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WEB-BASED TECHNOLOGIES FOR ONLINE E-LEARNING ENVIRONMENTS

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Abstract: *Implementing an e-Learning system is not just about bringing a new technology in practice and improving teaching and learning. It is also about changing long-lasting conceptions that in classical methods are better than in computerized ones, without replacing them. This is also why software solutions for online learning and testing must be as user-friendly as possible, but also provide high-quality solutions to suit the teachers' and learners' needs. This paper shows our developed e-Learning system, Education Management Tool, with the purpose of enhancing classical teaching and examination methods, without replacing them. EDM is continuously being developed and perfected, with new modules and functionality added regularly for efficient communication and collaborative project work of students or document management of teachers. We also extend the interactive teaching section with lessons focused on graph algorithms (breadth-first search, depth-first search, Dijkstra, etc.) and binary tree operations (insertion, deletion, traversal, search, etc.). Such algorithms can be better explained through visually illustrated examples which might help the students to easier understand them. Therefore, we present the above mentioned algorithms with the help of interactive Flash files as part of the lessons.*

Keywords: *e-Learning system, web technologies and tools, interactive and collaborative application, algorithms.*

I. INTRODUCTION

Merging traditional ways of teaching – based on the blackboard, chalk and monologue exposure in front of students, with modern approaches as e-Learning, focused on online multimedia applications and technologies, developed in a collaborative manner – became a real necessity in order to enhance learning and educational management. The current tools for developing web applications have greatly improved and the developers of e-Learning platforms must make proper use of them and develop Web 2.0 environments efficiently in order to meet the teachers' and learners' needs. Combining the technical dimension of using e-Learning tools with the pedagogical dimension of putting them into practice, the teachers' competences using current technologies are emphasized, whilst the accent is put on the fact that "learning motivation is more important than technology" [4].

Although there is still a lack of confidence in the effectiveness of online education, the educational materials are being developed, and often without taking into account of the content representation and design, students are very open and enthusiastic about the inclusion of authentic interactive activities. They considered the authentic learning environment to be very relevant to their learning and became more engaged and actively involved in their learning process [8].

Considering that the future in education will be based mainly on the freedom of choosing an accessible way to study according to the necessities of each person, which should eliminate the

physical and mental borders, the development of e-Learning platforms certainly becomes a priority of the modern education. The evolution of the digital, multimedia and communication technologies has created the possibility of using the e-Learning way in education on a large scale. This has revolutionized the traditional education system leading to its reorganization and transformation, so that it offers the possibility to learn and instruct to all those preoccupied by their continuous professional evolution. The new technologies allow accessible documentation of those interested in any studying field, without being necessary to leave their houses, by watching digital television programs and/or by consulting huge virtual libraries which have elaborated courses and electronic didactic materials accessible from distance (by visualizing or printing) in any corner of the world.

Researchers estimate that a boom of digital content will happen in the near future. In the past few years, multimedia content management systems became more and more popular, with applications on the Internet, PCs, mobile phones, PDAs, etc., that are downloaded millions of times, growing exponentially in a relatively short period of time. In addition, the semantic-based organization of data has brought a new dimension to the very definition of multimedia, where information becomes easily accessible and can be queried using our natural language. Integrating complex and useful multimedia applications in the new mobile hardware devices has revolutionized the everyday lives of people, transforming their way to work, play or travel.

The current interests of many teachers focused on the use of mobile (portable) devices in different e-Learning environments and settings, in embedding learning resources in objects and creating smart augmented learning environments [7]. Mobile learning does not represent the complete solution to e-Learning but this could be a quite effective tool to keep the students engaged and involved in e-Learning environments, providing support for collaborative activities through communication. Through this method teachers send reminders and some important news that needs to be sent quickly, keeping students informed about recent e-Learning/e-Testing activities and other related issues. Also, mobile communication technology is used whenever is expected a quick feedback from students or colleagues. We started to implement this concept in our collaborative Education Management Tool.

