International Journal of Information Science and Management

A Saas-Based Approach in an E-Learning System

Abdelraheem Mousa Basal
Michigan, USA
Corresponding Author: Abasal@ltu.edu

A. L. Steenkamp ,Ph.D.
Lawrence Technological University, USA
email: steenkamp@ltu.edu

Abstract

In the United States schools in the K12 School System, that provide education for primary, junior and senior high school students, are moving toward information systems to solve and automate some manual processes performed in these schools. With this movement, and the pressure on schools to use technology to improve student achievement, many schools are turning to learning management systems as a way to enhance student learning. Recent surveys show that K-12 online learning is a rapidly growing phenomenon. Also, many states in the United States, including Michigan, require an online experience for all graduates. Due to the rapid growth of cloud computing and Platform-as-a-Service (PaaS) there has been a shift towards web applications in some E-Business systems. Another shift is in the way software is being delivered to the end-user, namely using the Software-as-a-Service (SaaS) model. System integration is part of the huge challenge facing K12 schools in small and large school districts. Not having an integrated system is causing schools many tribulations, such as inconsistent data, duplicate manual data entry, and extra time needed to manage user accounts, and non-productive time spent on technical support. In addition, the task of maintaining the individual systems is time consuming. Despite the potential advantages, these systems can bring challenges to schools' existing architecture. This research paper focuses on a comprehensive and innovative solution based on a conceptual framework and utilizing Web 2.0 technologies. The aim with the research project was to design a conceptual architecture for next generation of education system (E-Education 2.0), based on open source and Web 2.0 technologies, and utilizing cloud computing. This proposed solution has involved an analysis of all the business and information technology systems in the K12 environment. The solution also addresses the concerns of stakeholders by utilizing an integrated enterprise architecture, and when implemented would result in a cost effective, adaptable and scalable E-learning System. Teachers will be able to integrate information technology based features into the curriculum. Furthermore, the proposed solution provides a clear roadmap of how to transition existing individual systems into one integrated system, based on SaaS and PaaS technologies. The introduction of E-learning management systems into the mainstream K12 schools is expected to solve some of the problems in this education sector, but poses challenges such as systems integration of existing architectures. While SaaS has been widely

used and adopted in several countries, there are still barriers to entry in developing countries.

Keywords: E-Learning, Saas, Cloud Computing, Web 2.0, K12 System.

Introduction

Academic institutions at all levels are introducing Internet based technologies to enhance student learning, management and delivery of coursework (Rienzo & Han, 2009). Countries such Saudi Arabia are investing in the initiative of implementing an E-learning and looking to learn from successful experience of some other countries such as the USA, Canada, England, and Malaysia. (Ministry of Education - Kingdom of Saudi Arabia, 2008).

There has been much interest in the notion of software as a service (SaaS) as a new model for delivering software to the end user. Most of the discussion on SaaS focuses on business-to-business and business-to-consumer services (Gianpaolo, Carraro; Fred, Chong, 2006). In the education sector current implementations of supporting information technology (IT) based systems face many challenges. This is equally true in many K-12 Schools in the United States that lack funding to support their IT systems and are short on IT technical staff to manage the IT infrastructure and many applications running on it (Schooldude, 2008). This paper presents the business case for an integrated E-Learning System, addressing issues regarding E-Learning systems in K-12 Schools. It contrasts the capability to adopt such systems in Michigan, United States with that of some developing countries in the Middle-East. The challenges posed to implement SaaS in developing countries and barriers to entry are examined. The paper reports on research done on a SaaS based product for an E-learning system and presents the case for school management to consider it as a solution. A prototype of the proposed system was built utilizing Open Source Technology, Web 2.0 technology, and Cloud Computing (Basal & Steenkamp, 2009). Section 2 provides some background to the research project and presents the motivation for the study. Section 3 presents an overview of E-learning in the context of E-Business. Section 3 also describes the challenges facing schools in implementing SaaS as well as barriers to entry for developing countries in the Middle-East. Section 4 presents the systems diagram of the proposed integrated system, and Section 5 summarizes the project, the lessons learned, and offers some conclusions.

