A Database Approach to Partnership in Global Learning

Rubens N. Melo
TecBD DI/PUC-Rio/Brazil
rubens@inf.puc-rio.br

Lúcia Blondet Baruque
TecBD DI/PUC-Rio/Brazil
lbaruque@inf.puc-rio.br

Abstract

This work proposes that the current database research has much to contribute to e-Learning. It defends that this area can be seen as a new database application domain and the Partnership in Global Learning (PGL) Project as a good case study. The paper begins with a brief introduction to the PGL Project then describes its main technological needs. It also proposes that the main technological support to the project specifies a database problem to be solved and ends with a list of topics of database research for eLearning.

1. Introduction

The Partnership in Global Learning (PGL) Project is a virtual organization for research, development and dissemination of e-learning in which secondary schools, universities, and corporations may participate. The structure of PGL includes five charter universities. Corporations, other universities and secondary schools may become PGL associates [1].

The management of PGL includes a PGL Board with a representative from each of the charter universities. The University of Florida is the administrative head of PGL. Bilateral agreements between each of the universities and the University of Florida currently form the organizational basis of PGL. These agreements are administered through the Latin American Studies Center at the University of Florida. As PGL evolves, it will become an independent, non-profit entity under the 501C3 legislation.

The PGL charter universities are:

- The University of Florida, Gainesville, USA
- Fundação Getúlio Vargas, São Paulo, Brazil
- Universidade Estadual de Campinas, São Paulo, Brazil
- Pontifícia Universidade Católica do Rio de Janeiro, Brazil
- Instituto Tecnologico y de Estudios Superiores de Monterrey, Mexico

The PGL Project is an international initiative, designed to produce technologically enhanced learning that is distributed on a global scale. Its aims are to promote broad-based learning community and also technologically to accelerate economic, social and cultural advancement [2].

In addition to designing, delivering and managing learning contents, PGL is also to render corporate and academic services which encompass: content development; content regional localization; content conversion to new media formats; e-learning and related infrastructure needs analysis; training services; facility rental and content dissemination [3].

The PGL is currently involved in supporting important internationally e-learning projects, such as: a) *The Virtual School: Converging Technologies for e-learning* that aims at providing low-cost access (using TV and Web resources) to educational technology at schools and university levels, for children and adults from all socio-economic backgrounds (Brazil, Mexico and USA); b) *The Standardized Patient Assessment Center* being developed by the University of Florida College of Medicine and the College of Medicine at the Unicamp University in Campinas, Brazil and c) *K-12*

PGLDB'2003, pp. 1-8, 2003.

Modules Development that aims at developing course modules in Mathematics, Biology, Chemistry, Environmental Science, e-Commerce and a number of other subjects for future population of the PGL Database. Content will be made available in Portuguese, Spanish, and English to the users. A dissemination plan is underway which will reach more than 200 K-12 teachers and 30000 students.

This partnership implies that we need to collect and integrate e-learning content developed or maintained by the partners. The physical distribution of the partners, which may be in any part of the world, requires the adaptation of data from one region to the other so that regional characteristics can be incorporated. This work proposes that the current database research has much to contribute to e-Learning and that the PGL Project is a good case study.

The remainder of this paper is organized as follows. Section 2 discusses in more details the "problem statement" that fundamentally establishes the basis for the proposed database approach to PGL. Section 3 proposes that the main technological support to the project is a database problem to be solved and in this direction section 4 presents a list of topics of database research for eLearning. Some final remarks are made in section 5.

2. PGL Problem Statement

The three major aspects which shape the proposed focus of database research for PGL are:

1) The *Partnership* aspect that calls for developing, collecting and integrating multimedia content and services from many sources in a collaborative manner.
2) The *Global* aspect that requires a unified and integrated view of distributed heterogeneous content which has to cope with internationalization and localization issues.
3) The *Learning* semantics, modeling and processing aspects that encompass items such as the development of learning objects (LOs) and modules in such a way that content and tools may be easily adapted to teacher and student needs and curriculum.

2.1. PGL is a Partnership

Since PGL's inception in 1999, its members have been working together on a number of activities. From administrative meetings to the actual development of PGL Web-based learning modules, all activities have a teamwork nature. Collaboration between PGL partners can take many forms such as establishing a common strategic direction; creating communication vehicles that allow progress at one institution in a common activity to be transferred to others and building common interfaces to external systems and entities. Therefore, PGL needs a database technology which is able to support teamwork and the storage and fast retrieval of PGL-related content and services.

