Towards supporting the teaching of history using an intelligent information system that relies on the electronic road metaphor*

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Abstract

The new educational system in Greece, as far as teaching of history is concerned, is characterized by a shift away from sterile memorization and towards a critical approach of historical facts and phenomena that would contribute in both the development of pupils' historical concept and conscience and the promotion of critical thought. This reflects the globally accepted goals of teaching history courses. Such teaching goals can be greatly supported by computer-based applications, which can offer access to vast amounts of historical texts and data to be used next to the main scholar textbook and be analyzed by pupils. Still, existing applications seem to be quite inadequate for this purpose, as they require that the pupil be already informed on a matter, before the initiation of a quest for data. In this paper, we describe an intelligent information system that is designed to facilitate browsing of educational material and historical sources, thus allowing pupils to efficiently retrieve information on topics that are not yet known to them and expand in this way their historical knowledge. This can help in fulfilling the teaching goals of the new educational system.

1. Introduction

With the establishment of the new educational system in Greece, the teaching methods of theoretical courses have been substantially altered. Some of the goals that have to be achieved through the teaching of history, as defined by the ministry of education and religious affairs in Greece, are the following: (i) the pupil should be able to compare historical facts or phenomena and find similarities and differences among them, (ii) the pupil should be able to comprehend that the credibility of the historical narration relies on the proper use of the sources (iii) the pupil should be able to approach different kinds of historical sources, (iv) the pupil should be able to associate and correlate facts, periods, ideals and civilizations of different periods and areas, and compare important historical figures based on their actions and total offer (v) the pupil should be able to comprehend the correlation of historical elements synchronically and diachronically and the correlation of the historical facts with contemporary facts [6][7].

In conducting the course, the teacher needs to exploit all available tools, in order to stimulate the pupils to achieve all the above. Next to traditional methods of teaching, the ministry gives much value to the research of historical sources by pupils and to projects, either personal or prepared by groups of pupils, that can refer to one educational unit or to broader thematic units. Sterile memorization of historical facts and dates is being set aside and a critical approach is being required from pupils, by asking them to commend on primary sources or visual material and to relate them to the historical facts. This means that pupils need to have continuous access to such material, in order to develop the ability to approach it critically and analyze it.

Studies have shown that electronic – based independent learning environments can take their place in a traditional educational environment. Moreover, they indicate that, as the new generation becomes more affiliated with computers, their perception of the structure and content of electronic material is enhanced [1]. The importance of technology particularly in the teaching of history has been outlined by Vertsetis [2]. Technology can help teachers locate the appropriate teaching material to use, next to the main instructive textbook; this refers to primary sources, photographs and other visual material. Furthermore, it can help pupils perform their assignments and projects, have a closer intercourse with the primary sources and have access to a broad range of learning material.

In this paper we focus on tools used in research for the preparation of a project on a historical topic. The goal of

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this process is not merely that pupils acquire knowledge on the specific topic, but they review a wider range of documents and topics, exercise their judgment in comparing and correlating events, and form a personal but justified opinion on a matter. Therefore, the tools used for locating information should be designed in such a way, as to promote the above. As we shall explain, traditional search engines and existing bibliographical databases are both improper for this task; they fail in that they (i) demand that the pupil already possesses the information, in order for them to use the tools efficiently and (ii) they do not facilitate the study and comparison of facts that, although similar in nature, may differ in time, location and participating historical figures. In this paper we describe a system that is designed to overcome such difficulties; this system is based on a novel implementation of the electronic road metaphor [3].

The structure of the paper is as follows: in Section 2 we review related applications and technologies that can be used by pupils in the framework of history courses. In Section 3, we present the electronic road metaphor and explain how it can facilitate the aforementioned teaching goals, when integrated in an information system. Finally, in Section 4 we present the architecture of the proposed system, and in Section 5 we discuss the utilization of the system in secondary education. In Section 6, we list our concluding remarks.

2. Existing approaches and applications

When preparing a project, apart from books and libraries, pupils most often use general – topic search engines, such as Google, in their quest for information. Such engines most often return numerous documents, most of which are either unrelated to the user's quest. More importantly, returned documents are unreliable, as far as their content is concerned, as they have not been checked and approved by teachers and historical experts.

Documents that are related to historical events can also be accessed via web search engines that are dedicated to this subject. An example of such a search engine is Argos, which is developed and maintained by the University of Evansville. Pupils can also access resources for ancient Greek and Byzantine history from the Perseus Project web page. Perseus is a digital library, which started out as a digital library of and has been expanding its holdings to include Latin texts and lexicographical resources. It provides web access to a large number of images and translated Greek and Latin texts, which can be queried with the use of keywords. It also provides access to tools such as the electronic version of Liddell-Scott Dictionary, web based versions of Smyth's Greek Grammar and Allen and Greenough's New Latin Grammar, a web exhibit about Hercules and the Olympic Games, a tour of Olympia and access to Thomas Martin's overview of archaic and classical Greek history.

