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## A PROPOSED E-LEARNING MEASUREMENT VISUALIZATION TOOL (E-LMVT)

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**Abstract** – An important characteristic of e-learning environments is that the instructor should know whether a registered user is sufficiently attending the lessons. E-LMVT is a tool that measures and calculates official or pre-set indicators of learners' diligence and then graphically depicts them in the form of a polychromatic (multi-colored) tree. In this way, the instructor can quickly and accurately form a first impression of the trainee's diligence, an element important in order to enhance the trainee's guidance and to ameliorate the further co-operation between the trainee and the instructor.

Keywords: e-learning, indicators of diligence, diagnostic tree.

### 1. INTRODUCTION

E-learning is called the process of learning/training, accomplished through modern technologies, such as computer programs, digital and network technology and so on. There are two kinds of e-learning: Synchronous [1] and Asynchronous [2]. Synchronous e-learning means instructor and learners are concurrently connected to the web and their communication takes place in real time. In Asynchronous e-learning, concurrent web connection of instructor and learners is not necessary, since all communication takes place through e-mail.

Various platforms (e-Learning Environments- WebCT [3], BlackBoard [4], Top Class [5]) have been developed to support this kind of distance education. The success of an e-learning course depends very much on the learning environment in which it is placed [6].

Any kind of e-Learning Environment, that is available in the market, offers functionalities like Creating Courses, Delivering and Management of Web-Based Training, Monitoring Students Progress and others. These functions also include:

- The insertion of the lesson in the server. The lesson is stored in a Data Base (D.B) in the form of page-slides (p-s). Each page-slide features a multimedia context (text, image, video, animation and sound) and also includes the corresponding links.

- The dissemination of the lesson to the users through Internet or Intranet.
- The observation of the trainee's diligence.
- The evaluation of the trainee.

The E-LMVT is a java tool, [7] designed to measure and calculate official or pre-set indicators of the learner's diligence (2). Then, depending on the values of the indicators, the tool graphically depicts them in the form of a polychromatic (multi-colored) tree, according to a predetermined scale of colors (3).

### 2. INDICATORS OF DILIGENCE

While processing the evaluation results of the users-trainees, the instructor may often discover negative results. It is therefore essential to diagnose the reasons of this failure, so that the instructor, who is responsible for training this particular user, can determine upon a new strategy of guidance.

As with classic teaching methods, one of the most usual reasons of failure is that the user has not had enough exposure to the material, or more commonly put, the user "has not studied". Diligence can therefore be defined as the value, which specifies the degree of exposure that each user has had on the course. Which degree of exposure is considered acceptable or sufficient, can be determined by the instructor or be pre-set, according to the strategy of guidance for a particular trainee.

In order to determine the degree of the user's diligence, the following indicators are set:

- P-S frequency visit (P\_S\_fv) reports how many times the user has visited the page-slide
- P-S time remaining (P\_S\_tr) reports the amount of time that the user spent on each particular page-slide, during each visit.
- Global P-S time remaining (G\_P\_S\_tr) reports the total amount of time that the user spent on each particular page-slide, from the first to the last visit.
- Course frequency visit (C\_fv) reports how many times the user visited the lesson, from the first to the last visit.
- Course time remaining (C\_tr) reports the total amount of time that the user spent each time he visited the lesson.

- Global Course time remaining (G\_C\_tr) reports the total amount of time that the user spent on the lesson (from the first to the last visit).
- First Date entry (F\_D\_e) reports the date of the user's first visit to the lesson.
- Last date entry (L\_D\_e) reports the date of the user's last visit to the lesson.
- Date Course frequency visit (D\_C\_fv) reports how many times the user has visited the lesson on the same date.

### 3. E-LMVT'S FUNCTION AND MODULES

As depicted in fig. 1, the E-LMVT, can be used each time for every particular registered user. Furthermore, the tool can be used for any other lessons that the same user is attending. Finally, the same procedure can be repeated for any other user.