Today the Web has become an integral part of the learning process. The number of on-line courses and face-to-face courses that use online mechanisms has been increasing dramatically. Also, to cope with the rapid advances in the subject fields, contents of each course must be reviewed within short revision cycles. In addition, the continuous change in many disciplines has broadened the synergy and the overlapping between courses. Moreover, courses need to be stored efficiently using computer software that facilitates the fast retrieval of their contents and services. These issues make it necessary to seek greater efficiency via: (a) approaches that hasten course design and

development; (b) techniques that facilitate sharing between courses; and (c) tools that support reusability of course´s components [4].

Concomitantly, we are aware that the recent advances in the database technology have made it possible to store, catalog and retrieve data of different nature. This provides the opportunity for the PGL community to create a global repository in which multimedia content originated from various sources can be used in a standard way by all PGL partners and users. This distributed database system would be the core component of a globally distributed multimedia e-learning environment to support the most important tasks necessary to fulfill the PGL mission.

2.2. PGL is used globally

As far as global aspects are concerned, a number of issues should be addressed to support the development of the PGL global database, as described in the above section. However, this work will only address those general aspects which may have an impact on the database research area.

We need first to understand what it is meant by the word global in this context. PGL is global because its learning contents can be of any domain, its users can be in any part of the world and it is Web-based. PGL has started its work as a pilot project in the CALA region, and, as such, K-12 learning modules have been developed in English, Spanish and Portuguese. However, PGL is intended to reach Europe, Asia and Africa in the next years. Thus, the regional characteristics and technology level are issues to be taken into consideration, if we want PGL to reach larger audiences.

It is necessary that PGL learning modules be able to run on heterogeneous distributed multimedia platforms. Therefore, device-independence of the learning material (content and services), interoperability between the different platforms and portability are essential.

As a consequence, content and services integration emerges as an issue of priority [5]. In order to achieve it, industry standards should be set up. It is desirable that the proposed database should not be an isolated application. It should provide content and services that can be integrated with documents, web sites and multimedia authoring tools and applications that can run on different machines in a network.

Furthermore, it should be noted that PGL learning modules are to be translated in order to be used by different nations. This has to do with interface design issues where software internationalization and localization calls for a number of principles to be followed. Language is just one aspect of software translation; in order for a product to have good acceptance in a given market, it is necessary that cultural meta-models be used as a reference to help understand people' values, attitudes and behaviors [6].

Web learning content producers, such as PGL partners, need tools to efficiently build huge data stores with sophisticated applications. This in turn creates huge demand for database technology that supports the creation, management, searching and security of Web learning content. Web learning content consumers, on the other hand, need tools that can discover and analyze learning materials on such databases. Consequently, there is a need that LOs must be searched consistently and that standards are established so that LOs developed by different vendors or organizations can be searched consistently.

However, good content material is just one factor in a valued learning experience equation. According to some educational theories, learning is fundamentally both social and experiential [7]. Content and pedagogy plus a technologically supported learning community are the right ingredients for successful e-learning activities. The social space should be managed for the teaching and learning needs of a particular group. This requires a platform that can be easily modified to take into consideration the needs of

the particular learners. So, the database technology should also be able to link people and material in new ways which will help the learner understand the community he joined.

Furthermore, for learning resources be used in a global market place, there is a need for a curricula supported by different nations, so that learning resources can be shared in different granularity levels by various institutions. Thus, there is a need for supporting multiple views of the material in the database.

2.3. PGL is mainly oriented to e-learning

So far PGL learning modules have been developed by K-12 teachers trained by the PGL partners. The ADDIE model (Analysis, Design, Development, Implementation and Evaluation) has been adapted and used in this development. In this case the main tasks for module development are: audience analysis, lesson design, storyboarding, information design and evaluation techniques. Recently, the PGL module development process was reviewed and a nine-step methodology has just been established by the Instructional Design Team. Now a methodology based on LOs is underway [8].

In order for PGL to be able to accomplish the mission of deploying worldwide high quality and interoperable learning materials, there is a need for a PGL module development methodology that incorporates the concept of Learning Objects (LOs). This allows for flexibility, ease of updates, searches and content management, customization, interoperability and increased value of content. All of these attributes are in line with PGL vision.

