Integrating Business Intelligence Module into Learning Management System

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***Abstract* -- Distance learning is more and more interesting to everyone. Learning Management Systems are capable to be the source of data for business intelligence software. Business Intelligence software integrated with Learning Management System can help to analyze the way student uses distance learning, what are the effects and how to improve its quality. This paper describes the design of Business Intelligence Module integrated with Learning Management System used in project for Department of Education, Croatia. Special attention is given to experiences, like measuring competency level or gap analysis on training requirement against job function.**

I. INTRODUCTION

E-Learning has many definitions, because of its rapidly evolving nature. Distance learning is learning where the instructor and the students are in physically separate locations. It can be either synchronous or asynchronous. It can include correspondence, video, satellite broadcasts, or e-Learning.

E-Learning is a way of learning over Internet or intranet. It uses adjusted multimedia content synchronously or asynchronously [3]. In asynchronous e-learning the learner takes training courses independent of time and place via compact disks, company intranet or through some other media. Synchronous e-learning is held in the real time, similar to classroom teaching, and the participants gets training courses over the Internet or the intranet. Synchronous e-learning also brings in the possibility to have specialist trainers all over the world, without wonder of their real location.

Users with Internet browser can access multimedia content. If company implements the Learning Management System on intranet, it can be real effort demanding for them and their technology infrastructure [3]. To prevent those issues, the company providing it often hosts the system. To preserve the organizations identity, the portal system can be established and designed in that manner.

There are many benefits of e-learning based on Learning Management Systems:

- Increase competences of all participants with high effective knowledge transfer
- Provide training for distributed staff
- Provide communication channel for the exchange of e-learning experiences and building knowledge base
- Simplify the skills-gaps detection
- Provide adjusted e-learning materials for every participant
- Decrease the time needed for classic education, with considerable return of investment
- Provide pre-defined reports for participant's progress.

Because of those reasons, e-learning is not just a technology for knowledge transfer, it also enables that every participant gets it in the most appropriate format [3]. With targeted and personalized content, e-learning rapidly improves education process and in the same time it dramatically cut training costs.

E-learning becomes more and more important for big corporations and education institutions because competitive advantages are needed. It is a way to locate knowledge gaps, fill them up and build the competencies. That way e-learning increase the organization's intellectual capital, competencies and leads to a more efficient work force.

This paper will focus on Learning Management System. It is customized implementation in a form of public portal. It represents a framework and infrastructure of an e-learning solution, including all kind of users: administrators, mentors, managers and learners. An administrator defines the whole environment, group users and defines security in virtual classroom. Mentors can use communication tools for motivating participants and answering some issues in a form of message, public forum or chat with other users. Managers can plan education and track progress. Learners can learn, make questions to mentors and discuss with others.

E-learning has to include a few styles of accepting knowledge for high level of training success: auditory, visual and introspective. Learning package style must correlate with participant style to produce the best level of training. For that purpose, Learning Management System as data source integrated with business intelligence tool is a good starting point to provide needed answers. The real potential of that kind of databases is not just in holding data, but also in implicit patterns that are hiding in them. The main concurrent additions for most of service providers is a possibility to find, understand and use those patterns with intelligent analyses on very large databases.

This paper describes processes of intelligent analysis and their efficiency. Business Intelligence Module is developed and integrated with eLearner® [1] Learning Management System, and implemented in project for Department of Education, Croatia.

Published e-learning materials cover the education for European Computer Driving License (ECDL) certificate. Until today, project includes over 600 teachers and they made about 1500 e-learning hours. For Croatia market, those numbers are promising, and they makes possible processes like discovering skills gaps and learning styles of participants.

II. BUSINESS INTELLIGENCE MODULE INTEGRATED WITH LEARNING MANAGEMENT SYSTEM

eLearner® LMS [1] consists of Front End Server, Database Server, Repository Server and Collaboration Server (Figure 1).

