Computer Aided Software Engineering[1] at service of Higher Education Innovation

Piedad Garrido[1], Jesús Tramullas[2], Francisco J. Martínez[1], Fernando Naranjo[3]

[1] Univ. de Zaragoza, Informática e Ingeniería de Sistemas, Ciudad Escolar s/n, 44003 Teruel, Spain
{piedad, f.martinez}@unizar.es
[2] Univ. de Zaragoza, Ciencias de la Documentación, Pedro Cerbuna 12, 50009 Zaragoza, Spain
jesús@tramullas.com
[3] Servicio de Infomática de la Universidad de Zaragoza, Ciudad Escolar s/n, 44003 Teruel, Spain
{fnaranjo@unizar.es}

Abstract. The current work shows the CASE tool development called ACAR. It generates its automatic translation to Tuple Relational Calculus and later to SQL from a designed query or constraint in Relational Algebra. It is thought that this tool may be used in the database subject teaching (part I) in lessons given to third-year students of Technical Engineering in Administrative Data Processing. On the one hand, ACAR aims at making the comprehension of database manipulation languages easier (which are to be used for information system interrogation), and at placing a tool at the student's disposal that translates and obtains a syntactic real-time correction of queries or constraints. On the other hand, ACAR has provided a group of students the chance to develop their academic and professional competencies. It is a fundamental tool, to completely adapt the practical side of the subject to the EHEA[2]. It will be of great use for the next academic year when degrees are offered in the Universidad de Zaragoza platform known as ADD[3], which is a distance and attendance learning environment.

Keywords: EEES (EHEA), CASE, software, teaching competence, distance learning.

[1] We will use CASE acronym from now on.
[2] European Higher Education Area (in Spanish EEES: Espacio Europeo de Educación Superior)
[3] Anillo Digital Docente: http://add.unizar.es

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1 Introduction

To obtain a degree as Technical Engineer in Administrative Data Processing in the current Universidad de Zaragoza (UZ) curriculum, the study of database discipline is divided into two core and compulsory subjects: Database I [1] & Database II [2]. The former is placed in the fifth degree semester and the latter in the sixth respectively. Concepts such as, what is an information system, its components and functions, what is understood by Relational Database Management System (RDBMS), and what is a database, are defined in the former. Subsequently, a panoramic of the relational data model is presented, which explains the physical database organization and provides an in-depth dealing of SQL (Structured Query Language) [4] by stressing the importance of its adaptation to the relational data model evolution.

The Database II subject is a continuation of Database I, which aims at presenting a relational database design methodology based on the Entity-Relation Model.

The teaching of both subjects in the current curriculum is arranged into (4+2): 4 theoretical credits and problems and 2 practical credits in the laboratory. Nowadays, the work philosophy consists in performing a series of practicals, which are coordinated into theoretical and practical lessons, and which in turn reinforce the understanding of studied concepts so that they may be correctly applied.

With the integration of the Spanish University System into the EHEA [5], this work philosophy based on teaching methodologies and LRU credits, whose correct operation is based only on attendance learning, is inadequate and must be changed. A group of Research Teaching Staff (in spanish PDI) from several degree studies with database teaching, a group of students who study the subject, and the Services and Administration Staff (in spanish PAS) as technological adviser, got down to work on the 2003/2004 academic course to design and develop freeware ad-hoc software which helps make this transition within the convergence process easy.

In the present paper, the ACAR tool is presented. It is a CASE (Computer-Aided Software Engineering) tool that will provide the student with advice throughout the practical sessions of the Database I subject, regardless of where he/she is, and it allows the student to strengthen the theoretical knowledge acquired by studying the problems and theory modules. Specifically, the aim within the subject syllabus is to achieve an in-depth learning of three Data Manipulation Languages (DMLs). These languages are: Relational Algebra, Tuple Relational Calculus and SQL. The three DMLs are used to construct

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and resolve queries and requirements which are presented to a database covering a specific subject matter. The purpose behind the practical lessons is to attempt to put into practice the theoretical work the student has already achieved within a real environment.

The content of this paper is arranged as follows: introduction, a second section with comments on the teaching innovations introduced by this tool in the database and why it was created. A third section will analyze the tool in detail and its software architecture will be shown. In section 4, the work that students are to carry out will be explained, regardless of whether the modality in question is of an attendance or semi-distance learning type. Furthermore, the new methodologies used will also be described (collaborative work, Project-Based Learning (PBL) etc.).