Background

In recent years there has been a large increase in Internet usage worldwide (Internet World Stats, 2009), as shown in Figure 1. From this chart it is apparent that the Middle

East and Africa are at the top of the growth trend. The Internet has become accessible to almost everyone in the world in the past decade. This trend has led to many changes in the maturity of web application technology. “IDC increased its SaaS growth projection for 2009 from 36% growth to 40.5% growth over 2008 (IDC, 2008). Also, while statistics have shown that SaaS demand is highest in North America, other countries in the Middle East, Africa, and Asia are also becoming customers (IDC, 2008). With the advancement of tools for web application development there has been a shift in the way software is acquired. The SaaS model, which is supported by a service oriented architecture (SOA) design, has led to a shift of ownership of software (Gu & Qing, 2008). Part of this research project has examined SaaS in relation to E-Learning Systems.

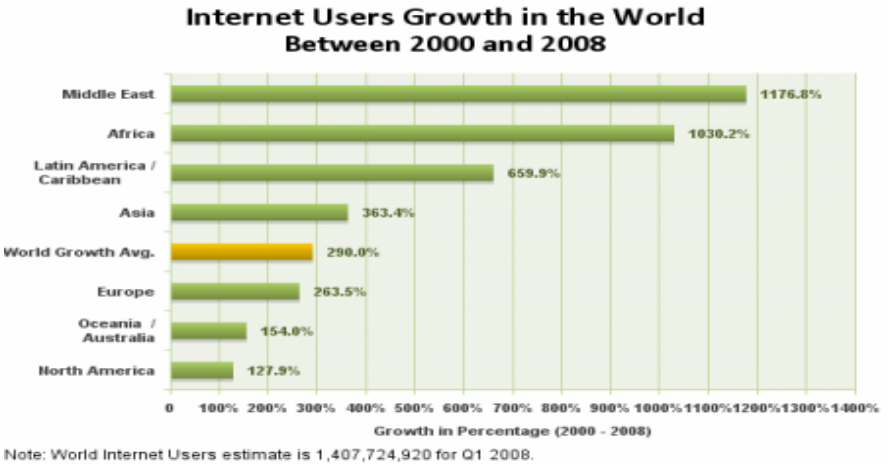

Figure 1. Growth of Internet usage worldwide.
Source: http://www.internetworldstats.com/

Need of the Study

With the rapid growth of Internet based technologies in recent years, there has been a paradigm shift toward emerging web application technologies. This includes the Web 2.0 tools, supporting Open Source Technologies, Cloud Computing, and SOA that are adopted to improve ubiquitous services to clients and their customers. Implementations of some of these technologies have been demonstrated by social networking on websites such as Facebook, Micro blogging Twitter, YouTube, Second Life and the Image sharing Flicker (Harris & Rea, 2009). One common aspect of these applications is that Web applications are moving from read-only static applications to user generated applications. Research has been done on student interest and participation in Virtual World Environments such as Second Life (Shen & Eder, 2009).

This phenomenon of dynamic interaction has been the main force behind part of this research project, with objective to analyze the features and functionality of these technologies for potential applicability in the education sector. The literature review and discussions with educators have revealed that school system have disparate information systems to support teaching, learning and school management and administration. The intent in this research has been to provide a solution that gives the users (for example teachers, school administrators) some control, with tools enabling them to generate content for the learning system, and also improving collaboration between all stakeholders (for example students with teachers, parents with teachers, school administrators with parents, and more). An early decision was made that such a learning system would be based on the SaaS model, where the school and its stakeholders take full advantage of the benefits of the model as described by Basal (2009). The goal is that a school will be able to focus its efforts on enhancing student learning supported by technology, where the technology is well integrated into the business processes and pedagogy of the school. When examining the existing K-12 Learning System in the United States one sees a strong need for teachers to enhance and enrich student learning by utilizing the capabilities of IT (Hew & Brush, 2007) . It is also apparent that K12 schools are aiming to solve some manual processes, and searching actively for solutions to enhance student learning. There have been several attempts using Open Source Technologies to enhance student learning (Dougiamas & Peter, 2003), such as Moodle, an Open Source learning management system, which is widely used all over the world (Moodle, 2009). An analysis of Moodle shows that it is an excellent learning management system for creating online courses that provide opportunities for rich interaction, but does not include tools for managing school information, leaving the burden of hosting and configuration to the end-user. While Moodle may solve some of the problems schools are facing in terms of functionality and integration, it is not the comprehensive integrated solution that schools need.

