6<sup>th</sup> International Conference on Applied Informatics Eger, Hungary, January 27–31, 2004.

# Teaching database systems at the Institute of Informatics of the University of Debrecen

István Juhász<sup>*a*</sup>, András Gábor<sup>*b*</sup>

University of Debrecen, Institute of Informatics, Department of Information Technology

> $^{a}$ pici@inf.unideb.hu  $^{b}$ gabora@inf.unideb.hu

#### Abstract

Due to the worldwide spread of the Internet, information flows much faster than before. The huge amount of information available via Web has to be stored and systematized, as well. The role of databases has appreciated. Information Society expects the elaboration of more effective, faster and more precise methods for information retrieval from professionals. Vendors of database management systems have the challenge of technologically serving out the portals presenting information, considering speed and availability aspects. The main goal of the qualification of software engineering professionals is to furnish practical and usable knowledge to the students.

This paper describes the database systems related learning curves available at the Institute of Informatics of University of Debrecen during which students first acquire a general knowledge of the topic and then get more specialized knowledge on certain areas according to their choices.

In our Institute every IT student must get acquainted with database systems by attending and completing a mandatory course. Besides completing the mandatory classes, students are required to choose a minimum amount of courses from sections of courses related to a certain IT topic, like database systems. The major of the student determines the amount of the classes (in credit points) one must complete from a section. To fulfill the credit requirements of the degree program, students can also choose from a collection of optional classes. Among these are classes focusing on special areas of the database systems.

Most of these optional and optionally mandatory courses are inherently practical.

### 1. Introduction

Nowadays, at the dawn of the *Information Age*, the role of databases is more important then ever. More and more information is being accumulated worldwide which introduces one of the biggest challenge for people in the 21st century: we have to find our way among the available sources of information on the web and we have to make the process of information acquisition more efficient as it is apparently needed in our every day work.

This user requirement has many aspects that impose different tasks for the computer industry. Among others we have to assure the possibility of accessing the accumulated data and information at any time (high availability), we have to give a way for the users to find easily (according to their logic) the information needed for their work or relevant to their concerns.

The IT-education sector has the responsibility in this field to train highly qualified professionals who can keep up with the progress and learn to use the newest technologies available in order to fulfill the existing and emerging user needs, requirements.

### 2. Education

At the University of Debrecen the courses of the IT education are organized according to the following concepts: every graduate program has mandatory classes required for the degree. The knowledge acquired in these fundamental classes serve as a basis for the other classes facilitating the specialization of students. These classes are organized into course sections, where each section except one contains optionally mandatory classes (Section A - Artificial Intelligence, B - Database Systems, C - Networking, D - Computer graphics, E - Image Processing, F - Applied Mathematics, K - Computer Algebra and Cryptography, KTK - Economics). The expression "optionally mandatory" means that students are required to take a minimum amount of courses from each of these course sections. The major of the student in credit points determines the amount of the classes one must complete from a section, but the actual classes taken depend on the students' decision. There is one section G - Optional Classes) which contains the optional classes: students take only those classes that concern them.

#### 2.1. Database Systems

The course "Database Systems" is a mandatory fundamental class for students participating in the following graduate programs at the Institute of Informatics in the University of Debrecen:

- full-time study: M.Sc. Software Engineering and Mathematics, B.Sc. Software Engineering and Mathematics, M.Sc. Information Technology Teacher
- evening study: B.Sc. Software Engineering and Mathematics

- correspondence study: M.Sc. Information Technology Teacher

This course introduces the basic theoretical concepts of relational and OO databases throughout lectures, while focusing on practical knowledge on relational database systems during the computer lab activities. In the lab activities students get familiar with relational database design, normalization and SQL, the standard query language for relational databases by using a concrete relational database management system. We use all parts of SQL:

- the Data Definition Language (DDL) to create and drop tables and views,
- the Data Manipulation Language (DML) to insert, delete, update rows stored in database tables,
- the query language (SELECT statement) to query the stored data,
- the Data Control Language (DCL) to grant and revoke user privileges, and to control (commit, rollback) database transactions.

However, during the term the main goal is to drill students in queries. Students become skilled in performing table-joins, using many kinds of clauses and functions in statements dependably.

After completing the mandatory "Database Systems" course students specialize by taking classes from section B that contains numerous database related classes. Table 1 contains all classes in section B. These classes allow interested students to get more specific knowledge on certain topics. There are also optional classes that are about database topics; these are listed in Table 2 (only classes relevant for this article are listed). References [1], [2] and [3] in Hungarian focus on certain areas of the database systems education at the University of Debrecen (formerly KLTE) in more detail.

In this paper we talk more about classes related to Oracle, one of the leading database product in the industry. There has been beneficial cooperation between the Institute and the Company for a long time and also many of our former students now work there and help in keeping up the good relationship.