2 ICTs, UZ & EHEA

The Universidad de Zaragoza (UZ) carries out several initiatives to adapt its teaching system to the EHEA. It is not in vain that the Universities Organic Law needs a new rule on university activity within its preliminary recitals, which allows universities to "take on the challenges derived from innovation in the forms of generating and transmitting knowledge within the information and knowledge society framework". At this point, ICTs (Information and Communication Technologies) play an essential role in the culture of the knowledge society. This culture is linked to the understanding of education (just as lifelong learning is), and is not only based on the cultural globalization principle, but also on the continuous scientific-technological advances that pressurize all university levels along with a set of peculiarities which are characteristic of the context surrounding the current university system: European curriculum convergence, a confluence of different cultures, the drop in birth rates, etc. From a teaching point of view, the social environment changes so quickly that work methodologies, tools, the curricula, etc. have to be redefined.

In short, ICTs make teaching and research tasks easier since they allow us access to all kinds of information, they offer immediate communication channels to diffuse data and to contact any person or institution worldwide, they automate a group of tasks, they allow large amounts of information to be stored in small, transportable mediums, and they digitalize all kinds of textual and audiovisual data, etc.

In many aspects, ICTs have contributed to improving the teaching of any matter. If the matter is complemented with new teaching methodologies, and with organizational modalities which have

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emerged as a result of the EHEA adaptation, they can make the search for curriculum areas of integration and for learning and teaching methodologies possible. This in turn will favor the approach to professional reality as a way to obtain significant in-depth and constructive learning, which allows the beneficiaries to continue learning permanently. For this reason, the Campus of Teruel, formed by the Engineering School (Teruel) and the Faculty of Social Sciences and Humanities (both delegated to the UZ), has carried out some initiatives since the year 2000 which allow for a constant and progressive adaptation. A clear example of such is the presence of a multidisciplinary group of Digital Education (2000), whose main objective is to research the use of new technologies in education and to promote their use by means of new experiences and teacher training in multimedia, network use, semi-attendance learning, and through the Tutor Project (2002) coordinated by the Institute of Education Sciences[4], in which the Teruel Campus is a pioneer. The Board Team [Jenui 05] offers a yearly announcement of aids to improve teaching methodologies and an ad-hoc training offer for teachers (2001), strategic planning (2006-2008), etc. All this has enabled a large number of teachers from both university centers to be involved in this complicated task. Results have already been seen and multidisciplinary work groups have emerged.

Part of the adaptation work, carried out by a group of Human and Social Sciences teachers, has been addressed to develop an approach to an exclusively mathematical system in order to obtain the equivalence between LRU (Universities Organic Law) credits and ECTS credits of current subjects. Thanks to this system, teachers of several degrees are able to form an idea of how to share their subject credits from the point view of how much work will the group of programmed activities create for the student, as well as detecting whether the present-day teaching system actually adapts to, or exceeds, the aims of the European credit system and the number of hours students have to dedicate. By way of example, we now go on to present the card which corresponds to the adaptation of the Database I subject, the object of study in this paper:

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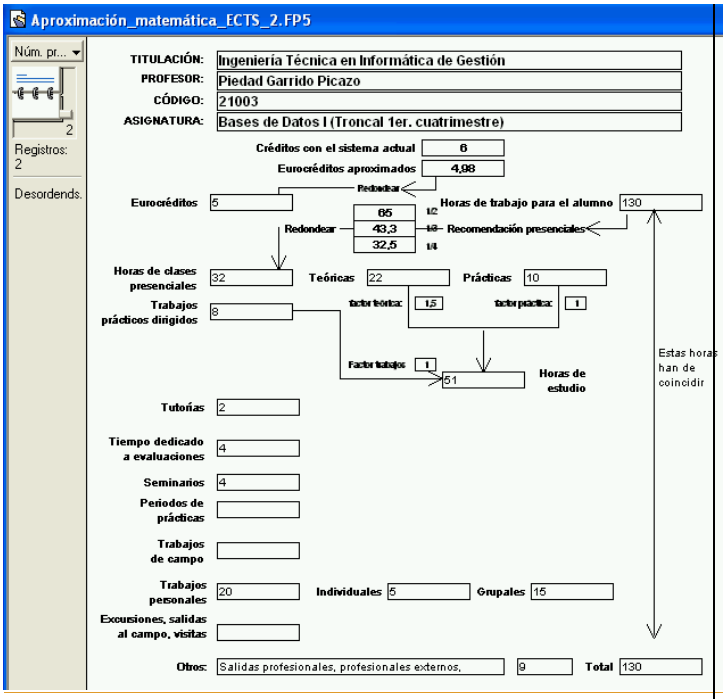

