XML-based development of electronic library for teaching and educational subsidiary materials

Tsvetanka Georgieva-Trifonova* and Gabriela Chotova**
* Department of Mathematics and Informatics, University of Veliko Tarnovo, Veliko Tarnovo, Bulgaria
** Professional School of Electrical and Electronics, Gorna Oryahovitsa, Bulgaria
cv.georgieva@uni-vt.bg, chotovagm@abv.bg

***Abstract*— Recently, there has been increasing interest in the use of electronic libraries for teaching and educational subsidiary materials on informatics and information technologies at Bulgarian schools. There are noticeable possibilities for development and improvement of the existing systems, which would help to maximize the benefits of their applying. One such possibility is collecting of the information concerning the count and ratings of downloaded materials and their analysis by subjects, authors, keywords, type, etc. Similar analysis could assist to improve the quality of the materials in a way that they to be useful, as well as to arouse an interest. In the present paper, XML-based solution of that option is proposed, based on the advantages provided by the semi-structured data model.**

I. INTRODUCTION

Nowadays, the world of information technologies is faced with the challenge of constantly growing software systems. Business software, social networking, online trading systems, electronic libraries generate huge amounts of data.

If we look back in time, database management systems had begun their way from automation tasks to record structured information. They go through several stages of development to the emergence of the concept of the relational model of Edgar F. Codd in 1970 [1]. This had made data modeling and creating software for their management much easier. Flexible structure, theoretical justification, standardized language and well-defined rules for construction are just some of the advantages of the relational model.

Beyond all other benefits, the relational model is suitable for systems of client-server type and has established itself as a key technology for storing and processing data of the web-based and business applications. But over time, these systems are becoming larger and are accessible to more users. With the entrance of Web 2.0 and the dissemination of social networks, in the foreground, the requirements for high performance, scalability, reliability and flexibility are placed. The relational databases management systems can be easily scaled vertically by adding supplementary hardware resources. However, the horizontal scaling, the delay caused by the excessive normalization and the increasing amounts of data are becoming a problem.

To solve these problems, much effort is exerted concerning the development of different types of non-relational (NoSQL) database management systems. They are used in everyday writing of comments by millions of people on social networks (Facebook, Twitter, Instagram, etc.), data products in major electronic stores (Amazon, eBay), Google search and systems of large corporate funds.

The main problems facing most NoSQL databases are associated with [2]:

- data portability;
- compatibility between NoSQL databases;
- dependence on the provider (vendor lock-in).

XML databases overcome these problems as they take advantage of the standard languages: XML [3], query language XQuery, language for modifying XML data – XQuery Update (W3C Recommendations).

It is no accident that in order to solve these problems, some NoSQL databases offer integrated solutions such as integration of Zorba XQuery Processor with MongoDB, which is documentary-oriented and is currently the most popular NoSQL databases management system.

The advantages of building digital libraries based on XML databases can be summarized as follows [4, 5, 6]:

- It makes easier sharing of various resources;
- XML data are essential in a need of linked data, which are becoming more popular;
- The scheme of the data can be readily changed;
- It is possible to retrieve the information from data sources that are not restricted by a predetermined scheme;
- It allows flexible format for exchange of data between different databases.

II. MOTIVATION FOR USING XML DATABASE WHEN BUILDING A DIGITAL LIBRARY FOR TEACHING AND EDUCATIONAL SUBSIDIARY MATERIALS

In [7], we have exanimated current status of the implemented web-based multimedia information systems for e-learning materials and their use by students at Bulgarian schools. Besides, we have considered the role of electronic library in teaching information technologies at Bulgarian schools in order to provide more time for the application of the studied material and to increase the effectiveness of the educational process. There have been summarized the advantages and disadvantages of the use of digital libraries in teaching information technologies and are presented the main features of developed electronic library for teaching and educational subsidiary materials. The electronic library is built by means of HTML, CSS, PHP, MySQL.