Front End Server is based on Internet Information Services Server (IIS). IIS hosts application Component Object Model (COM) components [6] and it is the heart of system.

Database Server is based on MS SQL Server. Relational Database Management System (RDBMS) holds data, store procedures and functions for handling with data. It is the storage for entities like User, Group, Category, Plan, Class, Course, Shareable Content Object (SCO), Test, Activity, Request, Session, Archive, Vendor and all of their attributes that are interesting for e-learning environment.

Collaboration Server is a server that makes possible mentioned synchronous communication between students, but there is also possibility for asynchronous communication with messaging feature.

Repository Server is a server that holds multimedia content.

Shown LMS is a system that enables e-learning and makes possible for use every known e-learning feature. It works with secured environment, with optimized functions and procedures. Its functionality is recognized, even in Croatia where this kind of education is not yet fully implemented.

The next step in developing process of Learning Management Systems is to discover learning styles of users. This is the next interesting domain where it is possible to improve benefits and effects of e-learning. It is important to optimize e-learning materials, to make them just like the recipients want, or the way they feel most comfortable.

Second aspect of e-learning process is the way that users access e-learning materials, communication tools and other features. It is not the same if users complete course in only one or two sessions, or do it in much more, but shorter sessions. Even if that is the case, users can be grouped considering their habits, so that mentors and administrators can adjust plans, courses, tests and all activities in a class.