Fig. 1. An approach to an exclusively mathematical system to obtain the equivalence between LRU (Universities Organic Law) credits and ECTS credits of current subjects.

The elaboration process of these cards, which are of a merely informative nature, has been most useful because, although the current credit has no mathematical or methodological equivalence to the eurocredit, it has proven useful to demonstrate that most subjects in the current teaching model exceed the work volume that students have to do. This is owing to the fact that the number of hours students invest in certain tasks, such as bibliographic information searches, drafting works, compositions, correction tasks, study hours, etc., have not been taken into account to date. What current credits have reflected was to distribute the attendance learning hours into two blocks: theoretical and practical modules, respectively. Teaching guides and the syllabus fitted around these hours, and the fact that a student invested approximately 1.5 hours of study to do one

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attendance lesson, for example, were not taken into account. Furthermore, a student requires approximately the equivalent of one hour per hour of each practical lesson.

An example would be: the Database I subject has 60 work hours in a LRU system (40T+20P). With the new model, it would have around ((40T*1.5) + (20P+1)) = 80 work hours, without including extra activities such as the time spent on evaluation proofs, tutor projects and other academic activities that are carried out in the present-day, but which the model does not estimate until the 130 hours of the ECTS system for 5 ECTS credits are achieved.

The Database I subject has gradually been adjusted since 2003/2004, when the content of the theoretical subject block was adapted. We adapted the practical subject block during the following academic year, and activities and techniques such as: tutorial group, problem based learning, case studies, collaborative work, etc., were integrated in the academic year 2005/2006. We have certain items outstanding, such as job opportunities or external professional collaboration, which have not been performed due to budgetary cuts within the university.

The practical subject module content has benefited more with the ICTs and EHEA. By focusing on applying ICTs to the teaching of database disciplines, we should point out that at the beginning, all the software used was our own. Therefore, most students involved could not have a software license to carry out the practical subject exercises from home, after the stipulated hours, and certainly not in a distance learning environment. Thankfully, this situation changed given the emergence of free software and the several kinds of licenses at various prices; software became more accessible, it allowed the creation of new teaching platforms, and eliminated geographical frontiers and information accessibility problems. The present-day problem, which our campus has to fight against, is the low registration tax for some degreees so that all technological innovations are few to be able to reach out to a greater public in general.

Now the Database I subject is part of attendance learning on the whole, and the practical module is also offered in the ADD (Anillo Digital Docente – UZ), which is a distance learning environment as from the 2006/2007. For this reason, the philosophy of practicals has changed, and students do not need propriety software in a laboratory with concrete configuration features to resolve them. Up until a few years ago, the student was obliged to buy a license for this software, as well as a computer and environment with enough features to ensure its correct operation, and learning was much more expensive if she/he could not attend class. Therefore, the need to change the use of

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typical query analyzers and system administrators of such propriety tools was detected for the creation of ad-hoc tools, which fulfilled the requirements imposed by the student who was to make use of them.

Since the proposal was suggested by the student body, and since students are to become an active part of the learning-teaching process in the analysis, design and the ACAR implementation, a group of students, PAS and PDI was formed to develop this tool. The PDI contributes with an in-depth knowledge of the matter, and students lack this kind of software, so they are perfect clients. The PAS is the technical adviser in items such as the technology to be used, etc.

The ACAR tool has been tested in the labs over the last two years for the purpose of obtaining a robust software package and to solve future problems. In the following sections, we briefly explain the tool and the results of this two-year teaching experience. We end this paper with a section of future extensions and conclusions.