After the conducted examinations of the current state of the creation of web-based multimedia information systems for e-learning materials and their use by students, it has been concluded that there is an outlining of the enhancing of their use in the learning process. The analysis shows possibilities for development and improvements to existing systems, which would help to maximize the benefits of their application.

Data storage for the materials in the database provides opportunities to collect information concerning the number and estimates of downloaded materials and their analysis in subjects, authors, keywords, type, etc. Such an analysis could help to improve the quality of the materials in order they to be useful and to arouse interest. Besides writing of comments to the electronic materials provided, it would facilitate the sharing of additional information (comments, additions, interpretations, clarifications) between users and authors of the materials.

Providing a possibility to maintain data on the number of downloads, ratings and comments on materials, is the main motivation for using the benefits of non-relational databases management system in the implementation of an electronic library for teaching and educational subsidiary materials.

Non-relational database system management is used for storage of data about the electronic materials together with the comments to them. Because the developed system must support search descriptions of electronic materials, the optimum is use of XML-based system for managing non-relational databases, since the built-in form of queries XPath / XQuery is standardized and optimized.

One of the fastest and lightest for using non-relational database management systems is BaseX. It is applied in a large number of software products – from those related to scientific activities, to libraries of XML documents. One of the customers of BaseX is Nexoma, developing platforms for Internet commerce and online applications. The software product which uses BaseX, is XS-KatalogExpress and it represents an electronic catalog of products.

These facts determine the use of BaseX in this present system to maintain electronic materials as an appropriate XML database management system.

III. Development of XML-based Electronic Library for Teaching and Educational Subsidiary Materials

In the present study, we transform the existing relational model, described in [7], in a model of semi-structured data (Fig. 1a).

The successors of the root element `elibrary` are:

- `materials` with one or more successors material with attributes `materialid` and `authoridrefs`, referencing one or more elements `author`;
- `authors` with one or more successors to the author with attributes `authorid` and `materialidrefs`, referencing one or more elements `material`.

The successors of the element `material` serve to present the characteristics of a given material – title (`title`), subject (`subject`), category (`materialcategory`), description (`description`), keywords (`keywords`), files (`materialfiles`), as well as additional – estimates (`ratings`) and comments (`comments`). The element `author` has successors intended to describe authors – name (`firstname`), family (`lastname`), title (`title`), short biography (`shortbiography`), username (`username`) and password (`password`).

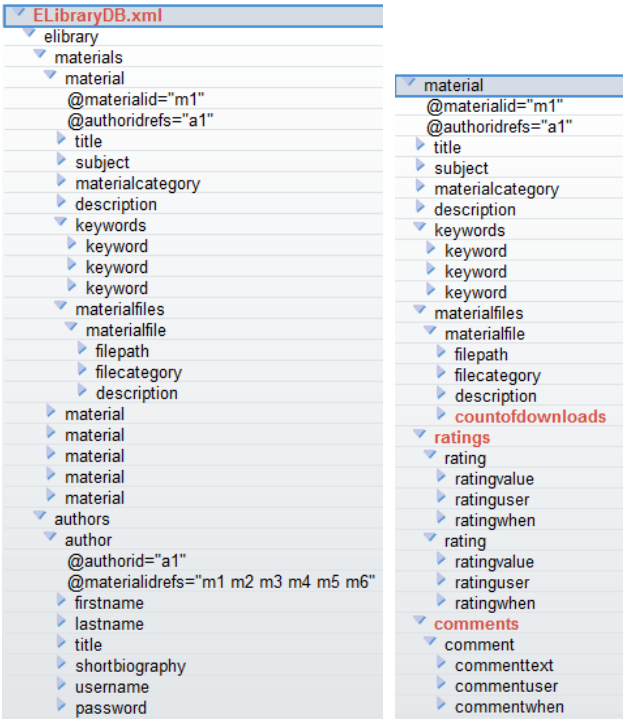

Figure 1. XML database `ELibraryDB`: a) Transforming the relational model into semi-structured data model; b) Extension with elements for downloadings number of a file, comments, and material's ratings

Moreover, we have extended the resulting model with the following elements (Fig. 1b):

- Counting the file downloadings (`countofdownloads`);
- Writing the comments – only for registered users (`comments`);
- Evaluation of materials – only for registered users (`ratings`).