Learning Objects (LOs) are chunks of learning material. In a lower granularity level, they are composed of reusable learning objects (RLO). Surrounding texts are explanations or comments which accompany the LO given by the teacher as an orientation to students. The idea is that by using RLOs, there is no need to start a course or module from scratch and there is a significant reduction on time and costs spent for module development [9]. One problem is that we cannot have interoperable LOs without industry-wide standards.

During 1998, the Advanced Distributed Learning Initiative (ADL) observed that several organizations were developing a variety of draft standards, each of which affect different aspects of Web-based learning systems. Much effort has been devoted in search of a proper standard for LOs. Many systems tend to comply with IMS-LOM metadata standard. These efforts, however, lacked a common framework. So, ADL developed the Sharable Content Object Reference Model (SCORM) incorporating many of these emerging standards into one reference model [10].

Another important issue is that the key for deploying LOs effectively is to provide ways for the learner to contextualize the information. Without context, LOs can be confusing, misleading or utterly meaningless. The use of LOs will empower on-line learners to participate more actively in the contextualization of information (semantic relationships).

Whatever development environment and tools are used, a sound instructional design technique will remain important both for customized development and for template-based development. The combination of thoughtful planning with intelligent deployment of advanced authoring tools will result in benefits for both content producers and learners.

One of the great advantages of the Web is that it can organize information so that it is personalized to an individual's needs. Personalization is an area where databases can demonstrate their power. Information can be organized in such a way that learners are given only what they need when they need it. They can also be given total control over

their learning environments. Meaningful user-controlled personalization is something that needs to be incorporated into e-learning design from the beginning. The Web offers the ability to create deep profiles of students and use that information to create personal, unique experiences.

3. PGL needs a Database solution

Some time ago the Database Management Systems (DBMSs) used to manage simple and formatted data according to the so called commercial or administrative paradigm. Records or tuples of simple data were stored into tables and then the data could be retrieved, updated and deleted and not much more than this. Many important traditional systems were successfully implemented on top of this DB technology.

Then new defying applications appeared (non-conventional DB applications) where the data was now more complex and possibly multimedia. The DB research responded and changed the DB technology. Extended or new DB models were devised (Extended Relational Model, Semantic Models, Object Oriented Models etc) and we saw great contributions of the database approach to new areas of application such as Geographical Information Systems, Decision Support Systems and others.

The Object Orientation in Database gives us the framework that can be specialized into several domains, each one with specific semantics. We may have applications of Geographical objects in GIS, of Design Objects in CAD etc. The database problems in these areas of application have been treated by the new DB technology with the proper specialization of the semantics of the objects.

Now we have the Learning Objects (LOs) to be managed according to a so called e-learning paradigm. The users want to search, access, and use, analyze, develop on-line the learning objects, as well as store, organize and retrieve them. These LOs should be multimedia and interoperable and personalized to the users' context and needs. Again we have to model objects with a proper structure (complex object possibly multimedia) and a proper semantics (learning) in order to be a good solution to the "problem statement" of Partnership in Global Learning.

Thus, PGL needs a "Multimedia e-learning Object Oriented Distributed Heterogeneous Database" that should provide specific functionalities:

First, this database must be able to store media resources, such as images and image collections, sound files, video, animation, assembled presentations (e.g. PowerPoint), documents, applications (Java applets, simulations etc). Thus, this database is in essence multimedia.

Second, it must be e-learning oriented. It means that the objects stored should follow an e-Learning Object Model [11]. The reusable LO model allows flexibility, easiness for updating and customization, and interoperability as far as course design and development is concerned. In other words, e-LOs would be stored in this multimedia database which will record its corresponding title, ownership, licensing arrangements, media format, content and other relevant metadata [12].

Third, this database has to be distributed and heterogeneous although the users see it as a centralized and homogeneous database. It will capture data from many sources on the Web and deliver content and services to multiple points on the Web.

Fourth, this database will have several user classes. We can foresee the following major classification of users: *administrators/developers* whose major responsibility is to maintain the resource on-line, correct problems and enhance the associated tools; *providers* will submit multimedia e-LOs to be stored in the database with relevant metadata for identification; *general application developers* will look for multimedia

resources by specifying search terms and/or browsing through predefined subject hierarchies and *compose* their applications (courses, modules etc). It is important that e-LOs can be displayed using a wide variety of hardware and software combinations. Different media formats to meet the users' needs are also desirable. *End users* will browse the PGL database and use the e-LOs directly.

