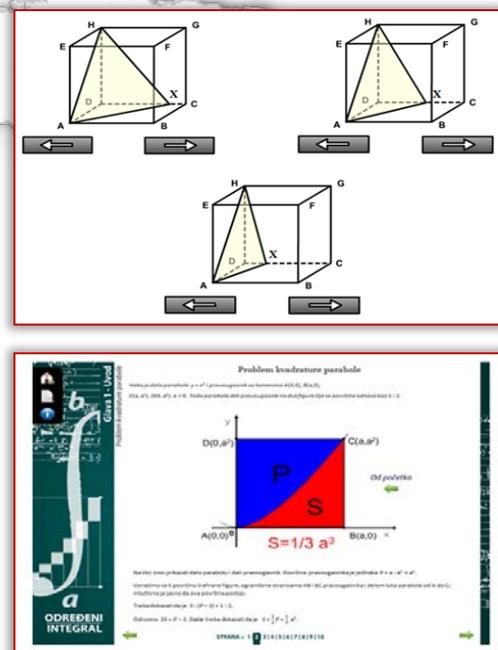

Figure 1. Examples of animations for teaching Geometry (a) and Analyses (b) created with Macromedia Flash.

RESULTS

In summary, multimedia learning helps to promote a better understanding of how to foster meaningful learning through the integration of words and pictures (printed or spoken text andillustrations, graphs, maps, animation or video).

Students' opinion

The students tested and worked with all the animations and subsequently responded to a series of surveys

giving us, the teachers, their opinions, advice, comments and recommendations on the use of animations in the classroom.

The purpose of our first question is to go to the core of the issue concerning the use of animations in the classroom. We proposed to the students that the traditional explanations of theory given by the teacher should be replaced by animations, (Fig. 2). The students were not positively impressed by the idea of receiving a class of theory without the teacher, as, despite their interactivity, animations still do not have the same level of interactivity as a teacher. However, students mentioned that animations may be a great help for the teacher in the classroom.

In a second question, when we asked whether they prefer classical or multimedia way of individual learning mathematics, the students were answered multimedia - Flash animation, explaining it with the following reasons:

✓ **Step-by-step**: The most frequent answer to the survey is directly related with the control students have over animations. Most of the animations have controls that allow the user to stop, resume, go to the beginning, go to the end, go one step forward or one step back. These devices allow the students to control the visualization and adapt the animation to their learning rate. Flash allows the user to control the animations, and although, in most cases, this is one of its most important properties, it may be counterproductive if the user progresses through the animation at a higher speed than the speed of the visualization itself [4].

✓ **Amusing**: The students find animations amusing and they consider this a positive characteristic. As many of them pointed out, they are learning unconsciously, without being aware that they are visualizing three-dimensional concepts with quite a high level of complexity. This affective characteristic of learning is highly motivating as it attracts and holds the users attention – an essential aspect without which teachers will never be able to use with advantage any kind of educational resource [12]. This is why affective characteristics may play a very important role in the teaching–learning process.

✓ **Availability**: Another of the strong points of animations is that, as they are located in a web server, they can be consulted at any time. Furthermore, the students consider that having material they can access as many times as they want constitutes an enormous advantage.

✓ **Explanation**: The three characteristics mentioned above would be of no use if the teaching animations created do contain clear explanations with a well-

defined structure that address the most important concepts of each lesson in a didactic way.
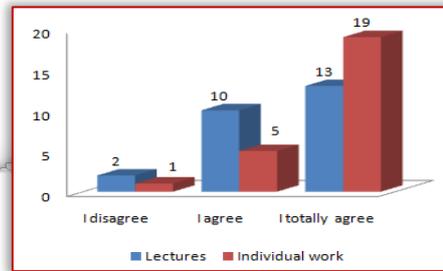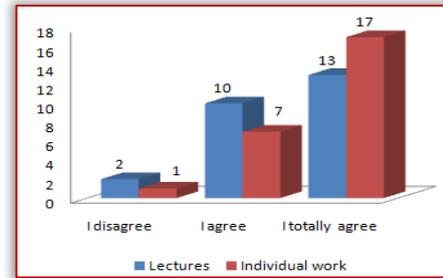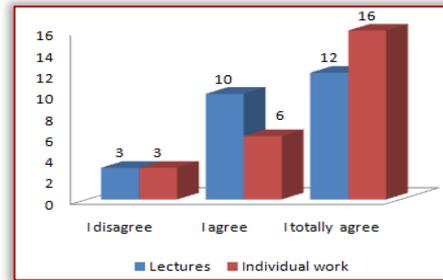

Figure 2. Students' answers to the question: Should Flash animations be used in lecturing and individual learning mathematics?((a) – generation 2010, (b) – generation 2011, (c) - generation 2012)

CONCLUSIONS

Flash technology has revolutionized Internet. The generation of animations of a very small size, together with their interaction capacity and ease of use, has led to the spread of this technology among most creators of web pages, and many sites include animations or colorful presentations in their initial pages, thanks to Flash.

This technology opens a field with many applications for university teaching, since the theory content of the subjects can be converted to a greater or lesser extent into multimedia content, which students may consult and control at any time. But animations are not a solution to teaching problems since, if they are not correctly designed, they may be counterproductive for the learning process.

In the specific case of engineering education, the use of these animations is more enriching as, in many cases, it accelerates the development of the students' spatial perception – a basic objective in the training of any engineer. From experiments carried out with students who used animations created with Flash, a series of practical findings were obtained on how to create

educational animations for educational teaching – learning process:

- ✓ Split up the content to be animated by Flash into basic learning units.
- ✓ Provide the animations with as much interactivity as possible.
- ✓ Hold the user's attention without recourse to unnecessary distractions.
- ✓ Allow the student to control the animation at all times.

The creation of these animations, together with their use in theory classes as a supplement to the work of the teacher, is guaranteed success among the students, as our experience shows. There was clearly a very significant improvement in the student's test scores as a result of introducing animations in traditional classroom instruction and great number of the students who believe that animations of mathematical concepts did contribute significantly to their understanding of mathematics.

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