Using the Parser module, the E-LMVT extracts the user's history file, which is the data for the calculation of the diligence values and then stores them in the Data Base [8].

Through the Site Tree Extractor module, the E-LMVT finds and stores all the existing links for the lesson that the trainee is enrolled.

Using the module Diagnostic Tree, the E-LMVT recreates the lesson, which the user is enrolled, in a tree form. The root directory and the page slides are represented using a different color, according to the trainee's degree of diligence. There is a specified color for a particular degree of diligence.

For example:

The color white indicates that the trainee has not had any contact with the certain part of the lesson, that is, the trainee has not visited the corresponding page-slide or the lesson.

The color yellow indicates that the trainee has had a brief contact with the lesson, that is, the trainee has visited the corresponding page-slide, or the lesson, once or more times but the total amount of the time spent was less than required. The degree of diligence is low.

The color green indicates that the degree of diligence is moderate, while orange indicates that the degree of diligence is satisfactory. Red color indicates that the degree of diligence is very good and blue indicates that the degree of diligence is excellent.

More analytically, the modules that compose the E-LMVT are:

- Parser
- Site tree extractor
- Diagnostic tree.

The module Parser is executed in the user's computer. It is comprised of two other modules, the File Parser (FP) and the Data Base Updater (DBU).

The File Parser extracts data from the user's history file, which are then used for the calculation of the indicators of diligence. The Data Base Updater obtains the data from the File Parser and stores them in the Data Base.

The module Site tree extractor is comprised of two other modules, the URL Creator (URLC) and the Data Base Manager (DBM). The module Creator URL finds and

recreates all the URLs of the lesson. The module Data Base Manager stores the URLs of the lesson in the Data Base.