Purpose of study

When examining existing problems with systems integration related to enhancing student learning, and management of multiple school systems, it is clear that this research lies at the juxtaposition of two major issues, namely application system integration and E-Learning management systems. The purpose of this research project was to develop a solution which integrates multiple disparate application systems of schools into one integrated online system that may be accessed via a single sign-on process. The intent of this system is to utilize new web-based technologies to enhance teacher performance and student learning.

This paper addresses several questions related to integration of technology and E-learning within K-12 schools, namely

- How can an architecture approach to integrate a learning management system, student information system, content management system, and a file management system address the stated integration problem in the K-12 system?
- How can the SaaS model help faster implementation of the E-learning system?
- Why is SaaS ideal for K-12 schools in developing countries?

Overview of Focal Area and Application

E-learning in the context of E-Business.

One of the aspects of E-Learning from an E-Business perspective is that it involves multiple vendors and business customers, over and beyond the students. For example, a vendor providing a SaaS solution to a school (the end-user or customer) represents an E-business/ E-commerce transaction between the vendor and the school (known as Business-to-Customer, or B-2-C). Also, this transaction may involve other transactions between vendors themselves (Business-to-Business, or B-2-B), where independent software companies utilize the power of Cloud Computing, using Platform-as-a-Service (PaaS) and Infrastructure- as-a-Service (IaaS). Figure 2 shows the relationship of these technologies and illustrates an E-Learning System in the context of E-Business. This model has been widely adopted in recent years in the United States, after the emergence of Web 2.0 technologies and Cloud Computing (Gerard & Marinos, 2009). Typical features and benefits to the end users and vendors include:

- Fast Implementation
- Scalability to more comprehensive implementations
- The model provides a lower cost IT solution to schools by offering multiple services without upfront investment.
- Runs on an IT infrastructure with minimum investment; it usually needs an Internet connection with a web browser.
- Pay as you go approach
- Maintenance, Free upgrades and support are typically included
- Access to latest technology
- No lengthy contract
- Reduces the technical support requirements of the end-user.
- Provides greater flexibility when adopting new services.
- It offers platform independence

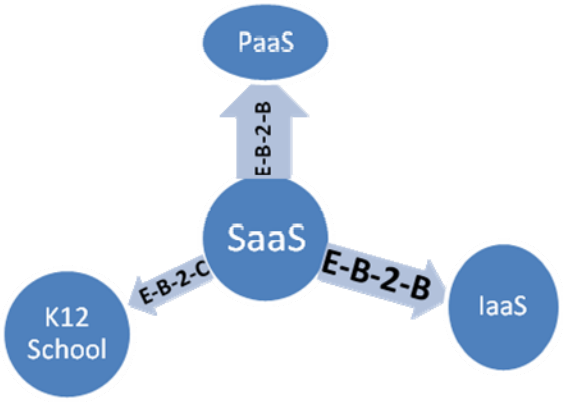

Figure 2.SaaS B-2-B and B-2-C relationship with PaaS and IaaS for K12 schools

Concerns about SaaS.

While SaaS has become popular some of the concerns are related to security when customers implement SaaS based systems. The main concern of customers is whether their data are truly secure at the SaaS site. This type of insecurity sometimes causes a deterrent for customers who wish to implement SaaS. Another issue of SaaS concerns the integration of the SaaS server. If there is no clear IT strategy in a school it might end up with several overlapping SaaS solutions that may cause duplicate and inconsistent data within the school, Such unintended consequences cause additional issues instead of providing a sound solution. Data location is another issue with SaaS, and some customers have concerns regarding how to access their data. A strong service level agreement (SLA) is needed to protect user data. One of the biggest issues with SaaS is the possibility that the end-users feel they are losing control. Some customers actually believe that by adopting the SaaS model they will lose control of their systems.

Barriers to entry in developing countries

One of the challenges of applying the SaaS model in developing countries in the Middle-East is that these countries, while classified in the category of "developing countries", vary considerably in level of IT maturity and IT enablement of business processes. Saudi-Arabia for example has invested US $3.6 billion in 2009, and this is expected to rise to US $4.9 billion by 2010, in IT communications and infrastructure (Report Buyer, 2009**).** In addition these countries have different rules and regulations, with different barriers to adopting new ITs, depending on their development status. Outlined below are some of the typical barriers that are faced in implementing SaaS in developing countries.