Fifth, authority and user access rights must be enforced. Thus, it will be important to define which content will be available to the general public, and which must be restricted to local intranets. Providers should be able to specify the level of access when they submit their content. Any copyright restrictions or credits must always be indicated whenever these contents are displayed.

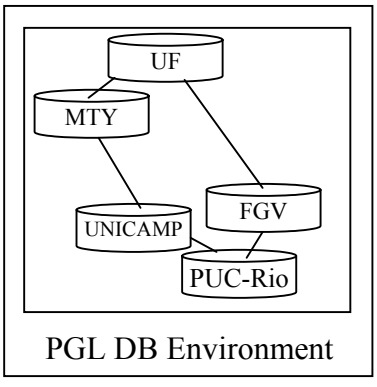
Finally, there is a need for a metadata model suitable for not only storing objects, but which can also provide intelligence needed to model subject matter domains and assist in locating relevant objects for the user. We see the Web evolving to managing dynamic content and providing information specific to the users needs. Personalization, however, require very sophisticated data models and applications [13]. Supporting this next generation of Web applications will require very sophisticated database services.

Therefore, all of the above calls for an environment based on a **"Multimedia e-learning Object Oriented Distributed Heterogeneous Database".**

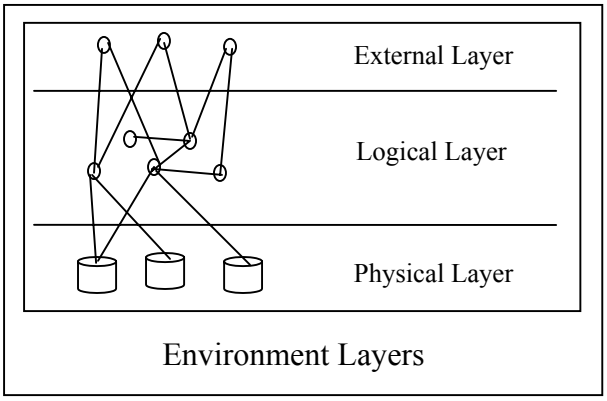
4. Database Research for Partnership in Global eLearning

The fundamental database system issues have changed dramatically in the last decade. We believe that e-learning applications, such as those addressed by PGL, pose new challenges for database research. Considering the problem statement in the previous section, we feel that a database approach is quite appropriate to support the solutions and services proposed by PGL. Issues such as modeling of e-LOs and heterogeneous content integration should be addressed as high priority items.

A global network infrastructure is to be set up to connect PGL partners and to allow the global distribution and sharing of PGL content. Because e-LOs may be composed of video, audio, text, images, graphics, animations, virtual laboratories (v-labs) etc, there is a need for a multimedia distributed database through which e-learning contents (LOs) can be accessed, developed and managed in different levels of abstraction and in a distributed manner allowing its use by all PGL clients, in an effective and efficient manner.



PGL DB Environment



Environment Layers

On April 18-19, 2002, a group of database researchers from the PGL charter universities and other collaborators met at PUC-Rio, Brazil to discuss a proposed database research agenda for the PGL project. A draft of the research agenda was reviewed and updated during the meeting. The report on the recommendations (PGL DB Research Agenda) which resulted from the

workshop is in [14].This section gives a brief overview of some of the BD research topics that can contribute significantly to the PGL project. More details on these topics are in [14].

4.1 A Multi-Layer Architecture for PGL DB Environment

A Multi-Layer architecture that considers typical levels of abstraction of database systems has to be developed [15]. In the Physical Layer: PGL sites will store the real content using the existing (local) database systems, file systems, content managers, etc. Therefore, content and services are heterogeneous and distributed all over the PGL sites. In the Logical Layer, the development, use and content sharing among participants will use a common model, which is an integrated view of the content and services. It is in the External Layer that the actual uses of PGL content and services via the logical layer will occur.

4.2 An Environment based on Multimedia e-learning Object Oriented Distributed Heterogeneous Databases (MeLOODH DB)

This is a huge task. Several sub problems have to be tackled, such as: a) defining an adequate LO Model for describing the PGL DB and its behavior in the 3 levels of abstraction mentioned above]; b) developing Query Languages and Query Processing techniques that may process queries that exploit semantic relationships, analogies, among LOs in order to solve queries and answer complex questions (the LO Model must support the representation of complex multimedia objects, their semantic relationships, as well as allow the expression of the queries that must be computable); c) developing new Transaction Models, which could use, for example, plans and workflow techniques that may be more appropriate for the creation, reuse, reassembly of physical LOs in a distributed environment and d) considering the use of a series of new database related techniques (Data Warehousing and Data Mining, Ontology and Digital Library and Cataloging techniques) in this environment.