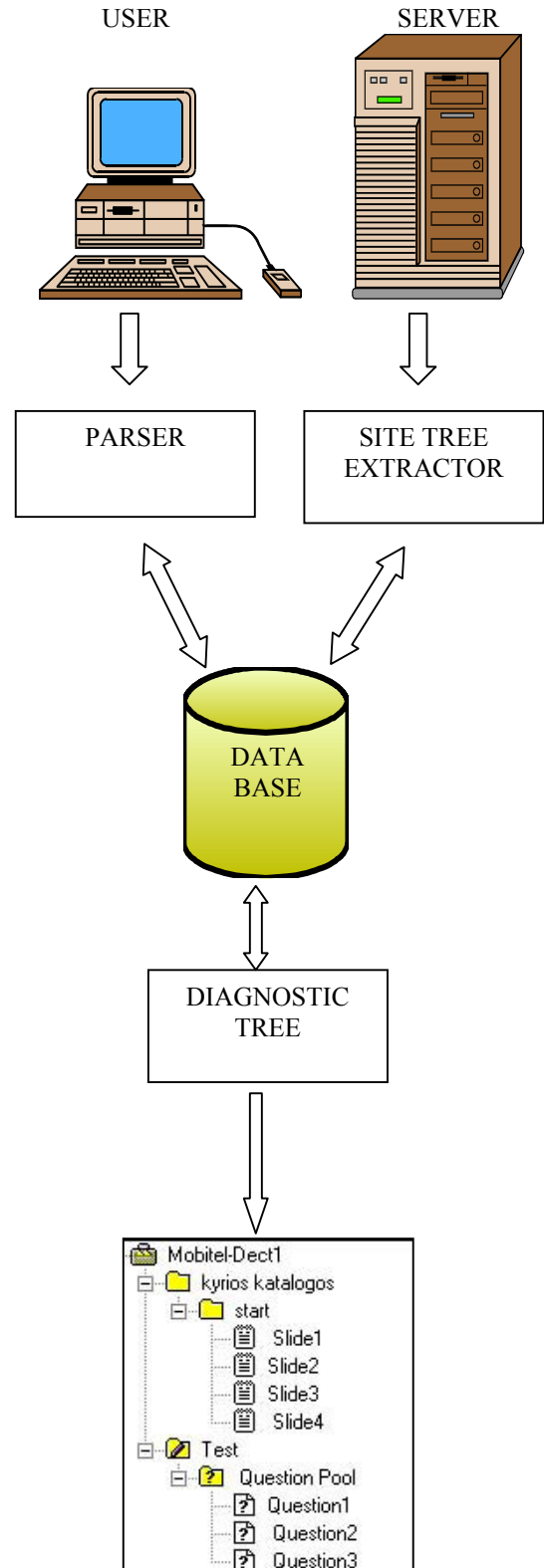


Fig 1. E-Learning. Measurement Visualization Tool  
 The module Diagnostic tree is comprised of three modules, the Data Base Reader (DBR), the Dynamic Tree (DT) and the Visualization Dynamic Tree (VDT). The

module Data Base Reader (DBR) retrieves the data from the Data Base and calculates the indicators of diligence. The module Dynamic Tree (DT) formulates the lessons tree form. The module Visualization Dynamic Tree, creates the graphic representation of the tree, using the relative colors.

The Parser Module, the Site Tree Extractor Module and the Diagnostic Tree Module are explained and analyzed in the followings paragraphs.

### 3.1. PARSER MODULE

The Parser Module application is executed in the user's computer. It was developed using Java and it presupposes that Opera Explorer is installed in the user's computer.

This Module allows us to observe the exact time the user visited each page of the course, when the visit was terminated and on the whole, how much time the user remained in each particular page.

More analytically, the operation of the Parser Module, as it appears in fig. 2, is the following:

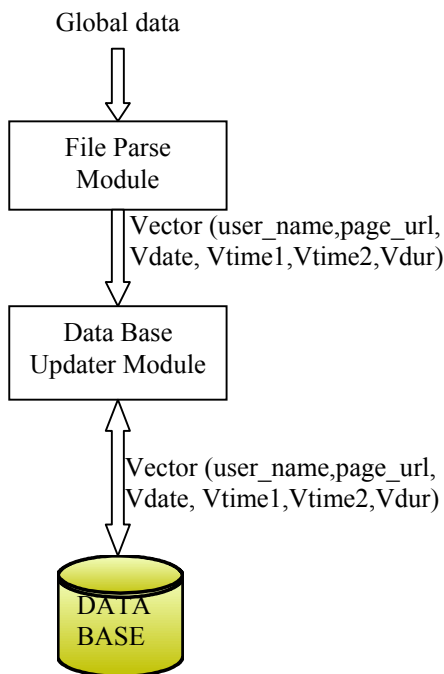


Fig. 2. Parser Module

The File Parser Module receives the Explorer's history file as input and processes only these registrations that have same domain. The Module therefore, only processes the pages of the courses that the user attends. From the aforementioned registrations, the username, the url (page\_url), the date (Vdate), as well as the time (Vtime1), that the user entered this lesson page are isolated, as it appears in fig. 3.

Simultaneously, the module calculates the output VTime2 and the Vdur=VTime2-Vtime1 that is the total time of the user's residence in one page. Vtime2 is the time the user entered the next site. It is considered as the time of exit from the current site and the time of entry in the next site. A problem that may occur is to

find the Vdur of the last page visited, in case the user closes the explorer. In this case, Vtime2 will be the time that the user re-opens the explorer and enters another site. This Vtime2, no matter how small or big it is, it is not the real time of the user's exit from the previous site. As a result, the Vdur will not be calculated precisely. However, this problem was solved in the following way:

14	Full software page
15	http://doom9.org/software 2htm
16	10192261102
17	ASTALAVISTA.BOX.SK/
18	http://www.astalavista.box.sk/
19	1019266163
20	Lowfare.com – Travel resource center
21	http://www.lowfare.com/
22	1019266187