This paper presents our developed e-Learning system, Education Management Tool, with the purpose of enhancing classical teaching and examination methods, without replacing them. EDM is flexible, extensible, interactive and continuously developed and perfected, with new modules and functionality. These are added regularly for efficient communication and collaborative project work of students or document management of teachers. We also extend the interactive teaching section with lessons focused on graph algorithms and binary tree operations. Such algorithms can be better explained through visually illustrated examples which might help the students to easier understand them. Therefore, we present the above mentioned algorithms with the help of interactive Flash files as part of the lessons.

The organization of the rest of this paper is as follows. In section 2 we review some web technologies and tools designed for e-Learning applications. Section 3 realizes a general presentation of Education Management Tool, whereas section 4 presents the new implemented concepts in EDM Tool. Section 5 describes how we extended the interactive teaching section with lessons about binary tree and graph algorithms. Finally, section 6 suggests directions for future works and concludes the paper.

II. WEB TECHNOLOGIES AND TOOLS DESIGNED FOR E-LEARNING APPLICATIONS

In this section we present some web technologies and tools designed for e-Learning applications, implemented in our e-Learning solution or intended to use or extend in further stage of our web application.

To simplify the learning process, a wide range of electronic materials and teaching/learning/testing solutions have been proposed over the years: multimedia maps, dictionaries and encyclopaedias (wikis), educational movies, electronic books, tests, tutorials, simulations tools, virtual laboratories.

Our e-Learning system that is used by professors from the "Lucian Blaga" University of Sibiu, entitled "Education Management Tool" (<http://edmtool.gotdns.com/>), has been developed using the latest available web technologies in order to be attractive for users and to be compliant with the latest available web browsers. On the server side, the application runs on the Microsoft platform, hosted inside the IIS (Internet Information Services) 7.5 application. The dynamic web pages are developed using ASP.NET (.aspx) server pages, combined with AJAX javascript technologies, in form of controls from the free AJAX Control Toolkit library. The database for the application is tied to Microsoft Sql Server 2008 R2, which is a solid and fast platform for hosting professional level databases. On the client side, the web application has been developed in such a manner, that it can be accessed from any type of popular browsers (it has been tested successfully on the following browsers: Internet Explorer, Google Chrome, Firefox, Safari and Opera). Programming languages that are used are ASP.NET with C# source code, external ASP.NET objects such as FreeTextBox, FlashControl. The main page uses popular Javascript libraries like Mootools and JQuery to present slideshow and menu controls. The third party lessons about Graphs Theory and Binary Trees were developed using Macromedia Flash trial version.

With our project, we reach the stage of implementing solutions for collaborative working in order to share/implement research ideas or projects with colleagues/students, teach anything, anywhere or give a remote talk at a conference/course. Next, we briefly present some technologies and tools that could inspire or be a solution for further stages of EDM Tool development. A proper and quite recent tool that changes the way the world conducts webmeetings and webinars is Zipcast [6]. This is the new meeting platform SlideShare (<http://www.slideshare.net/>) that lets user conducts inexpensive, secure private meetings and limitless free public meetings through web browser. SlideShare defined the way to share presentations on the web and was the first site to let users share PowerPoint and Keynote files on the web. The meetings are interactive and social and take place entirely within a browser window. Any user that has a SlideShare login [6] gets a personalized meeting room (at <http://www.slideshare.net/USERNAME/meeting>), providing streaming video, audio and group chat facilities. Zipcast is a simple, fast and social web conferencing system. Unlike older online meeting systems, the user can keep other browser tabs open and can invite people by giving them the meeting room URL via IM (instant messaging), email, or social networks. Every SlideShare user has free access to Zipcast for conducting public meetings. There are additional functionalities like (a) ad removal, (b) private, password-protected meetings accessible only to people invited by the host and (c) audio conferencing [6].

Besides Zipcast, Microsoft offers really interesting opportunities for online presentations. First of all, in its newest version (Microsoft Office 2010) it introduced the online presentation concept, in which a PowerPoint presentation session can be opened for other users, where the only requirement for the client is a web browser. In addition, Microsoft have created online versions for Word, Excel, PowerPoint and OneNote, where the user can create, edit and share documents from his web browser, without having to buy the expensive Office suite.