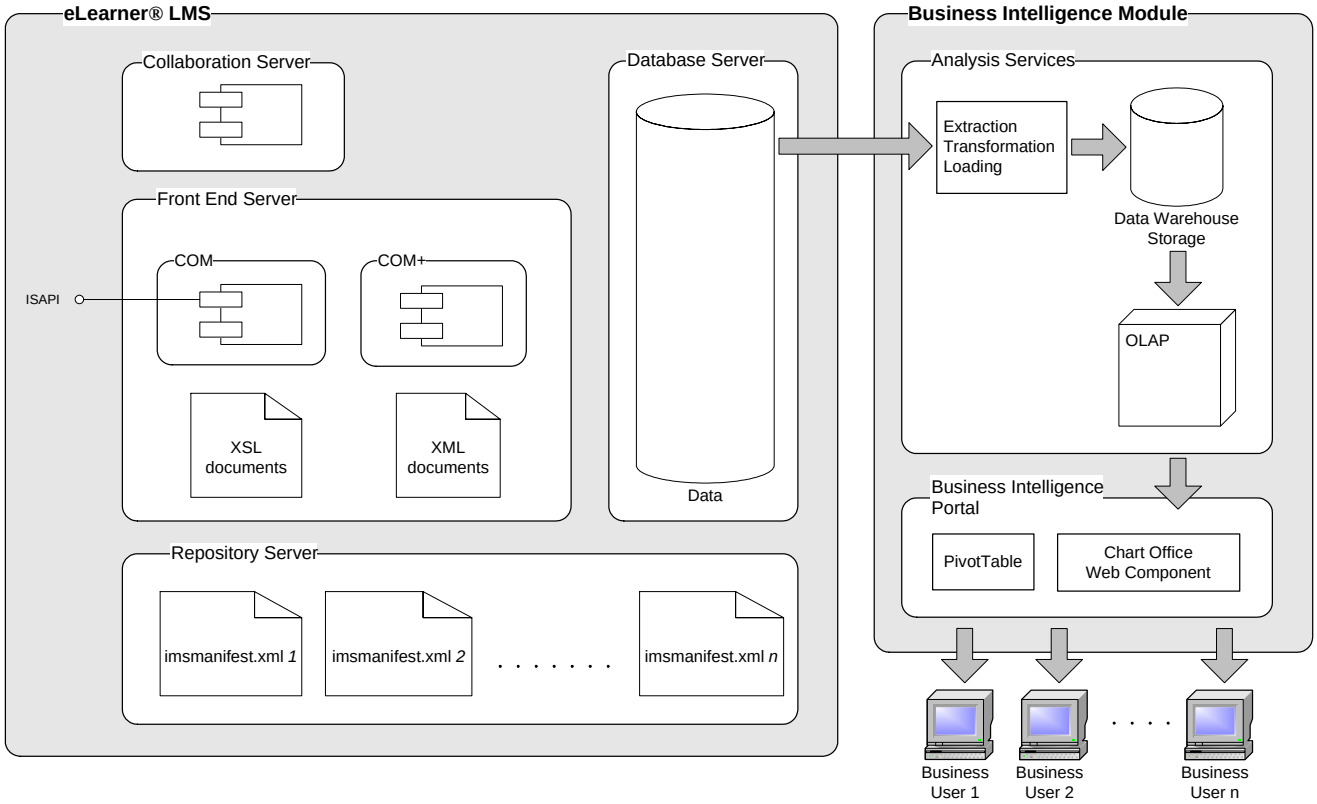

Figure 1. eLearner® LMS [1] and developed BI Module architecture.

In that step of adjusting e-learning process, very important thing are pre-education tests. They help to recognize users with similar needs or knowledge skills, helping us to group them and target most of their needs. Tests may be interesting at the end of education process too [4,5]. These tests are called post-education tests. They help to measure the effects after education. They also point to skills gaps that are missed in previous e-learning process.

E-learning is often only the one of the ways to learn that people use in their education. E-learning can be described as process with many iterations of smaller processes that help to organize the whole education in the way to get maximum effects.

For the good education process, necessary skills for participants had to be known. Then pre-education tests would help to discover what the level of existing knowledge is. Students with similar level of existing knowledge will be grouped together and led through e-learning process on the same way, with same time schedule and with the same e-learning materials.

After education process, post-education tests will be organized. They would tell us was the education process good, was it adjusted right for users, and what are the possible missed gaps that are needed to be fixed before next process.

The key for success is possibility to measure the effects of e-learning. The effects are not represented only with numbers. Effects could be measured by discovering gap areas in knowledge if they exist (before and after e-learning process), discovering level of user satisfaction, analyzing time used for education etc.

For those kinds of analyses, On-Line Analytical Processing (OLAP) technology is used. MS SQL Server with relational and archived data is used as data warehouse – data source for OLAP Services.

OLAP Services [7] enables data warehouses to be used effectively for online analysis, providing rapid responses to iterative complex analytical queries. OLAP's multidimensional data model and data aggregation techniques organize and summarize large amounts of data so it can be evaluated quickly using online analysis and graphical tools.

Business Intelligence Module (Figure 1) is based on OLAP Services, so it is able to use all of OLAP capabilities. For the connection provider, Analysis Services use Microsoft OLE DB Provider for ODBC Drivers. Connection is also defined by data source name (server name), user name and password for log on to server and initial catalogue (database name).

When Data Source is established, it can be used for multidimensional view on data, popularly called cube.

A cube provides an easy-to-use mechanism for querying data with quick and uniform response times. Business users use Business Intelligence Module as client application to connect to an Analysis server and query the cubes on the server. Business users issue a query on a cube by manipulating the user interface controls, which determine the contents of the query. This spares business users from writing language-based queries.

Summarized data called aggregations provides the mechanism for rapid and uniform response times to queries. Aggregations are created for a cube before end users access it. The results of a query are retrieved from the aggregations, the cube's source data in the data warehouse, and a copy of this data on the Analysis server, the client cache, or a combination of these sources.

Business Intelligence Module consists of Analysis Services and Business Intelligence Portal. Analysis Services include Extraction, Transformation and Loading (ETL) processes for populating the data warehouse, and cube definitions, which are the source for the Business Intelligence Module.