Fig. 3. Opera Log File User Information Parsing

- 1) An exit form was created, which the user is compelled to activate each time he leaves the course. This page is not considered as a course page and the File Parser Module does not take it into account as such, while the last beneficial page of the course (the page before the exit form) has Vtime2, so that the Vdur can always be calculated correctly.
- 2) The File Parser Module is activated each time the user leaves the course, so that the output of the module is a vector (username, page\_url, Vdate, VTime1, VTime2, Vdur)

Next, the File Parser Module calls the Data Base Updater Module. The File Parser Module receives as input the vector (user, url, date, Vtime1, Vtime2, Vdur) and updates the Data Base, as it is shown in fig. 2.

The Data Base table, in which user, url, date, Vtime1, Vtime2 and Vdur for the corresponding registrations are stored, is presented in fig. 4.

username	page_url	Vdate	VTime1	VTime2	Vdur
user1	http://www.domain.com/lesson1	19/12/2002	12:32:13	12:34:21	128
user1	http://www.domain.com/lesson1/1.html	19/12/2002	12:35:10	12:36:24	74
user1	http://www.domain.com/lesson1/2.html	19/12/2002	12:36:24	12:38:05	101
user1	http://www.domain.com/lesson1/3.html	19/12/2002	12:38:05	12:39:57	112
user1	http://www.domain.com/lesson1/4.html	19/12/2002	12:40:03	12:42:16	133
user2	http://www.domain.com/lesson1	21/12/2002	15:10:43	15:12:14	91
user2	http://www.domain.com/lesson1/1.html	21/12/2002	15:12:14	15:13:57	103
user2	http://www.domain.com/lesson1/2.html	21/12/2002	15:13:57	15:15:06	69
user2	http://www.domain.com/lesson1/3.html	21/12/2002	15:15:06	15:17:12	126

Fig. 4. Storage table of username, page\_url, Vdate, VTime1, VTime2 and Vdur, in the Data Base

### 3.2. SITE TREE EXTRACTOR

The code of the Site Tree Extractor Module has been developed in C++ [9] [10] and its operation consists of the following cyclic process. First, the initial page of the lesson, with all the relative links, is located. Then, the Site Tree Extractor Module stores all the links in the Data Base. The same process is applied to all the links found in the first page, then the second page and so on. The process is completed when all the pages with new links have been examined.

Analytically, the operation of the Site Tree Extractor Module, as it appears in fig. 5, is the following:

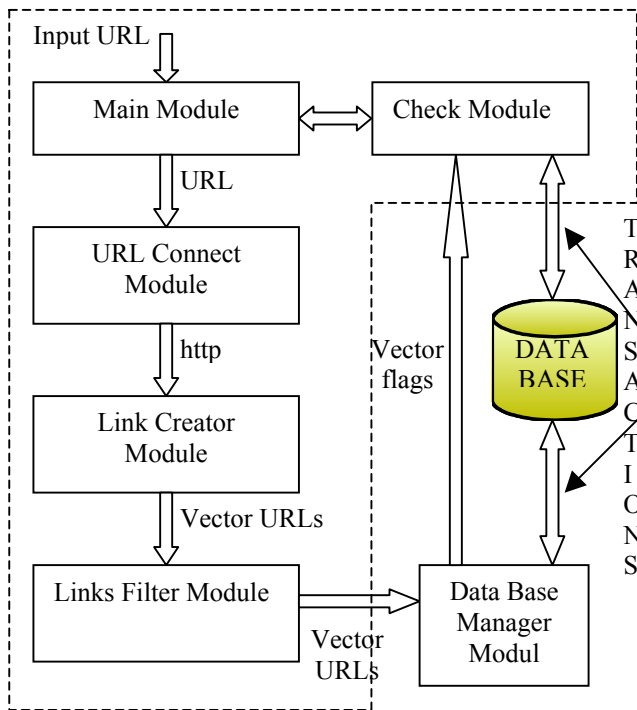


Fig. 5. Site Tree Extractor Module

The URL Creator Module consists of the following modules:

- Main Module
- URL Connect Module
- Link Creator Module
- Link Filter Module

The Main Module receives the URL of the lesson that is to be represented in a tree form. The module checks the output of the Check module and calls the URL connect module.