III. GENERAL PRESENTATION OF EDUCATION MANAGEMENT TOOL

Education Management Tool is an e-Learning system that has been developed with the purpose of providing access to educational content, university management items as well as a testing system for the evaluation of students. It is an application that is constantly being perfected, with new features being added on a regular basis.

3.1 e-Learning

Because it is an e-Learning system, the biggest emphasis and attention has been directed to the learning aspects. In this manner, professors that have an account within the system may create interactive learning materials in a collaborative manner. The text for the materials can be formatted in a way very similar to Microsoft Word; images can be embedded into these lessons, as well as interactive flash files. One key feature about this module is that the same lesson can be edited by multiple professors in a collaborative manner, with the system allowing only one editor at the same

time (sequential consistency [1]). Students will be able to access the materials from anywhere by using their own account to log into the system. The learning materials are grouped by professors and subjects to be more easy to find. More details about how EDM Tool works can be found in [4]. In the future, we will implement text differencing algorithms for enabling multiple users to work on the same materials at the same time. Besides that, we will enable search functions for e-Learning objects so that students can find them with the least possible effort.

3.2 e-Testing

After the students have received the information from the professors, they are usually tested regarding how much knowledge they have accumulated during the lessons. The system provides an infrastructure to create quizzes using four types of questions, grouped into chapters. The quizzes are afterwards used for generating sets of questions for examination. There are two ways of generating questions for each student: fixed or random. The fixed type will use a previously defined set of questions by the professor which will be presented to each student. The random type will randomly choose a number of questions for each student, so that, if a large enough quiz is defined, a relatively small chance exists that two students will get the same question. After examination, students receive feedback, so that they can see their strengths and weaknesses for the questions they answered. The professor has an overview of results, but can also see which answers each student has given to the questions.

3.3 e-Management

Although learning and testing are successfully covered within the system, there is another dimension that needs taken care of, so that a teachers' job becomes easier to handle. The teacher must keep track of students' attendance at his courses, keep organized folders with exam papers and grades, make statistics for various reasons, etc. There are several modules in Education Management Tool that help do this job more easily, like a module for managing attendance, with various statistics, one that has an overview of marks for every student, and one on the communication part, that facilitates messaging within the system.

IV. NEW IMPLEMENTED CONCEPTS IN *EDUCATION MANAGEMENT TOOL*

4.1 E-mail notifications

It is a fact that teachers check their e-mail very often, much more often than accessing Education Management Tool or other e-Learning systems. This is why they do not notice immediately when changes are made to items related to them. For example, another teacher may have updated the text of a lesson, added/removed an image, etc. This is where the system offers a helping hand, and notifies on demand all teachers that have editing permissions to a certain lesson. The teacher can see at what date and time he received the notification, together with an explanation of what was modified, completed by the teacher that generates it. Based on the idea proposed in [7], we started to implement the concept of e-mail notification in our collaborative Education Management Tool in order to send reminders and some important news that needs to be sent quickly, keeping students informed about recent e-Learning/e-Testing activities and other related issues. Thus, when students log into their Education Management Tool account, they will be informed about new lessons introduced by professors or other interesting, important and useful information (newsletters, news and events, conference announcements, exam schedules, etc.).

4.2 Advanced feature for exporting to pdf files

For attendance management, we have added to the latest version exporting capabilities in the management part of the system as well as allowing the professor to export pdf documents containing details about the student presence at course. In this manner, the professor is able to export presence in a printable manner so that he can keep track of student attendance at his courses. We export to pdf so adapted to display more information about the teacher, subject, specialization, etc. We adjusted the

size of the table so that students do not "disappear" from the list. We summarized, on the whole semester, the number of present/absent students (Figure 1).