3 ACAR Description

In the analysis and design phase of the life cycle, a state of art was elaborated, in which several freeware software tools that perform the defined tasks in the SRS (Software Requirements Specification) of the tool being developed were analyzed. The SRS was totally elaborated by a group students who were registered in Database I (academic year 2003/2004) after continuous complains about the lack of a compiler, which once adjusted to the subject syllabus, would allow them to work in a practical manner with the three DMLs studied during the first term. In fact, if we look at most syllabuses of universities nationwide, all of them mention an in-depth study of SQL and other data manipulation languages, such as Relational Algebra, Tuple Relational Calculus, Domain Relational Calculus etc., are worked in a theoretical manner. This is owing to the lack of tools to compile them.

The Relational Data Model, and all that which refers to database design and management, is essential for engineering studies. Besides, the results obtained may be consulted in comparative studies among freeware software tools which permit queries to be made in one or several relational languages on any database [6], such as LEAP [7], RelationalQuery [8], WinRDBI [9].

The conclusions reached clearly justify the creation of a new tool since the only one that was apparently adjusted to the given specification for all relational languages was WinRDBI. However, the functionalities are not the same as they define a specific syntax to each language, and the first thing that the student would have to do is

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to become familiar with it. The syntax is founded on the basis of established deductive database technology that uses a logic language called (Amzi! Prolog and Logic Server), an added a complex task which we tried to avoid from the beginning as we come across the same problem as with the query analyzer of proprietary software. For example, we are going to resolve a simple query over the employee table in WinRDBI and in ACAR:

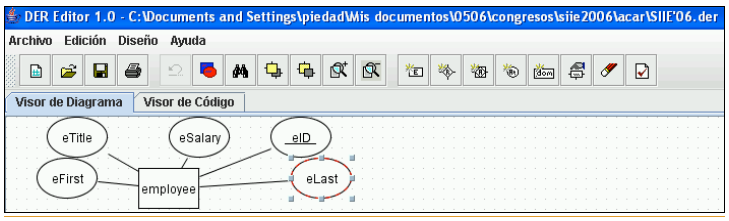

Fig. 2. Table Employee designed in DerEditor [10]. An example extracted from [4]

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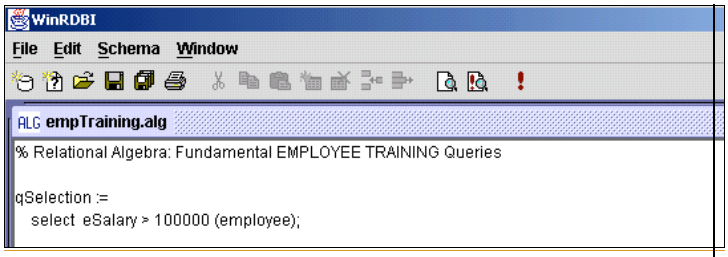

Fig. 3. We want to obtain the employees whose salary was over 100000 [9]

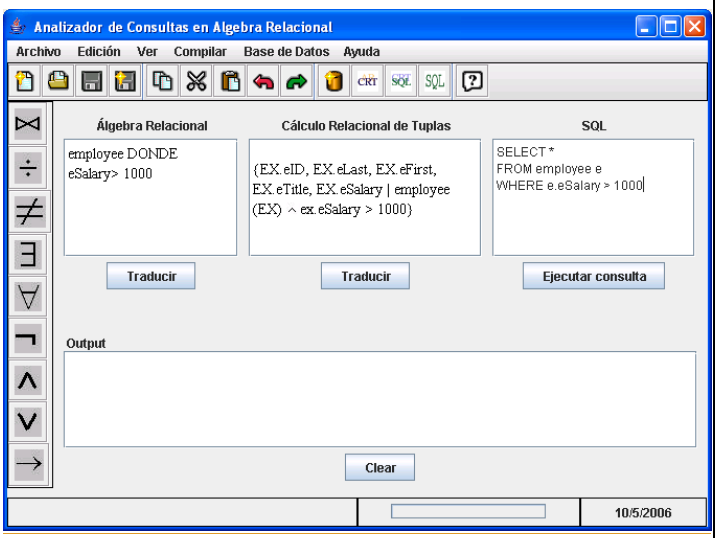

Fig. 4. We want to obtain the employees whose salary was over 100000 using ACAR.

The query simplicity in ACAR, as well as in the simplicity of its User Guide Interface (GUI), is obvious. Moreover, the student has at his/her disposal the chance to view the same query in three DMLs in the same interface, an impossible task to obtain with WinRDBI.