The URL Connect Module extracts from the Main Module the content of the first page, along with all the links to the other pages, and downloads it before calling the Link Creator Module. It should be noted that the page under examination contains at least one link to the next page of the course.

The Link Creator Module finds the corresponding http file and recovers all the existing links and then sends them to the Link Filter Module.

The Link Filter Module omits all the irrelevant links, namely the ones that do not belong to the site of the lesson. The rest of the links are sent to the Data Base Manager.

The Data Base Manager Module imports the URLs of the page and confirms whether the page exists in the Data Base. Then, after omitting duplicates, it updates the Check Point Module, in the following manner:

1. If the page under examination is found to contain links, the Check Point Module is informed as to the amount of URLs and the particular location they were stored in the Data Base.
2. If the page under examination does not contain any links, the Check Point Module is informed about the termination of the process.

Following the process of link storage for the first page, the Check Point Module is responsible for the successive supply of the Main Module with the rest of the links, and the same process is applied to those as well. The Check Point Module, as mentioned before, also controls the termination of the process.

Fig. 5 presents the Data Base table with the pages of the course. Each registration features the following fields:

id\_page: contains a serial number for the unique denotation of each registration (primary key)

page\_url: the page url

parent\_id: the course page where a particular link was located, for example, in fig. 6, the registrations with parent\_id 2, 3 and 4 (children), are the links found in the same page, namely page 1, as the value of the parent\_id indicates.

site\_id: where the code of the lesson is stored (domain name). In case a user is attending more than one course, there must be one table for each course.

id_page	page_url	parent_id	site_id
1	http://www.domain.com	0	1
2	http://www.domain.com/lesson1	1	1
3	http://www.domain.com/lesson2	1	1
4	http://www.domain.com/lesson3	1	1
5	http://www.domain.com/lesson1/1.html	2	1
6	http://www.domain.com/lesson1/2.html	2	1
7	http://www.domain.com/lesson1/3.html	2	1
8	http://www.domain.com/lesson2/1.html	3	1
9	http://www.domain.com/lesson2/2.html	3	1

Fig. 6. Link storage in the Data Base

### 3.3. DIAGNOSTIC TREE MODULE

The Diagnostic Tree Module, developed in Java [8], calculates the indicators of diligence, as they are reported in paragraph 3, and forms the graphic tree of the course. Furthermore, this module colors the tree, depending on the values of the aforementioned indicators.

Fig. 7 illustrates the block diagram of the Diagnostic Tree Module. The Data Base Reader retrieves from the Data Base the content of the table that the Parser Module has created (Fig. 4) and exports the V1=vector (username,

page\_url, Vdate, VTime1, VTime2, Vdur), to the Visualization Dynamic Tree Module.

The same module also retrieves the data from the table that the Site Tree Module has created (Fig. 3) and exports the V2=vector (id\_page, page\_url, parent\_id, site\_id), to the Dynamic Tree Module.