| Professor: Adrian Florea | | | | | | | | | | | | | Group: 215 | | |
|--|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|------------------|-----------------|
| Subject: Computer Organization and Design | | | | | | | | | | | | | Year: 1 | | |
| Specialization: Multimedia Systems Engineering | | | | | | | | | | | | | Semester: 1 | | |
| Students / Lessons | 06.10 2010 | 09.10 2010 | 13.10 2010 | 27.10 2010 | 04.11 2010 | 10.11 2010 | 17.11 2010 | 24.11 2010 | 01.12 2010 | 08.12 2010 | 15.12 2010 | 12.01 2011 | 19.01 2011 | Total Present | Total Absent |
| Androniciuc Alex | p | p | p | a | a | a | a | a | f | a | a | a | a | 3 | 9 |
| Apetrei Dan | a | p | p | p | p | a | p | p | f | p | p | p | p | 10 | 2 |
| Avram Ionut | p | p | p | p | p | p | p | p | f | p | p | p | p | 12 | 0 |
| Bilble Radu | p | p | p | p | p | p | p | p | f | p | p | p | p | 12 | 0 |

Figure 1. Advanced features for exporting Presence to pdf files

4.3 Collaborative assignments

Feedback from lesson to lesson is crucial for the professor, as he can assess his students long before the final exam. Furthermore, assignments are crucial for students because they are preserving and deepening their knowledge when they do their homework outside the school hours. Although this module exists only as a concept, it will be implemented shortly and will open up a new dimension to the e-Learning capabilities of the system. The system will optionally support assignments in a collaborative manner, so that students can work as a team to solve various tasks. The professor will require a workflow for them (uploading files, writing formatted texts, etc.) which are assessed afterwards, having the possibility to issue marks, visible in the grade books of students. Last but not least, the professor can keep track of the contribution of every student (number of edits for each of them, the amount of text that has been added, the number of files, etc.).

V. E-LEARNING TOOLS CENTERED ON GRAPH AND BINARY TREE ALGORITHMS

In this work we extended the interactive teaching section with lessons focused on graph algorithms (Breadth-First Search, Depth-First Search, Dijkstra, etc.) and binary tree operations (insertion, deletion, traversal, search, etc.). Such algorithms can be better explained through visually illustrated examples which might help the students to easier understand them. The visual presentation helps the teacher to better explain and the student to easier understand how a certain algorithm works, avoiding thus additional descriptive explanatory effort. Our approach is motivated since we teach algorithms and programming techniques but, more than that, we consider this topic with a high degree of difficulty, especially in high school, requiring a more in depth explanation of both theoretical notions and applications that accompany these notions. Therefore, we present the above mentioned algorithms with the help of interactive Flash files as part of the lessons which were integrated into our EDM e-Learning tool.

The first introduced lesson refers to Graph Theory. This is used in many scientific fields ranging from chemistry to economics, from the study of electrical networks to literature and text's critique, in politics and in social networks analysis. The student can build a graph (insert and delete vertex, add and remove edge) and the application illustrates how graph search operations like Breadth-First Search (BFS), Depth-First Search (DFS) and Dijkstra's algorithm are executed. Vertices can be inserted by introducing their keys through a text box, and after that they can be dragged or deleted easily with the mouse. Edges can be added by selecting two vertices with the mouse. The Flash application is presented in Figure 2.