Some WinRDBI drawbacks are that the division operator is not available and it is distributed with a license which renders it inconvenient to be supplied as a development tool for practicals in a distance learning environment. It is not available in Spanish, whereas

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ACAR is available to the user in whatever language is to be used by ERASMUS students or by other in-coming students for other projects.

All functionality starts from a central module called ACAR. It is the tool center and it the module in charge of the main interface instantiation. The compiler provides support to the logic language operator on the whole. In addition, the SQL compiler is able to interpret and translate equivalences between queries and constraints designed in both Relational Algebra and Tuple Relational Calculus. It is important to point out that ACAR is able to translate and interpret open and closed formulas. Keeping to the SQL standard, we can assure that the translation obtained and syntactically tested will run perfectly under any free or propriety Relational Database Management System. It has been totally developed in Java and MySQL, and is distributed under license by GNU/GPL. In the near future, it may be downloaded from SourceForge and FreshMeat.

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4. Experience Analysis

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The most remarkable point to be made is that the time saved, which was previously spent on learning the system administrator of a conventional RDBMS, may now be dedicated to real cases. This learning was necessary to make queries only in SQL. Relational Algebra and Tuple Relational Calculus were designed on paper, and no compilation regarding its syntax existed. After saving four hours, we have not only achieved a better understanding of data manipulation language, but also of the logic language used. This means that those students who had difficulties in this field did not only not abandon the subject, but were also able to pass it. This tool is fast and easy, and the group of students from the Human and Social Sciences, whose education is mainly humanistic, have no problems using it.

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Students are content to check for themselves that queries are right without having to assume that they were or having to turn to their teacher for their correction. At the same time, more time is made available and it has enabled the introduction of new learning-teaching processes in the lecture room, such as Problem-Based Learning (PBL) and collaborative work. In fact, the tool itself has been developed with this approach since both the group in charge of its implementation, and the group responsible for its analysis and design, were made up of PDI, PAS and students. Therefore, all members have been able to put their skills to test by having faced an aim-oriented work in a real environment, regardless of the group they belong to.

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Of course, this whole process may end up as nothing other than a huge effort. Besides, by having a user authentication module, ACAR is to be used as a user-evaluation tool in this academic year. As the student carries out the evaluation proof in a known environment, he/she feels more secure than simply writing on paper because he/she can check the query syntax, and motivation increases.

Thus the non-attendance rate has decreased with regard to the previous year in the first examination session. From attendance learning in the UZ evaluation framework, the student has three examination sessions from which he or she has to choose two. This combined with a continuous internal evaluation model, the tutor project with one teacher per subject and its inclusion in a distance learning model, makes it impossible to quantify the great effort the teacher makes in relation to these teaching matters. If on top of this the teacher is quite young, and is undertaking his or her doctoral thesis, the newly defined role of the teacher needs to be rethought, as it does not reflect the reality of the given situation.

5 Conclusions

Throughout the paper we can observe that ICTs, and particularly the CASE tools, are fundamental for adapting subjects to the EHEA, especially in engineering matters. The development of ad-hoc software as a research channel to correctly set up and develop new learning lines in teaching environments must not be excluded. Besides, this may lead to the achievement of a greater independence for students in relation to teaching staff, and since we can work with freeware software, no economic restrictions exist to provide quality teaching. In fact, by following the ACM [11], IEEE [12], UNESCO [13] recommendation, obtaining a tool that fulfills the professional competences described in the white books of degrees has been achieved.

In addition, it has been corroborated that the students' work finally matches the estimation made in section two. As an example, the subject has 24 students during this academic year, who are divided into nine practical groups. They have to do five lab practicals which cover 20 hours of the ECTS credit system. Only one group did not manage to achieve this, and it admits that this occurred because of lack of communication and coordination. Yet what is more relevant is that the drop-out rate has been null, quite unlike the previous two years when it was around 50%. This is a very important fact for us since it is not compulsory to pass the practical lessons to sit the exam

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and to pass the subject. All this information encourages us to plan future developments based on Learning Objects, standard LOOM, etc., which mean that establishing different learning itineraries is indeed possible in accordance with different student roles, itineraries which contemplate accessibility and usability that are sufficient to offer an education without frontiers.

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