Figure 2 shows the design for one of the cubes developed by Analysis Services Cube Editor. The set of joined tables in the data warehouse is source of data. Fact table is *dbo.vwCubeTestInteractions*, and it contains measures *AchievedScore* and *MaximumScore*. The other tables are dimension tables, the sources of the cube's dimensions *User*, *TestTitle*, *Organization*. Storage Mode is Multidimensional OLAP (MOLAP). A MOLAP dimension's data is stored in multidimensional structure on the OLAP Server. MOLAP dimensions provide better query performance than Relational OLAP (ROLAP) dimensions, and because cube is not very large, it is the optimal storage mode.

When the cubes in Analysis Services are developed, the next step is to give business users the ability to view that data. Because a cube enables drill-down feature and the possibility of customization directly by users, Business Intelligence Portal is a good solution.

The Microsoft Business Intelligence Portal (BI Portal) [2] is an integrated, Web-based Online Analytical Processing (OLAP) solution that enables end users to create and share OLAP or Relational views, based on online OLAP Services, offline cube files and Relational Database. It is a .NET-based, 3-tier Web application.

BI Portal encapsulates View, Category Tree, Folder and Data Source objects [2]. A view defines a Source of data, a query made on that source and its presentation layout. When a View is created, a Data Source on which the view is based must be selected, and the View is saved in one of Folders and Category Tree's.

The BI Portal [2] integrates Microsoft OLAP client tools (Viewers) into an overall OLAP solution. These tools include PivotTable and Chart Office Web Components (OWC), and the Microsoft Data Analyzer (DA). These tools are used to display a View.

BI Portal uses the Windows-Integrated authentication method and validates the user to be a member of one of the Windows user groups: BIP_USERS, BIP_PW and BIP_ADMIN.

The BI portal provides both import and export capabilities from or to XML files. The export to XML file capability enables a user to work in an offline mode and display Views that were saved in a local XML file. The import from XML file capabilities enables Views upload to the BI Portal Server.

A user can use the "Save as Excel" command to save the current displayed view to an Excel file. It is very interesting feature for those users who already use MS Excel on daily basis.