Infrastructure. Implementing a SaaS solution requires minimal investment in infrastructure at the client side, but does require a level of infrastructure providing a stable Internet connection. An example of the infrastructure requirements is having stable Internet connectivity between the end-user and the service provider of the solution. While Middle-Eastern countries generally have access to the Internet at this time, the connection and reliability of the connections are often unsteady. Intermittent electricity outages are experienced that cause unstable Internet connections. Such conditions pose a major barrier when planning to implement SaaS for clients.

Culture and regulation. Culture and regulations in any given country are unique and may present a barrier to adopt new technologies. Some countries require that data reside within a business location, or within the countries' boundaries. Such regulations can prevent the adoption of the latest technologies available outside of the countries' borders. Another example is that certain customers might decline to use Amazon.com services due to the fact that the organization resides in the United States.

Owning vs. Renting. Many customers in developing countries consider software from the perspective of either owning or renting. Many customers prefer to own the software but this entails unique challenges and it is important that the cost-of-ownership be calculated first. The rationale for wanting to own the software is that if the investment in the software is up front, the buyer can save money in the long run. While this may seem to be a good idea at first there is the disadvantage of not getting the latest technology offered by the SaaS model. SaaS is unique in that, while it may be rented it gives one the latest available updates and upgrades. If the software will be purchased (owned) then it is a final transaction according to the terms of the purchase. Renting gives the end-user opportunities to work with the SaaS vendor and have continuing customer care.

Government Schools. One of the drawbacks of implementing a system is that the schools are run by the government and therefore decision-making at a school must be escalated and approved by the government appointed bodies. Without government approval new IT systems cannot be implemented. While the government might approve a project, the decisions and meetings involved may be drawn out over months if not years. It is a challenge to influence governments in Middle Eastern countries about specific IT solutions that will improve their education.

Barriers from the Vendor Perspective. The vendor faces many challenges while pursuing accounts in foreign countries. One of those barriers is the lack of proper infrastructure. Also, a major concern is the lack of reliable service providers of PaaS and IaaS vendors. When a vendor is dealing with a developing country it is a known fact that the network of business and people may not be strong and reliable such as in the case of first world countries. The issue of copyright infringement is also a huge

concern for vendors. Many developing countries compromise the integrity of the software by obtaining illegal access to the source code. While copyright infringement occurs often there are few deterrents in place to prevent it from happening, and this situation is a major obstacle from the vendor perspective. Other issues are related to cultural barriers when vendors deal with customers in the different developing countries. While business as usual might be easy in the United States, business as usual might be defined in very different terms in another country. This often leaves vendors confused and frustrated while dealing business customs and culture of a developing country. It is also imperative for the vendor to learn about the culture and language, and exercise self control and patience when doing business in an environment very different from his or her own.

Potential Advantages

As many developing countries are becoming accustomed and moving towards computer information systems, they have many advantages in their favor. In particular these countries can learn a lesson from other countries which have already implemented systems in the past and had a mild to moderate difficulty in adopting their school to the new technology. The lesson which can be learned for these developing countries is that they can analyze and pinpoint problems which occurred in the developed countries, and in turn they can avoid those potential issues. This will save the developing countries time, money, and energy. An example of that is that schools in the United States are working on the area of integrating those disparate systems with different functionality and trying to connect them together and have had difficulty while trying to succeed but have worked out the major kinks and have solutions for problem solving when issues arise. So a school in a developing country can look forward to their system and transition being very smooth and easy. These schools in the developing countries will have solutions which combine multiple functionality as has been proposed in this paper.

Why SaaS is ideal for E-Learning

In this day and age we want everything right now without the wait or fuss. SaaS is perfect for E-learning because of its fast implementation. Within hours or just a few days SaaS is up and running alleviating the need to wait. Also, SaaS lessens the burden of maintenance and support from the school to the vendor, allowing schools to focus on their core business. Instead of multiple areas of the school being focused on the school management system and trying get it to function to meet their needs, secretaries, librarians, and teachers can focus on what really counts; the education and betterment of young minds which will lead the future. Furthermore SaaS is perfect for E-learning

since schools will receive the latest updates and features without any extra financial obligation.