Name	Credit	Lectures	Labs
Relational Database Design and Query Languages	2	2	0
Implementation Techniques	2	2	0
Application Development with 4GL Tools	2	0	2
Computer Aided Systems Engineering	2	0	2
OO Data Models	2	2	0
OO Database System Management	4	2	2
CORBA	4	2	2
Advanced Oracle 1	4	2	2
Advanced Oracle 2	4	2	2
Oracle DBA 1	2	0	2
Oracle DBA 2	2	0	2

Table 1. Optionally mandatory classes in section B

Name	Credit	Lectures	Labs
Special Oracle Features	4	2	2
Implementing DBMSs	2	0	2
XML technology and usage	2	0	2

Table 2. Optional classes

#### 2.2. Advanced Oracle

The class "Advanced Oracle 1" introduces the Oracle PL/SQL procedural query language. The two prerequisite classes "Database Systems" and "Programming 2" let students to use the previously acquired programming, database management and data modeling knowledge to get familiar with the concepts of PL/SQL variables, types and expressions. Besides that we focus on practicing the usage of control structures, non-stored subroutines and cursors in the first half of the term. Later on students learn to write their own stored procedures and functions, the concept and mechanism of triggers. At the end of the term we talk about how one can implement encapsulation using PL/SQL packages. The concept of encapsulation is also a hint for the next term, where the object relational features play the major role.

The class "Advanced Oracle 2" is the continuation of the previous one. Here students get familiar with the object relational features of the ORDBMS. Students already have a theoretical knowledge of abstract data types and object types; we demonstrate their usage in practice. In the database we can create collection types corresponding to the concept of arrays in the procedural languages. With these constructs we can model and store sets of values along with other values in a single row raising the abstraction level of the relational data model up to an non-normal form (0NF) closer to a human's viewpoint. Thinking about tuples as objects leads us to the creation and use of object tables. We can define object-to-object relationships between such tables using OIDs, the REF, DEREF and VALUE operators. We define object views upon the existing relational tables. We use large objects (LOBs) to store pictures, sounds, and large documents in the database. Students learn to use the DBMS\_LOB PL/SQL package to manipulate both internal and external LOBs. Additionally at the end of the term JDBC is introduced as a means of accessing the object relational data from an OO language.

Experiences show that these classes are rather popular as students find the subjects interesting and they also realize the value of the acquired practical knowledge. We have received numerous positive feedbacks from graduated students on how valuable this knowledge is for them in their current jobs and it is also great advantage when looking for a job.

#### 2.3. Oracle DBA

The prerequisites of the class "Oracle DBA 1" are the classes "Database Systems" and "Network Architectures". The latter is needed as the DBMS has the

classical client-server architecture. On this class students come to know the tasks of an Oracle database administrator. They learn how to create, tune and administer an Oracle database instance. The structural elements, the building blocks of a database are presented (blocks, extents, tablespaces, etc). We experience how creating different indices affect the performance. We demonstrate how to archive and load database content via the SQL\*Loader utility. User administration, management of privileges and roles is also an issue during the term. As globalization has more and more importance we consider relevant to mention the available national language support features (NLS) at the end of the semester too.

The class "Oracle DBA 2", as the continuation of the previous class, deals with the pitfalls in the software installation procedure. A deeper comprehension of the network administration issues is achieved here. Besides that students get familiar with certain administration and development tools available on the market.

#### 2.4. OO Data Models

The class "OO Data Models" is a series of lectures where students learn about ODBMS theory. The prerequisite of this class is "Technology of Systems Development" which is a mandatory class. This ensures that students have good knowledge of OO modeling techniques like UML and that they have faced real world problems thus they can understand how low is the abstraction level of the relational model. The first few lectures are about the evolution of data models starting from the EER model which extends the ER model with inheritance as a means of specialization and generalization, then the functional and semantic data models (FDM and SDM) are discussed. After that we enumerate the new OO features needed to be incorporated into the models: complex user data types, objects, object identity, encapsulation, types and classes, type and class hierarchies, inheritance, behavior via methods, overriding and overloading methods, dynamic and static binding, completeness of functionality, persistence, concurrency control, navigating relationships, distributed transactions, object interchange. We show how these features are present in the current standards and products. Students learn about the ODBMG 3.0 standard, the Object Interchange Format (OIF) and the nowadays widely used Object Query Language (OQL). Students also learn how the relational model has evolved into the object relational model which has been defined in the versions of the SQL standard: SQL-92 and the current standard SQL:1999 (formerly known as SQL3).

#### 2.5. Special Oracle Features

The class "Special Oracle Features" is the follow-up class of the "OO Data Models" as an optional class. The class presents the products and tools built upon the Oracle DBMS. Among these are datawarehouses and the e-Business support by Oracle. On the labs students get familiar with Oracle's Java development tool, the JDeveloper IDE. Using this tool one can quickly and easily create Java-based web applications storing data in an Oracle database. The Oracle Warehouse Builder tool helps us in the process of organizing volumes of data into datawarehouses, designing and implementing datawarehouses. This way it is easier for students to get acquainted with the datawarehouse concepts learnt at the lectures (fact tables, dimension tables, etc.) as they can try out and observe how these terms are used in practice. In the second half of the semester students learn to use the Oracle Portal (formerly WebDB), which is an easy-to-use web publishing system for portals.