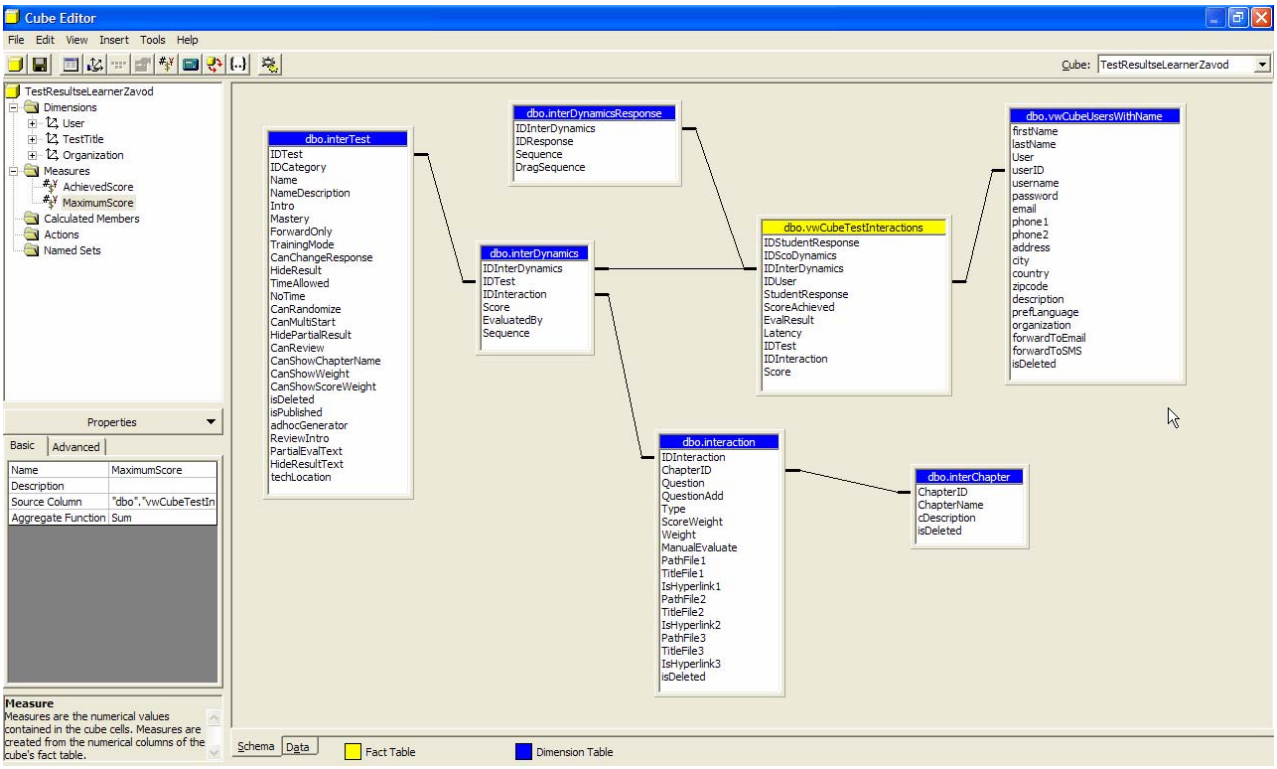

Figure 2. The design of one of the developed cubes used in Business Intelligence Module.

III. IMPLEMENTATION OF INTEGRATED SYSTEM IN PROJECT FOR DEPARTMENT OF EDUCATION

Project for Department of Education in Croatia is the first project of that kind in this part of Europe. Because e-learning is relatively new way of education in Croatia, the idea was to popularize online education in segment of public schools, especially for teachers. The user accounts were first created for teachers because one of experiences says that even teachers are under-educated in segment of Information Technology (IT).

After a few months, teachers got a possibility to establish an e-learning classroom in their schools. Because of the fact that most schools have only Integrated Services Digital Network (ISDN) access to Internet, if the whole classroom started to use e-learning at the same time, bandwidth bottleneck occurred. This is the reason that the customized solution was made.

Repository for multimedia courses was located in Local Area Network (LAN) of schools, and only synchronization traffic with e-learning portal had to use ISDN Internet access. That way, bandwidth bottleneck was bridged, and the users still can use communication features and features for tracking, mentoring, administrating and reporting in LMS.

The first interesting thing in that environment is to discover skills gaps before and after education. Aware of them, in next iteration of e-learning process only those areas can be target, optimizing that way the time spent for education. It makes costs of education lower too.

For that purpose, tests are developed with Test Module in LMS. They help us to locate the most interesting fields for e-learning. The results are that participants are most interested for applications that they need in everyday usage, but they do not recognize most of their features. For example, minority of teachers uses MS Access on daily basis, and they do not understand most of its possibilities.

Data captured with BI Module (Figure 3, Figure 4 and Figure 5) point out several things. The first one is that existing knowledge of MS Access is very low and that there are certain fields where users do not even recognize the fundamental idea. Example is Question K (Figure 3). Answers on that question in pre-education tests tell us that nobody understand the idea of relational databases, and conclusion is that course with very detailed explanation of Entity Relationship Model (ER) is needed.