Another advantage with SaaS is that it helps administration and teachers to share key resources all with the simple click of a button, using Web 2.0 technology.

To understand this better we can look at a small school in Jordan. With the software service model, this school can utilize the latest software solution with a minimal amount of cost and infrastructure to benefit from these solutions. This system is the same solution being used by the most advanced and successful schools in the world. With SaaS this small school in Jordan with its 200 students and 20 staff will be able to have a system which can be implemented within hours or days and the only requirement they will have to have is a stable internet connection. Once the system is implemented, they will continue to receive the latest updates and features, since technology is always advancing and changing. This will be convincing for this school is Jordan since the updates will not incur any further fees. This ideal for a developing country like Jordan, in order for this country to be able to place its money in other necessities needed to make it stable.

Research Approach

A positivist-empirical research approach was followed for the project, based on observation and interventions using several methods (Remenyi et al., 1998; Curtis and Cobham (2002) . This approach is appropriate for research into the phenomena, processes, and behaviors that form part of the K12 educational environment. The action research paradigm formed part of the research approach since the primary author was engaged in the domain of discourse, and participated actively in all the research processes. The research life cycle is illustrated in Figure 4. It depicts the research processes that were conducted, and is explained in detail in another research paper by (Basal & Steenkamp, 2009).

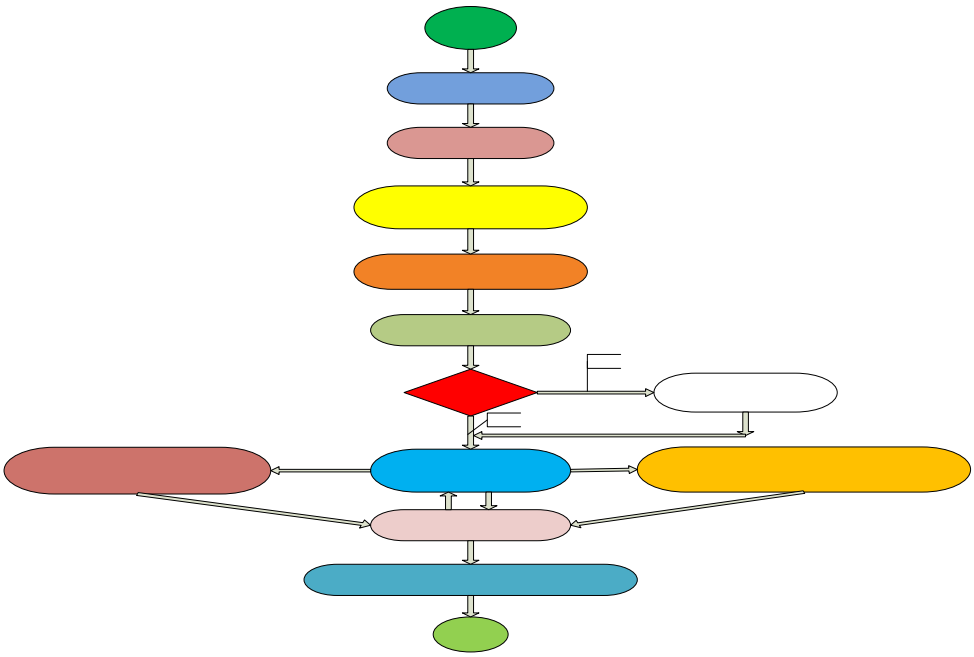

Figure 4. Positivist-Empirical life cycle.

The architecture approach followed to redesign the E-Education System architecture consists of the following key tenets: the principles guiding the architecture (including overarching principles of the education domain of discourse, and architecture viewpoint principles for each viewpoint of concern); the architecture meta framework used when performing systematic viewpoint analysis; the architecture process model and the supporting architecture methodology that is followed (Steenkamp, 2007).

Overarching principles pertinent to this research are:

- Interoperability
- Scalability
- Adoptability
- Ease of Use
- Affordability
- Use software as service for delivery model
- Service oriented architecture
- Use of open source technology
- Use of object oriented methodology

Proposed System

This section presents the high-level architecture of the E-Education System, the functionality of the proposed system and the context diagram of the web technologies utilized for the prototype.