Furthermore, pupils and teachers can access primary sources for ancient and Byzantine history with the help of the TLG and PHI projects. TLG has digitized most Greek literary texts that have survived from Homer up to the fall of Byzantium. Its goal is to create a comprehensive digital library of Greek literature from antiquity to the present era. The PHI project is a similar digital library containing a selection of Greek and Latin inscriptions and papyri and nearly all works of Latin authors.

Both TLG and PHI data can be accessed through special engine tools such as Musaios, TLG Workplace, Antiquarium and others. Musaios offers full support for the TLG Word Index, including the ability to view citations for all indexed words. Antiquarium generates reports for search results that users may print out. It allows sorting of authors by date and makes use of the TLG word index and bibliographical information. In TLG Workplace, works can be automatically selected by date, classification, provenience and gender.

More information on all of the above, as well as a vast collection of web and other resources for history (Chiron, Lector, V&F, Diotima, The Duke Papyrus Archive, The Ecole Initiative, History/Social Studies Web Site for K-12 Teachers, The Oriental Institute Home Page, The Ovid Project, The Roman Forum, The Seven Wonders of the Ancient World) is available through [8].

The Greek pedagogical institute is also in the final stage of developing another web-based digital library that aims to support teaching of a vast variety of topics. This library, although equipped with a wide range of annotation metadata, still provides the same indexing and searching services as the tools presented above [9].

3. The electronic road metaphor

In all applications and search engines presented above, search is conducted with the use of keywords, e.g. authors, locations and dates. Such systems are based on the perception of document space that is presented in Fig. 1, in which all documents are indexed by keywords. When it comes to school project related research, teachers identify the following disadvantages in this approach:

- In order to form a proper query, pupils need to possess some knowledge of the topic in advance, especially when the project is related to a chronologically distant period.
- Search by date concerns only the authors and the time of the creation of documents. The time period the documents refer to is typically not included in the index. Therefore, even if the pupil possesses date information, quite often it is not sufficient, unless the document itself includes some kind of chronological indication in a form that can be easily retrieved using keyword search.

- Similar documents cannot be located automatically, unless they contain the same keywords. This deprives pupils from the opportunity to locate and correlate similar events of different eras; quite often subjects are posed that demand from the pupils to do so.
- The index-based perception of the document space degenerates project research to a simple search for documents, rather than the stimulating journey in historical information that it is initially meant to be.

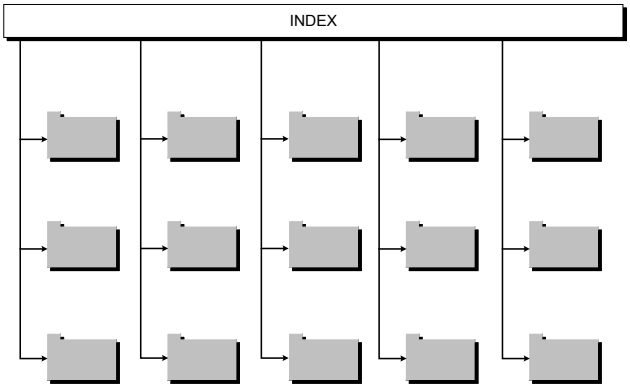

Figure 1. The indexed model

Figure 2 presents an alternative perception of the document space. In this approach, documents are characterized by the similarities that exist among them. An index still exists; using it one may initiate a search. Still, the main service offered is that of intelligent, adaptive navigation through documents, as the system can determine the documents that are related to the one the user is currently viewing.

In this approach, documents that are encountered during a pupil's interaction with the system are not considered to be unrelated from each other. On the contrary, they are considered to be the distinct steps of the pupil's path among available documents. This path is often referred to as an *electronic road* [3].

This notion can be used by the system in order to best determine the set of relevant documents to propose to pupils. In Figure 3 we can see the electronic road a pupil has followed (visited documents being shadowed and the current document being darker). The current document is related to three other documents, for various reasons (same historical figures, same location etc.). Still, only one of them (the dark gray one) is related to all the steps of the path. Thus, considering these steps as the pupil's relevance feedback, we can determine that only one document is truly related to this ongoing research.

As far as implementation of this notion is concerned, prior to determining related documents to propose, the system examines documents in the electronic road in order to detect which annotation units are common among them. These units form the *context* of the electronic road. For example, if all three documents refer to battles that have taken place in a specific location, although at different times and between different armies, then the extracted context shall be the combination of this location with the event of a battle. Documents that combine the two shall be proposed to the pupil.