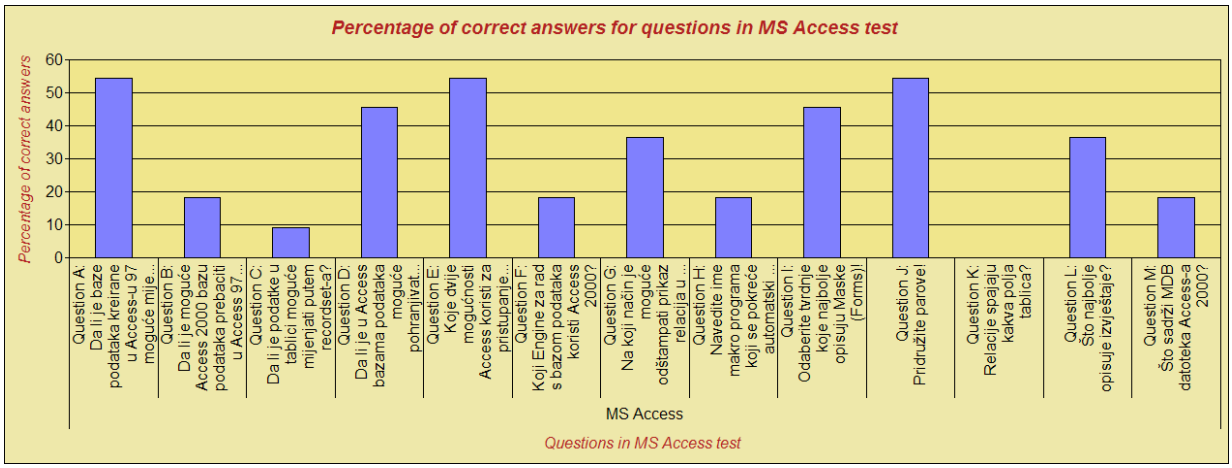

Figure 3. Example of finding skills gaps before e-learning process.

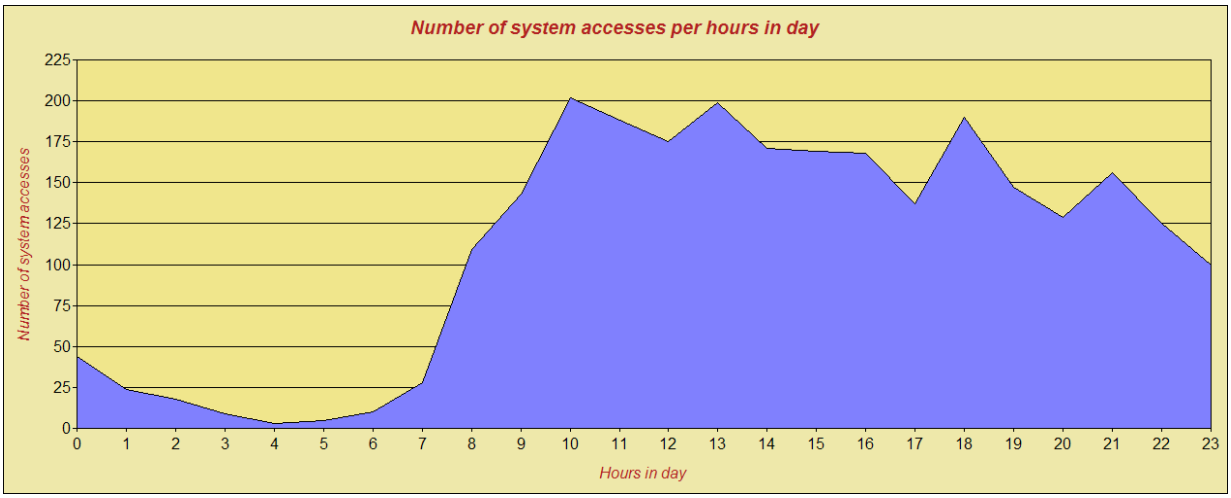

Figure 4. Example of habits in e-learning process.

