

XDLT: A Distance Learning Tool for consistent teaching of XML and related Technologies

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Abstract: The eXtended Markup Language (XML) has become an important data format in the e-learning world during the past years. A multitude of e-learning systems take advantage of XML for various purposes: to represent knowledge or content, for information exchange between distributed applications or just for platform-independent storage of data. Although XML reflects a technical issue of data representation and application architecture in most cases, an emerging need for students and teachers to learn XML and XML related technologies can be observed. For instance, a person who describes entities of a given domain with an XML-based ontology needs domain-specific knowledge and a certain degree of XML skills to express the knowledge. Current approaches to learn XML such as tutorials and XML editors lack in the field of guidance, monitoring of the learning process and interoperability of different XML related technologies like XML data modelling (DTD), XML transformation and query as well as update languages (XPath, XUpdate).

With this paper we introduce a web-based distance teaching and learning system teaching fundamentals of XML and major XML related technologies. In contrast to interactive tutorials that operate mostly with fixed XML examples and XML editors which offer no guidance for the learner, our approach enables a student to learn XML and related technologies based on custom data and exercises that can be defined and monitored by a teacher.

Introduction and Motivation

The Extended Markup Language (XML) [15] has become a standard format for information exchange between heterogeneous information systems and distributed applications. XML is an easy and flexible way to express tree-like data structures, called *semistructured* data. An XML document consists of so-called tags consisting of a name and a value; the tags are nested recursively. XML can be read and edited by humans and processed by computer systems as well. By definition, XML is independent from programming languages, operating systems and specific applications.

In the e-Learning context XML has become more important for many applications as an underlying data format: XML is used for content representation (e.g. [4, 11]), terminology for educational subjects (e.g. [5, 12, 16]), transformation of data (e.g. [18]), integration of subsystems into an e-learning environment (e.g. in *WebCT* and *Blackboard*), and for visualization purposes (e.g. [17]). Furthermore, XML is used as a standard data format for learning resources (e.g. [1,8]). One major goal of XML in the e-learning context is the expected reusability of content such as courses, learning objects, and annotations.

XML is a low-level technical fundament in most applications, so that a typical user is not aware of any XML usage. Anyhow, the relevance of XML and related technologies requires more often than not that students or

lecturers need to acquire XML skills. In general, this is just an initial step of a larger project, so that the acquisition of XML skills needs to be efficient, fast and goal-oriented.

The usual approach to study XML is to use a book or an interactive online tutorial [like 23]. Both approaches use fixed examples that may be far away from the learner's context, requiring additional time to determine relevant parts. This may be a discouraging process and runs counter to instant success. Additionally, it is desirable that further technologies that rely on XML, like the query language XPath or the transformation language XSLT for instance, are supported consistently in a learning system. A student who consults different books or tutorials has to integrate the examples herself into the learning experience. Lastly, there is usually no feedback for a teacher who wants to monitor the learning progress of the students in conventional approaches.

With this paper we are presenting a web based system for distance teaching and learning of XML technologies. A teacher may use any XML documents that cover the instructional scope the best. These XML documents are the basis for exercises of adjustable granularity and scope. Currently, an exercise can be expressed upon the following XML technologies: XML itself, XPath [19], XUpdate [22], Document Type Definitions (DTD) [21] and KeyX Indexes [7]. In addition, context-sensitive assistance for the exercises is offered by the system. The teacher groups exercises to courses and assigns them to students. The learning progress can be monitored because exercises passed by an individual student are tracked and stored on the web server. A teacher may control the learning progress of the class at any time.

Due to the open architecture of our prototype further exercise types (e.g. XML Schema [20] and XSLT [18]) can be added easily. The main idea of our approach is reflected by the seamless integration of XML teaching and learning without inconsistent documents or examples. For instance, a teacher can introduce XML with a sample document while all further examples and exercises are based on this document. We believe that this consistent approach enables goal-oriented, efficient and supervised self-learning.

The remainder of this paper is organized as follows: In Section 2 we define the requirements and features of our learning tool and present the implementation with some screenshots. The architecture and technical details are shown in Section 3. In the last section we conclude this paper with a short survey about related work.

The XML Distance Learning Tool

In this section we describe the functions of the XDLT XML learning tool more extensively. Basically, it is a web-based XML database that allows users to upload and store XML documents in folders. Existing documents can be browsed: The XML document is displayed as a tree of elements in an HTML page; and elements can be expanded separately in order to concentrate on relevant parts. The document can be queried by XPath expressions selecting and highlighting specific elements. The database aspect of XDLT is emphasized by the possible usage of KeyX indexes [7] that accelerate specific XPath queries.