It is unfortunate that we have to mention the difficulties we experience with the lab equipment. All these software products are very resource intensive and our hardware often fails to match these requirements. Despite of the inconveniences we can say that this class is also very popular among students as they recognize how valuable the knowledge acquired here can be later.

#### 2.6. Other related classes

In addition to the classes already mentioned in the previous subsections there are other classes where we use database products.

The class "Application Development with 4GL Tools" introduces students with Oracle 4GL development tools: Developer 2000 and Oracle Forms & Reports.

A relatively new course called "XML Technology and Usage" is available where besides obtaining fundamental knowledge of XML students also have the opportunity to study the XML support in the available DBMS products. In the first half of the term we focus on the definition and general usage of XML and after that come the tools. Oracle's XML SQL Utility (XSU) is introduced as a convenient tool for retrieving information in XML format and of course it makes possible to insert, update or delete data. The storage of the XML documents is demonstrated via the XMLType (object type). The Oracle XDK (XML Developer's Kit) contains XML parsers implemented in several languages (C, C++, Java, PL/SQL), XSL transformation processing software and XML Schema processors. The Apache web server supplied along with the Oracle DBMS is capable of running server-side applications (e.g. JSP, Servlet). In addition it is configured to handle a new kind of server pages, XSQL server pages, that are used to provide results of parameterized SQL statements as XML data sheets and then optionally applying XSL transformations converting the results into a customized format (HTML, XML, textual, pdf, etc.). In other words the webserver receives the request and its parameters and based on those produces a data sheet containing the appropriate and optionally transformed query results.

#### 2.7. Graduation thesises

According to the experiences of the recent years students choose databaserelated subjects in their thesises. Even the others who choose some other topic, especially web technologies, are likely to use at least one DBMS for storing different kind of data. So we can say that a great percentage of graduating students possess deep knowledge of database systems.

### 3. Oracle Academic Initiative

Our Institute has been participating in the Oracle Academic Initiative (OAI) program for several years by now. This permits us obtaining Oracle software, licenses and education material at reduced costs. This is a great help for our education as students can get acquainted with these products.

In the year 2001 Oracle Corporation has invited applications of students studying at OAI partner universities for the "Student of The Year" award. The applicants were competing in three regions: America region, Asia and Pacific region and Europe, Middle East and Africa (EMEA) region. The application was for groups of two students, and the goal was to create the most innovative portal using Oracle technologies under the title "The Internet Changes Everything". The first round was held locally at the Institute: the instructors in the jury found two high-standard applications worth for forwarding to the next round where an international jury was to make the final decision on the applications from the EMEA region. It was a pleasure to hear that two students from the Institute, András Gábor and Krisztián Földvári have won the competition with their website named "Secondhand Webshop" [4] that implements an advertising portal for second-hand goods. The prize was the title "OAI EMEA Student of The Year Award in 2001" and a trip to Oracle Headquarters in San Francisco.

### 4. Translations, Books

Translating foreign technical literature has long been a tradition in our Institute. Several books related to database systems management and especially the Oracle DBMS have been translated under the leading supervision of Dr. István Juhász. The following books have already been published:

- George Koch, Kevin Loney: ORACLE8: The Complete Reference, Budapest, 1999, Panem.
- Michael Abbey, Michael J. Corey, Ian Abramson: ORACLE8i: A Beginner's Guide, Budapest, 1999, Panem
- Kishore Bhamidipati: SQL Programmer's Reference, Budapest, 1999, Panem
- Kevin Loney, George Koch: ORACLE8i: The Complete Reference, Budapest, 2001, Panem.

Recently there has been two books written as well, which are also used as bibliographies for students attending some of the above mentioned courses:

 Gábor András, Juhász István: PL/SQL-programozás. Alkalmazásfejlesztés ORACLE9i-ben, Panem, 2002, Budapest.
Title in English: PL/SQL-programming. Application Development in ORA-CLE9i  Gábor András, Gunda Lénárd, Juhász István, Kollár Lajos, Mohai Gábor, Vágner Anikó: Az Oracle és a WEB. Haladó Oracle9i ismeretek, Panem, 2003, Budapest Title in English: Oracle and the WEB. Advanced Oracle9i

### 5. Conclusion

As personal computers and the Internet became a commonplace handling information is more crucial than ever. The role of databases has appreciated requiring education to keep up with the pace. In this paper we have shown how our University deals with the education of database systems and related topics. There are several possible learning curves offered to students via taking those mandatory, optionally mandatory and optional classes we have seen.

## References

- Hajas Cs., Fazekas G., Juhász I.: Az adatbázis rendszerek oktatása a KLTE-n, Informatika a felsőoktatásban '99, Debrecen, 1996, 358–362.
- [2] Juhász I., Fazekas G., Hajas Cs.: Objektum-orientált adatbázisok, Informatika a felsőoktatásban '99, Debrecen, 1999, 80–85.
- [3] Gábor A., Juhász I., Kollár L.: Oracle a Debreceni Egyetem Matematikai és Informatikai Intézetében. Informatika a Felsőoktatásban 2002, Debrecen, 2002, 922-928.
- [4] Gábor A., Földvári K.: Secondhand webshop, http://dragon.unideb.hu/~gabora/ws\_presentation/