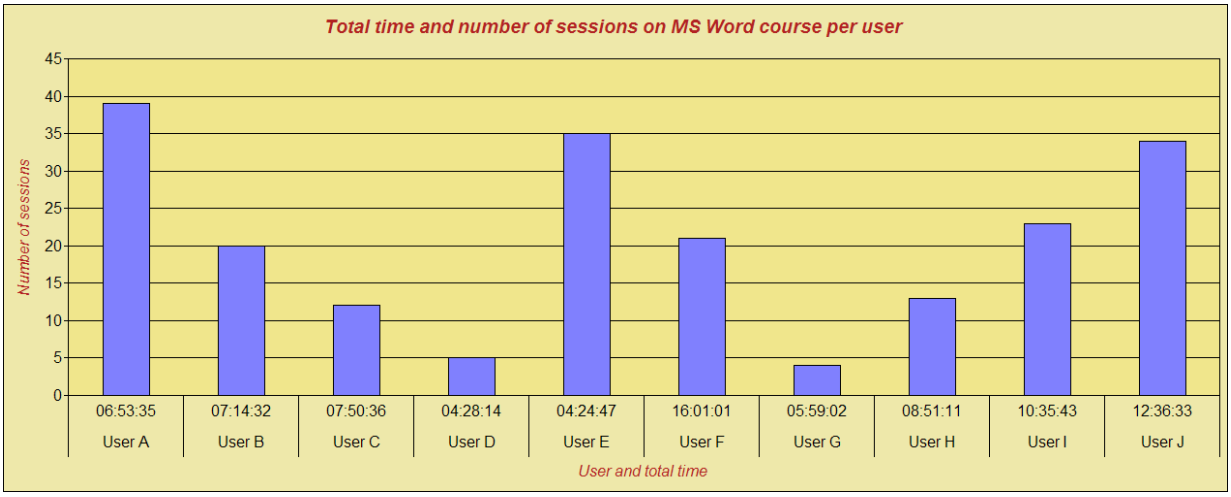

Figure 5. Example of effects after e-learning process.

The lessons should be descriptive, with as much examples is possible. Only a few points in course should show the MS Access full potential, in first place for additional motivation of user. That way course will be enough interesting to participants, targeting most of their needs, and at the same time, optimizing time needed to cover skills gaps of users. Except knowledge level of users and their skills gaps that is discovered, experienced e-learning styles is the next thing that must be considered when implementing e-learning.

Interesting thing to look at is the time when users most often access courses (Figure 4). The peak hours are 10, 13 and 18. This suggests that participants use e-learning before and after lunchtime, and in the afternoon when they come home, maybe while relaxing after working day. Most of teachers in this project use e-learning from their schools. Number of sessions dramatically falls down before 9 hours and after 18 hours. Partly this is because courses are totally free for teachers, and they do not have obligation to use them.

Another interesting thing is to see the way users accomplished „Completed“ status for course (Figure 5). There is a big difference if user access course in only a few, but long lasting sessions, or access course in much more sessions, maybe in every free moment. Of course, the effects are the same, but different e-learning styles are recognized. User D needed only 5 sessions and 4 hours and 28 minutes to finish MS Word course, but User E needed 35 sessions and similar time to finish MS Word course. The conclusion is that even users with no dedicated time for e-learning can make the same progress as users who have dedicated time for long e-learning sessions. The idea of e-learning is „any time, any where“, and this results proof it.

IV. CONCLUSION

This paper describes architecture of eLearner® LMS with integrated BI Module. This system is used in project for Department of Education, Croatia.

Described LMS is a system that enables e-learning and makes possible for use every known e-learning feature. The BI Module is an integrated, Web-based OLAP solution that enables end users to create and share OLAP or Relational views, based on online OLAP Services, offline cube files and Relational Database.

After the project was started, Business Intelligence Module helped managers and project leaders to optimize e-learning materials by discovering the skills gaps before and after education processes and by recognizing e-learning styles of participants. Business Intelligence Module used on data generated in real e-learning process gives the decision makers information that helps in bringing conclusions. It enables views at lower level of details that show trends and summarized data, but with possibility to drill down to higher level of details and to show exactly the searched facts. LMS with integrated BI Module is a modern tool in education process that improves its quality. The whole project is also the first and complete know-how in e-learning education in Croatia.

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