Figure 3.Typical ESIS, LMS, CMS, and FMS functionality in K12 schools

The proposed solution combines the four pillars of a typical K12 system into one integrated solution with features that eliminate overlapping functionality, enhance data consistency by having one source of data, and also provides a cost effective solution by eliminating the separate solutions from different vendors. The ability to access the system using a single-sign-on enables the end-user to access the system, and manage all functionalities according to responsibility and authority

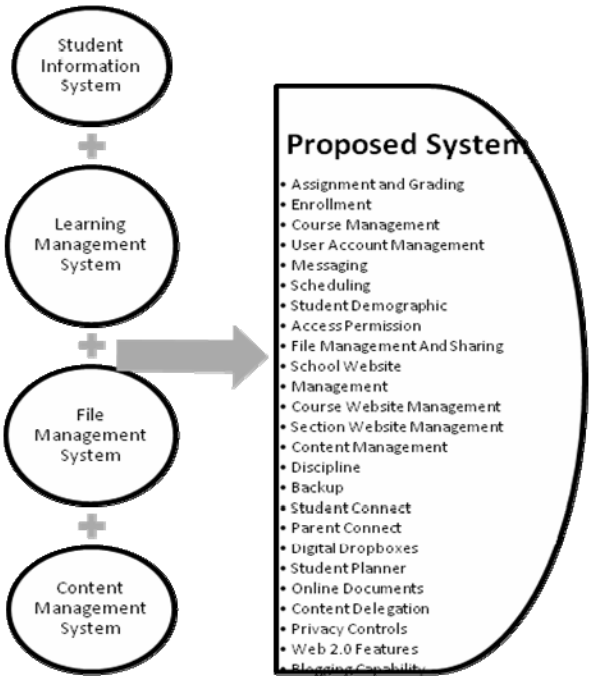

Figure 4. Functional systems of the integrated E-Education System.

The expectation is that the proposed solution will help education authorities in developing countries in the following ways:

- Reduce the cost of ownership of software solution by eliminating the purchase of individual system and integration cost to connect these systems.
- Increase the number of educational websites by providing every district, school, teacher, and course within a province region with website to enhance student learning.
- Allow family and community involvement through a school website and Parent Connect.
- Improve teachers' ability in a school to communicate, monitor student progress
- Improve the school administration's ability to manage multiple systems from one integrated E-Education System.
- Encourage and increase sharing of resources and best practices.

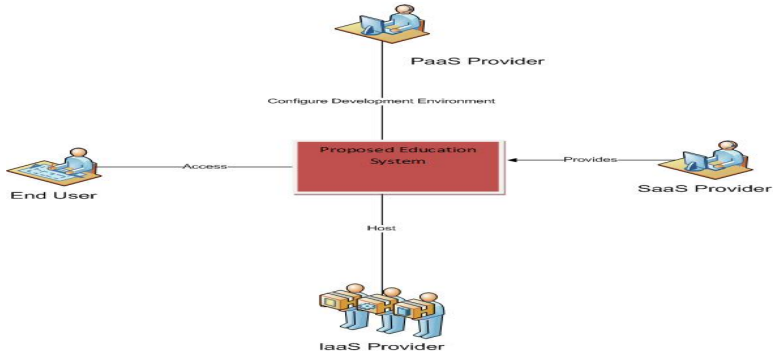

Figure 5. SaaS based E-Education System

SaaS architecture

Figure 5 shows the proposed system is being delivered using the SaaS model. It utilizes Cloud Computing Technology, where the system is being configured from the PaaS Provider and hosted from the IaaS provider. All this is being done on the "Cloud". This model shows that this architecture requires that the end user only use an Internet browser to access the E-Education System.

Summary and Conclusions

This paper has considered the IT enabled of K-12 learning systems in the United States, and found that there is a strong need for enhancing and enriching student learning using Web 2.0 technologies. It was also found that schools have disparate information systems to support school administration and management. This paper

reports on part of the research project, namely the business case for an integrated E-Education System, based on SaaS in K-12 schools. Also, the paper describes at a high level an integrated solution of a learning management system, student information system, content management system, and the file management system into one system delivered via the SaaS model. This integration utilizes Cloud Computing, Open Source, and Web 2.0 technologies. The literature review revealed that there are considerable barriers to entry into developing countries of this type of SaaS model. There are numerous potential advantages for developing countries if they choose to implement SaaS.

