

# Chapter 14

## An Information Visualization– Based Approach for Exploring Databases: A Case Study for Learning Management Systems

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### ABSTRACT

*Learning Management Systems (LMS) may use Information Visualization techniques and concepts for presenting their large amounts of data, in order to ease the monitoring and analysis of students learning process problems. Nonetheless, the generally adopted approaches are based on presenting data obtained by predefined database queries only, which does not consider unforeseen situations derived from final user's knowledge about e-learning domain. Therefore, the purpose of this work is to provide a resource for LMS users to define and execute queries related to these unforeseen situations. This resource is a prototype by which users may access a remote LMS database, create their own queries by selecting database attributes they want to analyze, and represent query results by means of automatically selected interactive graphical representations. User evaluations indicate that the approach is appropriate and points out possible enhancements.*

### 1. INTRODUCTION

Providing user-level access to data stored in a database is not an easy task. It is not just a matter of providing connectivity from a system to a local or remote database. In fact, it is related also

to how a user may query the database, and how he/she may interpret the returned results.

Querying a database requires that the user has gained much knowledge of database theory. This requirement includes, at least, concepts of table fields and tuples, primary and foreign keys,

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entities and relationships. It also requires that the user masters a database query language such as SQL. Even more, querying requires that the user knows what kind of data is stored in the database, in order to define what to query. Given these restrictions, the user's task of querying a database requires a cognitive overload which may not be dismissed, in part because typical users have not such theoretical knowledge and do not even know about the internal organization of the database to be queried. In fact, typical users are not interested in this kind of technicality, but instead they just want to obtain an answer for a question related to a system stored data.

When analyzing answers provided by a Database Management System (DBMS) for a query, one may think that the mostly common alphanumeric, table-based answer format is enough for answering users' questions. Even though this format is sufficient for obtaining some specific data, it may be difficult to get a data overview and to detect patterns, trends and outliers present in the data. Graphical and interactive representations of data, as proposed by the Information Visualization area (InfoVis, for short) (Card et al., 1999), are suitable for this kind of analysis. They may provide distinct levels of data overview, details on demand, and interactive capabilities of data reorganization and filtering, among other useful resources. For example, interactive filtering techniques (such as dynamic queries [Shneiderman, 1994]) afford user controls for selecting relevant data and for querying details, providing fast answers, and without the need to learn command-line querying syntax. When applied together, filtering and other techniques may enhance users' formulation of an internal model about the data under analysis.

Both difficulties—how users may query a database and how to represent query results in a useful way for them—may be analyzed from distinct scenarios, which may have distinct kinds of users with distinct computer-related and data-analysis-related skills. In this chapter, those difficulties were

analyzed within a Learning Management System (LMS) scenario, in which there are students and teachers involved in learning activities. LMS are virtual environments that enable and mediate communications among participants of courses. These systems group distinct computer-based resources, like electronic mails, chat rooms, resources for publishing readings and for delivering activities' results, among others. Each resource manages and saves different kinds of data, like messages, published contents, and participant data.

In this scenario, analyzing LMS data is an important task for monitoring students' learning process, making possible to detect its potential problems. For example, participants with few accesses to the LMS, or those who do not interact with other course participants represent situations that can reveal problems related to an adopted course methodology.

Different researches try to overcome the analysis difficulty by applying InfoVis concepts and techniques, in order to graphically and interactively present LMS data. Some examples of these researches are: InterMap visual representations of course participants interaction (Romani, 2000), France et al.'s interactive activity diagram for learning scenarios (2005), and GISMO (Mazza & Milani, 2005) and CourseVis (Mazza & Dimitrova, 2005) representation of students' social, behavioral and cognitive aspects. Nonetheless, these researches show data that are obtained by predefined database queries, and so these data fit specific analysis situations. Unforeseen situations derived from final user's knowledge about e-learning domain are not considered by these researches, which do not provide ways for this user to inform the system about the data he/she wants to analyze.

Overcoming those difficulties related to querying databases and understanding query results may provide an important way for analyzing LMS data. In the LMS scenario, the presented difficulties may be summarized by two questions:

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