For implementation of the database `ELibraryDB` has been used the XML database management system BaseX (http://basex.org).

There has been set a type of document by DTD (Document Type Definition) and XML Scheme. Modeled and implemented XML database `ElibraryDB` is validated in accordance with:

- the definition, the definition, stated in http://practicum.host22.com/data/elibrary/ELibraryDB.dtd;
- XML scheme, the definition, stated in http://practicum.host22.com/data/elibrary/ELibraryDB.xsd.

Figure 2 shows the visualization of the XML scheme of the database `ElibraryDB`, using the online editor (XML Editor / Viewer Online) xmlGrid.net, accessible from http://xmlgrid.net. Figure 3 shows the element `material` in more details.

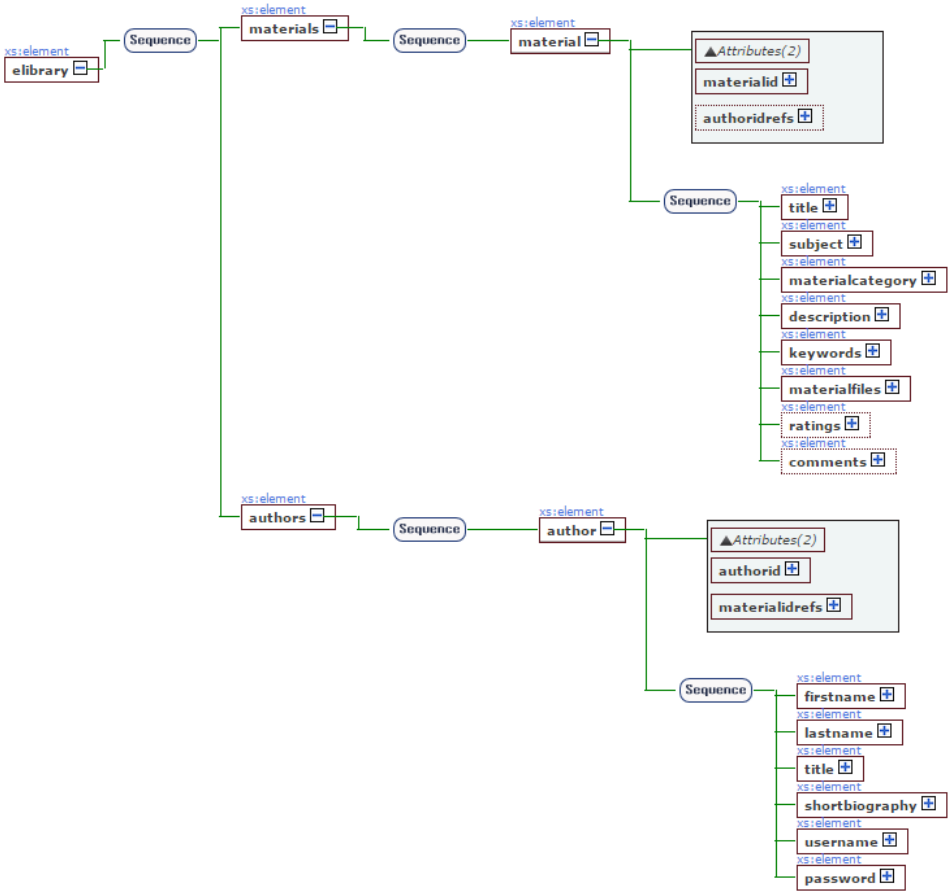

Figure 2. XML scheme of the database `ELibraryDB`, visualized with xmlGrid.net

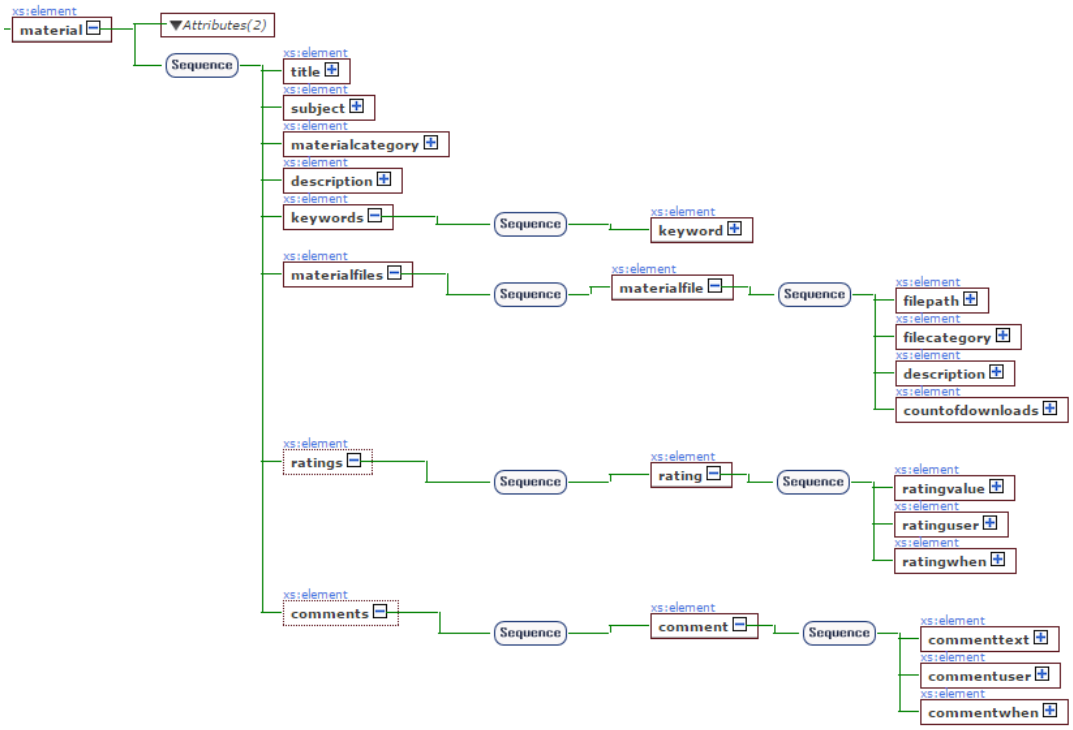

Figure 3. Successors of the element `material`

By using queries of XQuery, different requests needed for the given application can be retrieved. For example, a query of XQuery to retrieve data about materials on a given subject (Fig. 4):

- Title;
- Category;
- Description;
- Keywords;
- Files – location, category, description, number of downloads;
- The average of ratings by customers;
- Number of users who have given evaluations;
- Comments – text, user, when the comment is written;
- Authors – names.

```
<result>
 {
  for $x in
      /elibrary/materials/material
  where $x/subject = "Database management system"
  return
     <material>
        {$x/title}
        {$x/materialcategory}
        {$x/description}
        {$x/keywords}
        {$x/materialfiles}
        <avgrating>
           {fn:avg($x/ratings/rating/ratingvalue)}
        </avgrating>
        <countrating>
           {fn:count($x/ratings/rating/ratingvalue)}
        </countrating>
        {$x/comments}
        <author>
           {fn:id($x/@authoridrefs)/firstname}
           {fn:id($x/@authoridrefs)/lastname}
        </author>
     </material>
  }
</result>
```

Figure 4. Query of XQuery for retrieving data about materials on a given subject

Our future work includes creating of a convenient web-based user interface by means of HTML, CSS, PHP.

IV. Conclusion

In this paper, we have proposed XML-based building of an electronic library for teaching and educational subsidiary materials. The existing relational model is transformed into a model of semi-structured data and is extended so that it is possible to store the number of downloads of materials, writing comments, evaluation of materials. On the one hand, this additional information can be directly used by users, on the other hand it can be analyzed and the results of the carried analysis can be applied to improve the quality of materials.

One of our future tasks is to design and to develop an ontology of linked data by applying semantic web technologies.

References

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