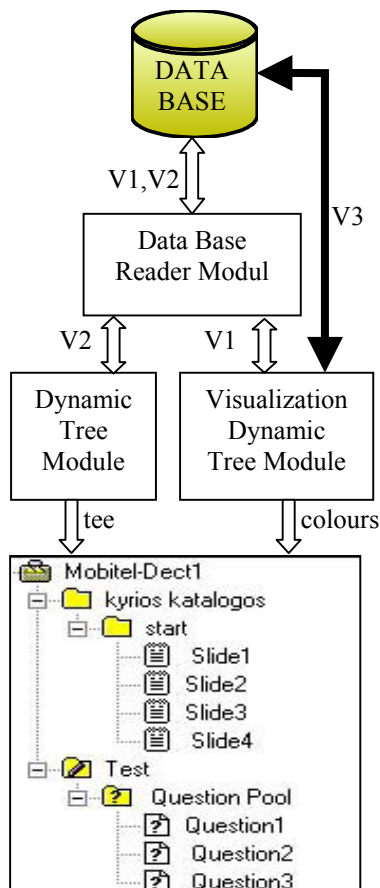


Fig. 7. Dynamic Tree Module

The Dynamic Tree Module receives the vector (id\_page, parent\_id, site\_id) as input and produces a graphical tree representation of the course’s structure.

The Visualization Dynamic Tree Module receives the vector (username, page\_url, Vdate, VTime1, VTime2, Vdur) as input and processes the data with the corresponding queries. Then, it exports to the Data Base the V3= vector (username, page\_url, P\_S\_fv, P\_S\_tr, G\_P\_S\_tr, C\_fv, C\_tr, G\_C\_tr, F\_D\_e, L\_D\_e, D\_C\_fv), thus creating new tables in the Data Base, as it is illustrated in Tables I, II and III. In the aforementioned tables, the fields of the records are the User\_name, of user, the Page\_url of each page-slide of the course and the indicators of diligence P\_S\_fv, P\_S\_tr, G\_P\_S\_tr, C\_fv, C\_tr, G\_C\_tr, F\_D\_e, L\_D\_e, D\_C\_fv, as they were analyzed in paragraph 2. The emerging data can be used for further processing, as described in paragraph 4 (Conclusions / Features Work).

The Visualization Dynamic Tree Module also compares the values of the indicators of diligence with the predetermined parameters and colors the course tree accordingly.

Table I Values of indicators of diligence P\_S\_Fv, G\_P\_S\_tr C\_fv, G\_C\_tr.

User name	Page_url	P_S fv	G_P_S tr(sec)	C fv	G_C tr(sec)
User1	<a href="http://domain.com/lesson1">http://domain.com/lesson1</a>			8	999
User1	<a href="http://domain.com/lesson1/1.html">http://domain.com/lesson1/1.html</a>	2	228		

Table II I Values of indicators of diligence V\_date, P\_S\_tr, C\_tr, D\_C\_fv

User name	Page_url	Vdate	P_S tr(sec)	C tr(sec)	D_C fv
User1	<a href="http://domain.com/lesson1">http://domain.com/lesson1</a>	19/12/02		544	5
		21/12/02		385	4
User1	<a href="http://domain.com/lesson1/1.html">http://domain.com/lesson1/1.html</a>	19/12/02	128		
		21/12/02	100		

Table III Values of indicators of F\_D\_e, L\_D\_e

User name	Page_url	F_D_e	L_D_e
User1	<a href="http://domain.com/lesson1">http://domain.com/lesson1</a>	19/12/02	21/12/02

#### 4. CONCLUSIONS / FUTURE WORK

Applying the E-LMVT tool in the e-learning procedure, allows the instructor to quickly and accurately detect any predicaments in the learning process and to intervene promptly, where necessary. The intervention can take place either before the evaluation, as a way of precaution, or after the evaluation, as a means of implementing a new guiding strategy for trainees, who have not displayed the necessary degree of diligence.

In addition, using the diligence indicators stored in the Data Base, the E-LMVT can be expanded to visualize further data which concern the formation of a direct and reliable estimation of the degree of diligence for each learner, in every lesson or of a whole class, or even of a whole course of lessons and so on.

Furthermore, after having evaluated a large part of trainees, it is possible to statistically process the diligence indicators stored in the Data Base and use them to evaluate either the methodology of context development for a particular lesson or the entire e-learning environment. Finally, using statistical processing, it is possible to improve the specification and the precise range of the indicators, for each degree of diligence.

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