The XDLT supports a user-management with a permissions-mechanism: Any user may store personal documents and protect them from others users; but even more users may share their documents with other users: A teacher is allowed to create XML documents and to assign them to his students who are also users of the system.

Lecture Approach and Exercise Types

A teacher is able to express lectures consisting of exercises based on the stored XML documents in the database. Exercises can be arranged in sequences so that an exercise can only be started if the previous were passed. For each student the XDLT stores the current progress, so that a teacher is able to identify typical difficulties of the students. Various exercises can operate upon the same XML documents. Therefore the students can keep their understanding of the data without permanent adoption just because the sample data for an exercise has changed. Each exercise is of a specific type, i.e. it covers a special XML technology. At this moment the XDLT supports the following types:

XML Data modelling: This task provides the students with a scenario that shall be expressed by an XML fragment. It is the easiest task and enables a student to learn the XML syntax. The student enters his solution into a form and submits it to the application. A validation function evaluates the entry and provides help if necessary.

DTD / XML Schema: XML schema information defines a set of valid XML documents. For instance, the *MathML DTD* defines the structure of any *MathML* [16] document describing mathematical formulas. Schemas for XML documents can be expressed by *DTDs* [21] or the newer approach *XML Schema* [20]. Our learning system supports two exercise types dealing with DTDs: After a student is given a DTD he will be requested to express a corresponding valid XML document. The second exercise type is inversely and provides XML documents of the same DTD. The DTD itself is hidden and must be determined by the student. For both exercise types, a validation function evaluates the results and provides online help if the student's responses are not correct yet.

XPath for Query Processing XPath [19] is a common query language selecting specific elements in an XML document by the use of navigation steps. XPath is part of further XML technologies like XSLT or XUpdate. In an exercise, a student is demanded to express a query upon a specific document. For instance, she will be asked to query all book titles that are written by a given author. Because a complex XPath query may consist of structure and content conditions, multiple exercises with increasing difficulty can be reasonable. The student's response is evaluated and the selected nodes are compared with a template that is defined by the teacher. This way it is possible to access the quality of the students response and to give him feedback.

XUpdate for Modifications: XUpdate is an XPath-based language for changing the content and the structure of an existing XML document. A student that is already experienced in XPath can learn how to change data with XUpdate exercises. The XUpdate exercises are structured similarly to the XPath exercises.

KeyX Indexing Indexes in a database management system are applied to accelerate the execution time of frequent queries. Values (keys) that are compared frequently (e.g. the names of authors) are stored in a search structure that is optimized for fast key retrieval. Our implementation allows the creation of *KeyX* [7] XML indexes that are defined by XPath expressions. This way, a student is aware of the impact and the benefits of indexed XML documents.

XSLT Transformation The Extensible Stylesheet Language Transformations (XSLT) [18] is commonly used in content management systems to transform XML based content into HTML pages. XSLT can be compared to a simple programming language which creates a new document with the content of another one. XSLT uses XPath to extract the values of specific elements. Currently, XSLT is not implemented in our first prototype.

Menu	Work on Task First Task
<ul style="list-style-type: none"> Logout Browse Indexes Lectures Lecture control File control 	<p>In Lecture Name :Introduction to XML Technologies Description :This is an Introduction to XML, XPath and DTDs</p> <p>In Exercise Name :Data modelling with XML Description :Data modelling with XML</p> <p>Name First Task</p> <p>Problem Please define an XML fragment that consists of a root node called 'user_list' and three user nodes with the values 'Peter', 'Tim' and 'Jim'.</p> <p>Answer for the Task: <pre><user_list> <user>Peter</user> <user>Tim</user> <user>Jim</user> </user_list></pre> </p> <p> <pre><user_list > <user >Peter </user > <user >Tim </user > <user >Jim </user > </user_list ></pre> </p> <p>evaluate Answer reset Answer</p>