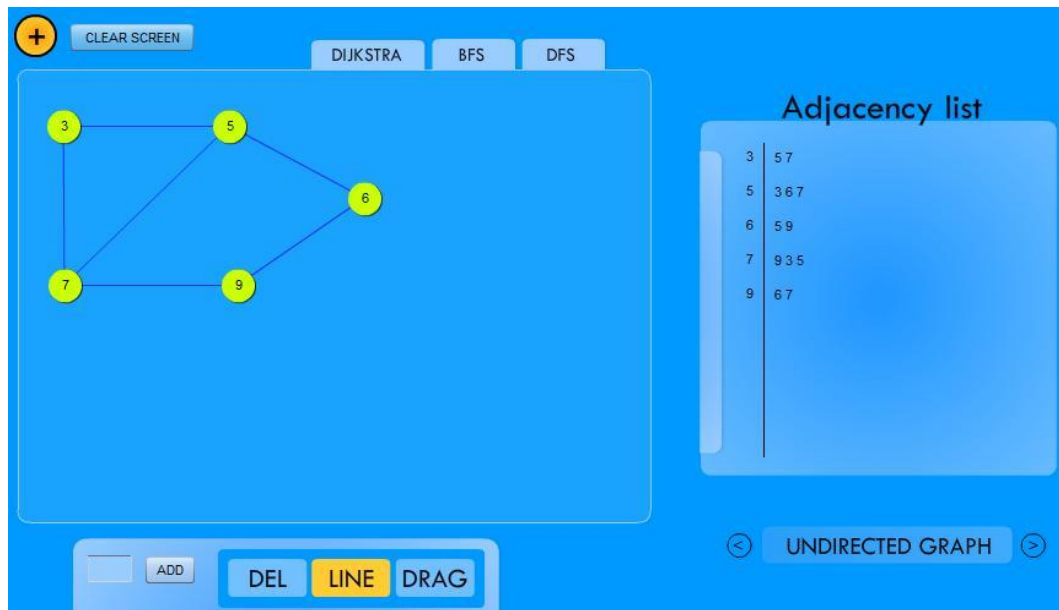


Figure 2. Building a graph

BFS starts the exploration with a certain given vertex and all its neighbour vertices. Then it continues with the unexplored neighbours of these nodes. The BFS algorithm discovers by using a FIFO queue all the vertices at a distance k from the source before those placed at a distance $k+1$. In contrast, DFS starts traversing the graph with the root and explores in depth each branch entirely before backtracking. In a non-recursive implementation, the in-depth exploration is assured by keeping the unexplored vertices in a stack. Dijkstra's algorithm solves the single-source shortest path problem in a graph with non-negative costs. Thus, for a given source vertex, the algorithm finds the paths with lowest costs to all the other vertices. Each iteration of the algorithm searches the unexplored vertex having the shortest distance to the source and minimizes the distances of its neighbours to the source vertex. The executions of all these algorithms are illustrated within our application by colouring the vertices as they are explored.

Another third party lesson refers to binary trees that are a special kind of graph. Binary trees have an elegant recursive pointer structure, so they are a good way to learn recursive pointer algorithms. The most important applicability of binary trees represents the language parsing. Through this lesson the student is allowed to follow step by step how insertion, deletion, traversal and search within a binary tree are performed. All these binary tree algorithms are presented in [3]. New nodes can be inserted into a binary tree by introducing their keys through a text field and performing the ADD button. The application also allows, by clicking on the RANDOM button, to build binary trees with randomly generated structure and nodes. Nodes can be deleted by introducing their keys into a text field and clicking on the DEL button. Deletion of a certain node treats three cases: when it has not children, when it has one child or when it has both children (in this case, the application illustrates that the key of the node is replaced with its successor's key, and the successor is deleted). For example, Figures 3 and 4 show step by step a deletion of a node with two children, in this case the root node 4. First, the application shows the successor of the selected node (see Figure 3) which is 5. After that, the key of the node that must be deleted is replaced with the key of its successor and the successor is physically deleted from the binary tree (see Figure 4, which also shows the maximum key of the binary tree after additionally clicking the MAX button).

