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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (15): 3484-3486, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.3484.3486

Educational Data Visualization via WebGIS Technology

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Abstract: This study presents a research that applies educational data-visualization techniques in a government employee training platform. A novel visualization system Web-based Statistics and Geographic Information System (Stat-Geo) developed by web service and WebGIS technology is employed. It is able to visualize student learning traces data and present the information simply and clearly to designers and instructors, thus gain insights of members' behavior and learning status.

Key words: Data visualization, WebGIS, e-learning, educational data mining

INTRODUCTION

During the past decades, the most important innovations in education systems have been related to the introduction of new technologies (Ha *et al*., 2000). As one of the most popular ICTs at present, Learning Management Systems (LMS) have been widely used by learners and lecturers. Some examples of commercial systems are WebCT, Blackboard and TopClass, while some examples of Free/Open ones are SAKAI, Moodle, and Caroline.

Compared with face-to-face learning environments, online learning environments make it more flexible to promote synchronous and asynchronous interaction and collaborative learning. The lack of a closer member relationship on the other hand, has long been blamed. Generally, the decision making of a classroom process involves observing students' behavior, analyzing historical data, and estimating the effectiveness of pedagogical strategies. In traditional learning environments, educators are able to obtain feedback on student learning experiences in face-to-face interactions with students, enabling a continual evaluation of their teaching programs, when students work in online environments however, this informal monitoring is unfeasible. As a result, looking for other ways to get students' feedbacks becomes necessary. Web-based education is a form of distance education delivered over the Internet (Johnson *et al*., 2000). Most learning behaviors of members can be recorded through learning management systems such as, login, visit, homework upload and chatting with others, etc. Systems are hence able to provide a huge amount of learning profile (Romero and Ventura, 2010).

Organizations running distance education sites usually get large volumes of data every day which automatically generated by web servers and collected in server access logs or databases. Decision makers, designers and managers of the website, perform their work based on the data of learner's portfolio including the learning path, preferred learning course, grade of course, learning time, etc. But in the environment of most existed platforms, these essential data are usually hard to gather.

The platform discussed here is operated to provide life-long learning service for Shanghai's government employee based on a training system, which currently engages 45,000 active learners. The problem of the platform lies in that it's difficult to observe members' behavior and learning status clearly from the collected large volume of data. The aim of this study is hence provide a solution to the problem through data visualization technology.

BACKGROUND

Led by Organization Department of CPC Shanghai Committee and Shanghai Party School of the Communist Party of China, the biggest government employee training platform (http://shgb.gov.cn, SHGB) in china was developed in 2005. This platform serves as the main government training system in Shanghai and rural area by providing 1200 courses for 45,000 learners. Through SHGB, learners can access a variety of educational resources to pursue their life-long learning objectives. The target learners of this self-regulated learning platform are employees from national organizations (e.g. government functionary and teacher). This system provides more flexible ways to choose courses and learners can regulate their learning pace by themselves. The panel and courses are illustrated in the home page of the web site. Besides, a Course

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Management System, Blog, Discussion Board, Online Test, etc. are main components of the platform (Guo *et al*., 2009).

APPROACH

Study context: SHGB training platform is a Self-regulated lifelong learning environment. Learning trace data are collected from 45,000 learners which come from 18 counties and 14 different government departments such as Publicity Department, United Front Work Department, etc. The information collected includes not only the system's resources information, like courseware, course, multimedia resources, but learners' study trace, like scores, courses passed, logins and logouts, access courseware, online period, social activities, etc.

There was lots of work for managers to analyses these data before making decisions. And the lack of friendly data present interface is another obstacle. Early research in this system indicated that usability is a factor that influences members' motivation and satisfaction (Guo *et al*., 2010).

Our research question mainly focuses on:

- Developing a web-based statistics and geographic information system (Stat-Geo System) for SHGB, making information exploration simpler and clearer through WebGIS technology
- Transferring and storing learning information effectively and providing a convenient way to display real-time learning information to managers and instructors

System design: The Stat-Geo and SHGB are two individual systems connected by Web Service program. Learners' information located remotely in SHGB's database is sent to Stat-Geo system. The SHGB provides not only information from Website organizers, like courses and resources, but information from learners, including learning plans, courses passed, scores, logins and logouts, etc.

The information is sent and real-time update statistical indicators with three dimensions as XML files via XML-RPC web service accessing technology to Stat-Geo web server. These web services which are based on Java provide unified interface for data accessing. All of the data will be parsed locally with URL (Uniform Resource Locator) in web server via XML-DOM method in PHP. Inside web server, the rendering of dynamic flash maps is based on the open source swfobjects.js, while charts plotting on the open source JPGraph library (Fig. 1).