It is recommended that future research should focus on how to overcome the barriers of entry of the new Internet based technologies into developing countries. Furthermore a topic for research is to examine how to best initiate and implement the integrated E-Education System by collaborating with education authorities in a developing country.

Acknowledgements

The authors of this paper acknowledge Global Educational Excellence (GEE) by providing their support and use of k-12 school campuses to perform the action research.

References

Aulbach, S., Grust, T., Jacobs, D., Kemper, A., and Rittinger, J. (2008). Multi-tenant databases for software as a service: schema-mapping techniques. In Proceedings of the 2008 ACM

Basal,A .(2009). Service Oriented Approach in Information Technology Enabled Education Systems

Basal, A. and Steenkamp, A.L. (2009). An Integration Approach to IT Enabled K12 School System, submitted to ISECON2009, Washington DC, United States.

Curtis, G. and Cobham, D. (2002). Business Information Systems: Analysis, Design and Practice, 4th edn., Pearson, Essex.

Dougiamas, M., & Peter, T. (2003). Moodle: Using Learning Communities to Create an Open Source Course Management System. Journal of Educational Multimedia and Hypermedia , 171-178.

Fruth, L., Larry, C. a., Michael, S., & Elizabeth, L. (2007). The Right Data to the Right People at the Right Time:How Interoperability Helps America's Students Succeed. Council of Chief State School Officers and Data.

Gerard, B., & Marinos, A. (2009). Digital Ecosystems in the Clouds:Towards Community Cloud Computing. in Digital Gianpaolo, Carraro; Fred, Chong. (2006, October). Software as a Service (SaaS): An Enterprise Perspective. Retrieved July 17, 2009, from MSDN Architecture Center: http://msdn.microsoft.com/en-us/library/aa905332.aspx

Ecosystems and Technologies Conference. IEEE Press, 2009.

Gu, Q., & Lago, P. (2008). SOA process decisions: new challenges in architectural knowledge modeling. ACM Special Interest Group on Software Engineering , 3-10.

Hew, K. F., & Brush, T. (2007). Integrating technology into K–12 teaching and learning: Current knowledge gaps and recommendations for future research. Educational Technology Research and Development , 223–252.

Harmon, P. (2003). A Manager's Guide to Improving, Redesigning and Automating Processes. Morgan Kaufmann.

Harris, A.L. and Rea, A. (2009). Web 2.0 and Virtual World Technologies: a Growing Impact on IS Education, Journal of Information System Education, Vol. 20(2).

IDC. (2009, August August). Retrieved August 12, 2009, from IDC: http://www.idc.com/

internet world stats. (2009, July). Retrieved August 12, 2009, from internet world stats: http://www.internetworldstats.com/

M. A. Roth, D. C. (2002). Information integration: A new generation of information technology. IBM System Journal , 563.

Mahmoud, Q. H. (2005, April). Web Services. Retrieved 11 1, 2008, from sun microsystem: http://java.sun.com/developer/technicalArticles/WebServices/soa/

Mark, G., & Cindy, G. (2006). Integrating Technology For Meaningful Learning. 2006.

Remenyi, D., Williams, B., Money, A. and Swartz, E., 1998, Doing Research in Business and Management, Sage, pp.73.

Rienzo, T. And Han, B. (2009), Microsoft or Google Web.0 Tools for Course Management. Journal of Information System Education, Vol. 20(2).

Shen, Jia and Eder, L.B. (2009), Intentions to Use Virtual Worlds for Education. Journal of Information System Education, Vol. 20(2).

Steenkamp, A.L. (2007), An Approach to Developing IT Architectures, The Open Group Enterprise Architecture Practitioner' s Conference, San Diego.

Report Buyer. (2009, August 18). Retrieved August 18, 2009, from Report Buyer: http://www.reportbuyer.com/computing_electronics/country_overview_computing_electronics_/saudi_arabia_information_technology_report_q1_2009.html

Schooldude. (2008). Retrieved July 15, 2009, from Schooldude: http://www.schooldude.com/elements/media/article_file/The_Unique_Challenges_Facing_the_IT_Professional_in_K12_Education.pdf

The Open Group (2009). TOGAF Enterprise Edition 9. Retrieved June 29th, 2009 http://www.opengroup.org.