4.3 A set of rich tools and proper User Interface.

Communication facilities for student interaction are needed. Moreover, tools for aiding the process of developing of LOs and educational modules and courses are also important. Because of its international characteristics, the PGL environment has also to provide facilities for internationalization and localization of the user interface. Language translation is also an issue.

4.4 New Data Administration issues.

Now we have to deal with questions such as the definition of policies and procedures, recommendations for candidate providers, intellectual property and security as well as auditing policy issues. Conventional database administration has to be extended to handle these questions.

5. Conclusions

This work proposes that the current Database research has much to contribute to the e-Learning arena. Many technical problems of eLearning mentioned in this paper may be seen as challenges to the new database technology and research. Several new applications areas, such as Computer Aided Design, Decision Support and Geographical Information Systems have well profited from this approach.

The precise semantics of Learning and the proper structure of Complex Learning Objects in this area are still demanding more research. Soon we will have better definitions for terms such as: Learning Management System (LMS), Learning Content Management System (LCMS), Learning Object Management System (LOMS), etc. They sound like the terms DBMS, extended DBMS, OODBMS, etc now applied to the Learning domain. We think that the topics discussed in this paper are a good starting point for a Database research agenda to really support the eLearning domain as a new Database application domain.

The Database approach to eLearning will certainly offer the proper support to the production of technologically enhanced learning that can be distributed on a global scale. Thus, we will promote broad-based learning communities and will also contribute to accelerate economic, social and cultural advancements.

References

[1] Lowe E., Partnership in Global Learning Annual Report, Year 1, July 1999 – June 2000

[2] PGL Site – Partnership in Global Learning; Available at http://pgl.ufl.edu/

[3] Legg S., Partnership in Global Learning Annual Report, 2001 – 2002

[4] M.D. Merrill and the ID**2** Research Group, Instructional Transaction Theory: An Instructional Design Model based on Knowledge Objects, Educational Technology, 36(3), 1996; 30-37; Available at http://www.id2.usu.edu/Papers/IDTHRYK3.PDF

[5] Meehan, M., Data Integration and Web Services, Computerworld, abril de 2002, http://www.computerworld.com/databasetopics/data/story/0,10801,70043,00.html.

[6] Shen J., User Interface Internationalization, CIS732 Final Project, 2000; Available at: http://eies.njit.edu/~turoff/coursenotes/CIS732/samplepro/user_interface_internationalizat.htm

[7] Banks B., Learning Theory and Learning Objects; Available at: http://www.fdlearning.com/fdlearning/html/company/papers/l-theory-l-objects.pdfd

[8] Baruque L., Porto F. and Melo R., Towards an Instructional Design Methodology based on Learning Objects; paper to be presented at the International Conference on Computers and Advanced Technology in Education (CATE 2003), June 2003;

[9] T. Kilby, Learning Objects, Web Based Training Information Center, 2002; available at: http://www.webbasedtraining.com/trends_objects.aspx

[10] Advanced Distributed Learning Sharable Content Object Reference Model Version 1.2 - The SCORM Overview. Introduction to SCORM, downloaded http://www.adlnet.org in June/2002

[11] Pereira, L. A. M., Porto, F. A. M., Melo, R. N., Objetos de Aprendizado Re-Utilizáveis: Conceitos, Padronização, Uso e Armazenamento, Pontifícia Universidade Católica do Rio de Janeiro – PUC-Rio, 2003.

[12] IEEE P1484.12.1/D6.4 Draft Standard for Learning Object Metadata, IEEE, March/2002

[13] Martinez M., Designing Learning Objects to Personalize Learning; Available at: http://www.reusability.org/read/chapters/martinez.doc

[14] Melo, R. et al; PGL Database Research Workshop Report, April, 2002

[15] Pereira, L. A. M., Melo, R. N., Um Ambiente de Banco de Dados Para Ensino a Distância Baseado em Workflows e Objetos de Aprendizado, Pontifícia Universidade Católica do Rio de Janeiro – PUC-Rio, to be published