Statistics indicators have been classified into three dimensions (Table 1): The first dimension classified by geographic distribution includes 18 counties; and the second one classified by source of learners' includes 14 departments; while the third is about time, statistic data being presented by monthly, daily and hourly, etc.

Varied learning information and the spatial distributions of learning resources which can be clearly shown via web charts, tables or flash web-based thematic maps of Shanghai City, are identified by different colors when plotting. According to these dynamic charts or maps, important information or problems may be found through deep analysis (Fig. 2).

Stat-Geo is a good tool for online learning management visually as well. The information it collects provides managers with good advices and suggestions in decision or plan making, which in turn promoting the role of the SHGB. In this way, more and more excellent learning resources can be provided to learners and the spatio-distribution of the system get adjusted.

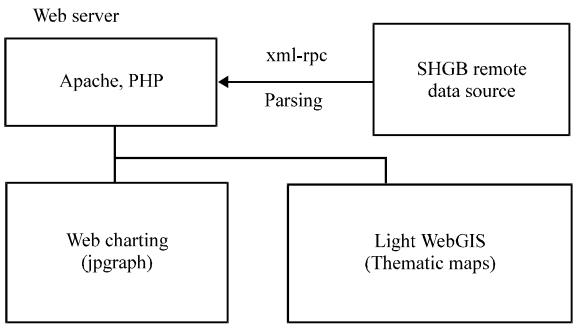

Fig. 1: Architecture of stat-geo system

Table 1: Statistical dimensions of stat-geo system

Time period scale	Statistical indicators	Spatial distribution scale: Geographic distribution	Spatial distribution scale: Department
Yearly	Statistics of System,:Courses, Resources, students, etc.	Whole city and each county	Whole and each department
Hourly Daily/weekly Monthly	Statistics of Learners:Login and Logout, learning courses, course passed, score, and resources accessed, learning period, credit, etc.	Whole city and each country	Whole and each department

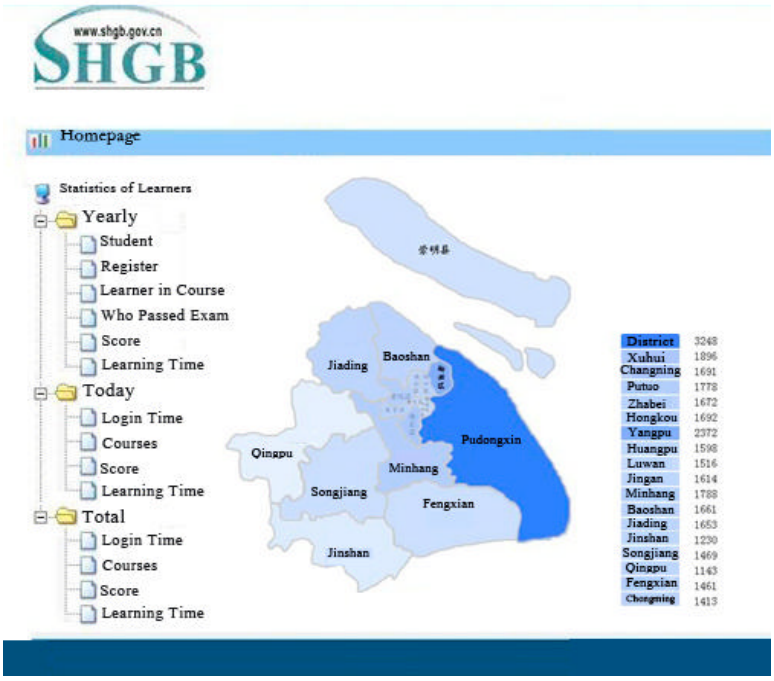

Fig. 2: Interface of stat-geo system

CONCLUSION

In this study, a remote web-based visualization system Stat-Geo was developed, through which the member's learning information can be presented simply and clearly to designers and instructors,. Members' behaviors and learning status are thus mastered. It is reported from the managers of SHGB that work efficiency was improved through Stat-Geo as plenty of time was saved from data analysis and visualization work. The Clearer and simpler presentation of learning information facilitated management and decision making as well. Stat-Geo is a significant attempt to connect e-learning and WebGIS technology, while it is still in its infancy at present. Special design and improvement are necessary to promote the system become a general learning data visualization tool to serve more e-learning environments. The future work mainly lies in two aspects:

- More flexible program interface should be designed to connect different e-learning systems
- Much more learning information should be presented through educational data mining technology

ACKNOWLEDGMENT

This study was supported by the Fundamental Research Funds for the Central Universities.

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