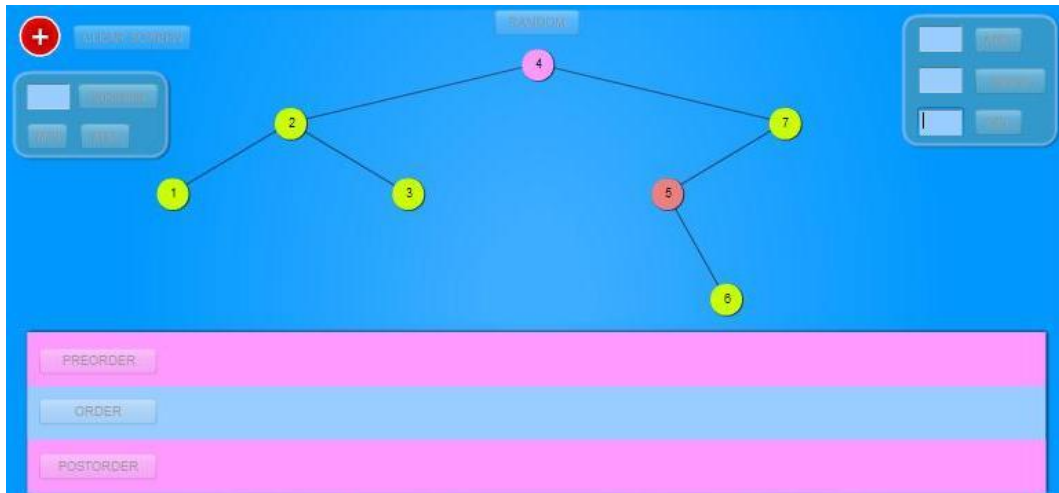


Figure 3. Removing the root of the binary tree

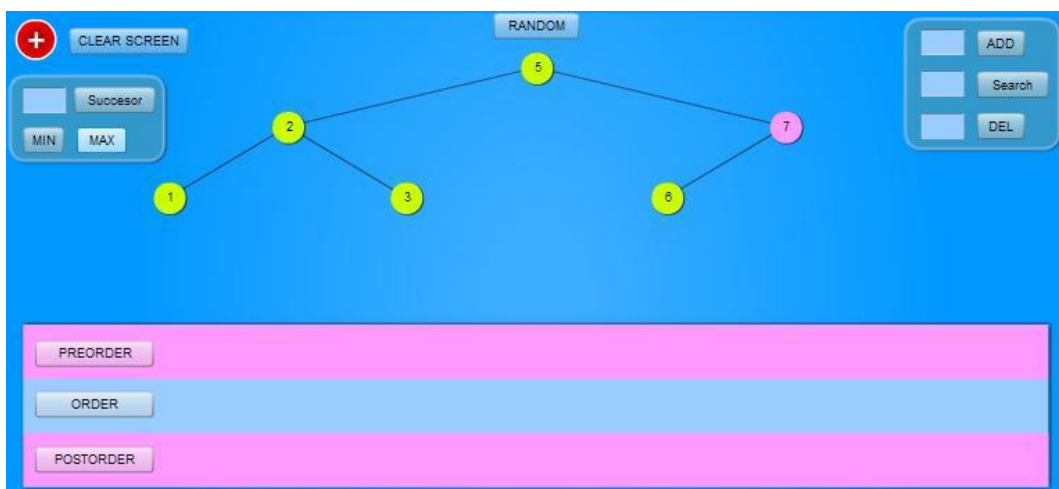


Figure 4. Illustrating the maximum key of the binary tree

Another binary tree operation, the search, can refer to searching for a certain key, searching for the minimum or maximum key and searching for the successor of a certain node. In all these operations the searched node is highlighted if exists. Figure 4 shows the maximum of the binary tree, in this case 7.

Traversal can be performed in three different ways (the application illustrates the visiting sequence for each method by colouring the nodes): preorder (the root is visited before the nodes from both subtrees), inorder (the root is visited between the nodes from the left subtree and those from the right subtree), postorder (the root is visited after the subtrees).

VI. CONCLUSIONS AND FURTHER DEVELOPMENT

Nowadays, combining traditional ways of teaching with modern approaches as online e-Learning environments focused on multimedia applications and using web technologies and tools, developed in a collaborative manner, is compulsory. Education Management Tool represents our proposed solution to enhance learning and educational management. EDM Tool became a system that has proven to be useful and has been tested in real-life situations with success. It features the key necessities of an e-Learning system, presented in an easy-to-use manner, with Web 2.0 aspects and design, which makes an attractive choice for professors and students. The third party applications presented in this work show how graph algorithms and binary tree operations can be visually performed within EDM Tool helping thus students to better understand these algorithms.

In future phases of the project, we will extend the system with new modules for securing the SQL server in order to protect the database from attackers [2] and also we want to find solutions for optimizing energy consumption of web application [5] at middleware or application level for a "green" society. Furthermore, we will implement text differencing algorithms for enabling multiple users to work on the same materials at the same time, thus, removing the delay involved by sequential consistency [1]. Besides that, we will enable search functions for e-Learning objects so that students can find them with the least possible effort.

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