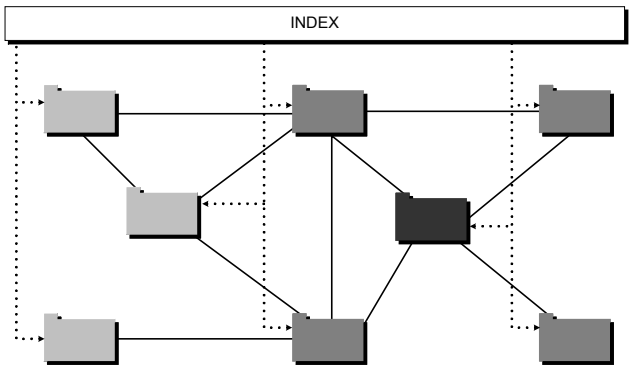

Figure 2. The relational model

Documents that appear last in an electronic road have a greater probability of being closely related to the user's wish and, as the principles of relevance feedback dictate, are taken into account to a greater extent when extracting the electronic road context [4], by using fuzzy weighting of documents.

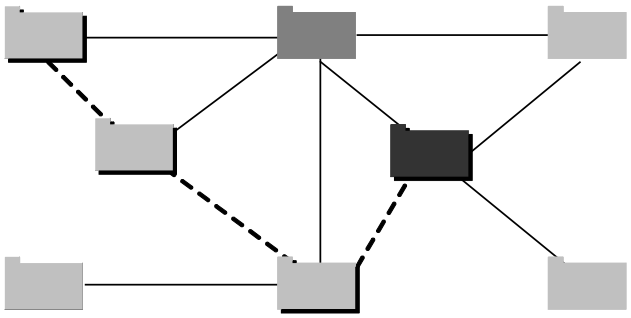

Figure 3. The electronic road metaphor

Continuing, candidate documents, i.e. documents that are related to the one the pupil is currently viewing, are compared to the extracted context, in order for the system to determine whether they should be proposed to the pupil, as possible steps for the continuation of the electronic journey.

4. System architecture

The architecture of the proposed system is presented in Figure 4. The distinct components that form the system, apart from the user interfaces, are the Digital Library and the intelligent modules. Both are presented in the following subsections.

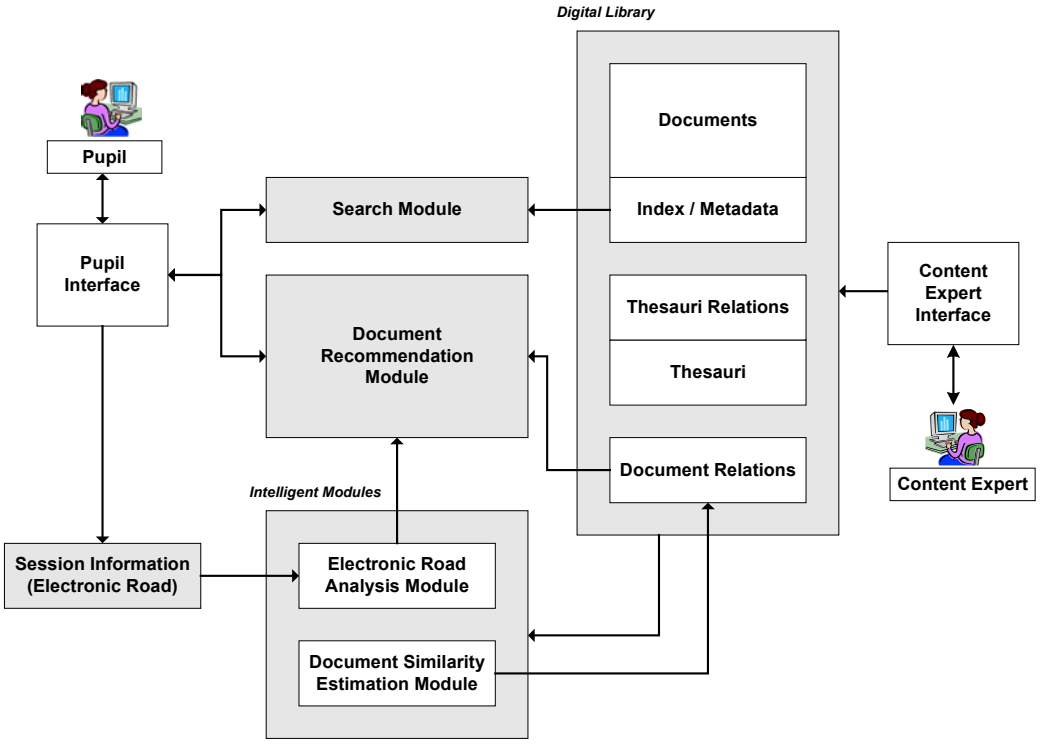

Figure 4. The electronic road

4.1. Digital Library

The Digital Library is comprised of the documents and annotation data, the thesauri and thesauri relations, and the document relations.