Figure 1: Defining an XML fragment

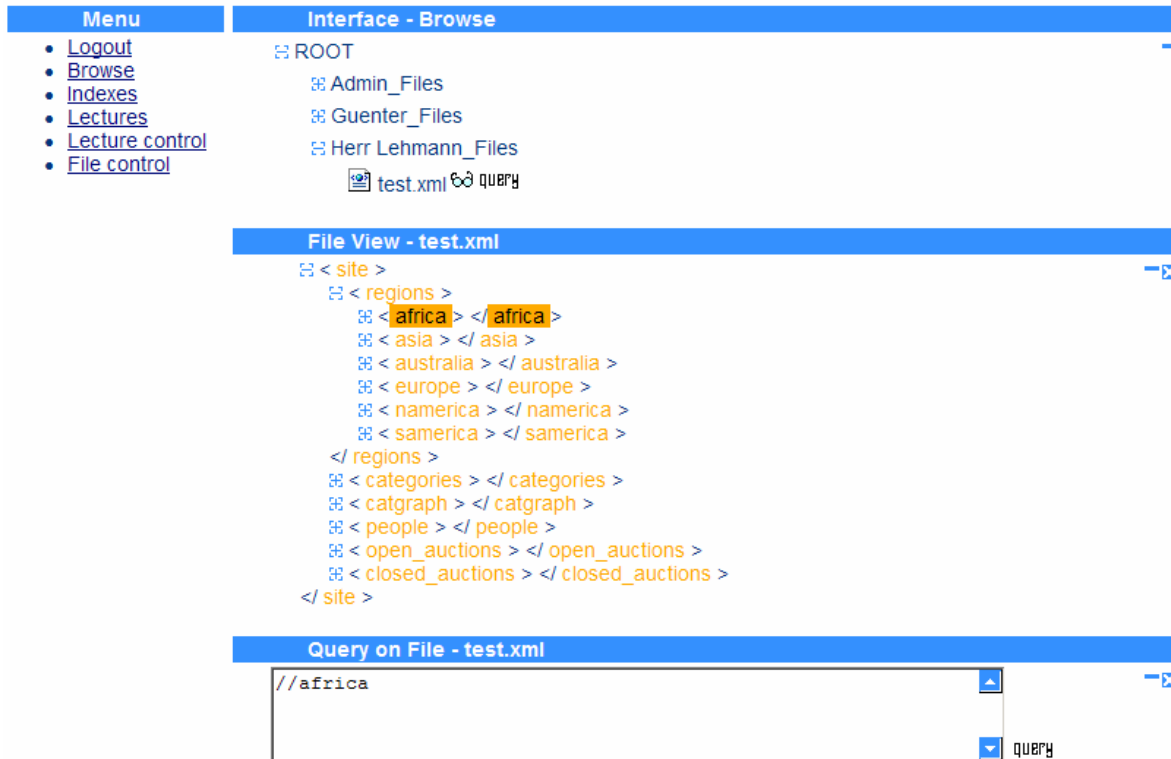


Figure 2: Querying an XML document and highlighting of the selecting nodes.

Architecture and Implementation Details

The XDLT learning tool is a web application, i.e. all interaction of the users are performed with a web-browser like the internet explorer. The application itself runs on a web server (*Tomcat 5* [3]). The implementation is done with Java servlets generating dynamic HTML pages. Any web browser is capable to access the learning system since standard HTML is used. The exercises consist of a description and exemplary solutions that are used to judge the students solution. For each type of exercise there is a module that performs the evaluation of the students' response automatically. The system's architecture is easily upgradeable with further modules with this generic approach. All XML documents, settings and exercises are stored as XML data in a native XML database management system (*InfonbyteDB* [9]). Since it is a native database, XML data is not mapped to relations and vice versa but stored in its tree-like structure persistently.

Related Work and Concluding Remarks

In this section we survey related work that is generally used by students who try to learn XML: XML editors like the *XMLSpy* [2] support a wide range of XML features; many editors even come with a huge set of examples for the different XML technologies. On the other hand, there is no exercise mechanism to allow teachers to guide their students. Additionally, XML editors are usually not centralized and web based, i.e. documents have to be distributed to all students. In most cases, there is no direct feedback for and from the teacher.

Online tutorials like the *W3Schools* [14] use fixed examples that mostly do not fit the learner's context; requiring extra time to transfer them to the learner's scope. Some tutorials are interactive (e.g. [22]), which means that the student is able to enter some XML data or an XPath query for instance, which is afterwards judged automatically by the tutorial engine. Anyhow, online tutorials are usually not adaptable by the teacher and there is no approach for guiding and monitoring a student.

To the best of our knowledge, the XDLT is the first distance learning and teaching tool that integrates major XML technologies with arbitrary customizable sample XML documents. With exercises assigned to students, a teacher is now able to guide and control the learner progress.

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