The annotation data for each document is comprised from the following units:

- Location – Time
- Historical term (revolution, treaty, civil war etc.)
- Participating figures and people
- Conditions / factors (under which an event occurred or phenomenon appeared)
- Author
- Time of creation of the document
- Location of creation of the document
- Causes and consequences

Few of these are described using free text annotation. For the others terms from the predefined thesauri are used. The usage of such controlled dictionaries is needed for the definition of relevance degrees among terms. These degrees are stored in the Digital Library; they are the thesauri relations. Document relations describe the degree to which documents are related to each other, according to each one of the annotation units. Thus, two documents may be related as referring to the same location, while at the same time they may differ as referring to different time periods. Degrees of relation may be provided by the expert users, or determined automatically by the system's intelligent modules.

4.2. Intelligent modules

Retrieval may be performed in two modes: search and navigation. Searches are performed using the indices. Navigation is controlled by the document recommendation module, which relies on two intelligent modules, the electronic road analysis module and the document similarity estimation module.

The document similarity estimation module operates off-line and aims to automatically determine the relations among documents. In the case of annotation units that rely on a controlled dictionary, the module's operation relies on the usage of thesauri relations. For the remaining annotation units that are described using free text, the module detects thesauri terms in the text and again uses the thesauri relations. Still, for these cases the result may not be meaningful; an expert is needed to verify it.

The electronic road analysis module accepts the last visited documents as input. These are considered as the last steps of a path and are compared to each other, in order to determine which annotation units best characterize the topic of the current session; this may be perceived as a soft intersection operation. The term soft is used, because of the weighting of documents, based on their position in the electronic path. Specifically, if w_i^a is the degree to which term a is related to document i in the electronic road, and W_i is the document's importance in the electronic road, then the term's importance in the electronic road $er(a)$ is:

$$er(a) = \bigcap w_i^a \cup c(W_i) \quad (1)$$

where c is a fuzzy complement. The union and intersection operators used are also fuzzy operators. (More on fuzzy operators can be found in [5]).

Using the result of the electronic road analysis module as a guideline, the document recommendation module ranks documents that appear to be related to the one the pupil is currently viewing, in order to form a meaningful recommendation.

5. Application to education

Lately, there has been a growth of utilization of computer – based curricula for self – directed, or semi – supervised study. Such programs have already lead numerous adults to the acquisition of professional certifications, thus proving their efficiency.

Still, two main obstacles delay the application of computer – based tools in earlier stages of the educational process, such as primary or secondary education:

- Teachers often find it difficult to use the tools themselves, let alone direct their pupils.
- Students are often required to follow a self – directed study approach, which teachers are reluctant to use since pupils may be too young to be made responsible for their own study.

Both obstacles have been considered in the design of the presented system. As far as the teacher's interaction with the system, it is practically eliminated. Unlike e-learning tools [10], this is not a system that requires the teacher to monitor student progress through it. It is rather a source for supplementary material, already prepared by historical and paedagogical experts, set to the disposition of the pupil.

As far as the need for supervision and assistance is concerned, this is offered by intelligent adaptiveness. The proposed implementation of the electronic road metaphor can aid pupils by directing them to relevant sources, without the direct need for immediate assistance by the teacher. Thus, teachers' input to the pupil can be asynchronous. For example, a pupil may use the topic of the given project to perform a search / navigation in the system, with the aid of the intelligent recommendation system. Then, results can be taken to the teacher for evaluation and feedback.

6. Conclusions

In this paper, we have pointed out that project research for pupils has a quite different aim than project research at other education levels. Because of that, the information services that pupils need are quite distinct. Specifically, they need to interact with a system that (i) allows them to locate information on topics they have not yet mastered (ii) drives them to critically approach new information (iii) aids them in specifying the topic of their research in an interactive manner.

Continuing, we have presented a system that attempts to offer such services. This system relies on a relational perception of the document space, as well as a novel implementation of the electronic road metaphor, in order to determine the context of the pupil's research.

This concept can be applied to other educational subjects or general purpose information retrieval systems as well. Especially for the latter, it would be quite interesting to integrate these approaches with user profiling methods and investigate the selection of meaningful fuzzy operators to use in this context. Finally, as with all systems that hold annotated documents, the facilitation and partial automation of the annotation process are always of major importance.

7. References

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