CLOUD-BASED E-LEARNING SYSTEMS

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Abstract Educational technologies are evolving rapidly and are closely following the progress of ICT. Today we are increasingly talking about using cloud computing as a new paradigm in e-learning. They offer very efficient use of different resources, adaptability, flexibility and can significantly reduce costs. The work deals with the types of cloud services, incl. E-Learning SaaS, as a model for offering e-learning applications. The main advantages and limitations of using this kind of applications in the context of the Bulgarian educational system are identified. A brief comparative analysis of some of the most popular Cloud-based e-learning systems has been made.

Keywords: cloud-based e-learning systems, cloud computing, e-learning systems.

Introduction

Education today has an increasingly important role both for the economic and social development of each country. Especially a key role will be played by countries such as Bulgaria, which are experiencing some transformation at all levels and in many directions, and must catch up with the highly developed countries in many spheres of life. The necessary changes in the field of education are related to quality enhancement, use of modern technologies and tools, for example e-learning systems and investment in the development of learning resources. Undoubtedly, in order to increase the quality of education, it will be necessary to invest in human capital (qualification), but also a drastic increase in the cost of hardware, software and information services offered by educational institutions. They should, in turn, step up efforts in order to address issues such as: reducing overall costs of information infrastructure, enhancing the security of information systems and data, using the latest developments in the field (hardware, applications, networks), offering - a great number of information services, incl. for e-learning and others.

Many of these problems can be solved by using cloud computing, both for hardware and software needs, through the implementation of Cloud-based e-learning systems.

Cloud computing is a model of providing computing resources (computer network, servers and applications) and information services called cloud services. They are characterized by easy and quick setup and that they do not require significant resources for administration and maintenance.

Cloud computing can be implemented in different ways, defining the provider of this service. Many of the leading IT companies such as Google, Amazon, Microsoft, Apple and Bulgarian Daticum offer their users services like: file storage, messaging, authentication, vipCloud (Virtual Private Cloud), and more.

Cloud Services

The cloud is an environment for providing certain services over the Internet. These services can be anything - from hiring space to store files to applications like e-mail.

All these services can be provided to users in three basic models (Tavkova et al. 2016: 157-158) shown in Fig.1
Fig. 1. Cloud service models

- Infrastructure as a Service (IaaS) - in this model for the user are provided resources such as CPU time, computer memory, computer network. Examples for such services are Amazon EC2, Windows Azure, Rackspace and Google Compute Engine.

- Platform as a Service (PaaS) is a category of cloud computing services that provides a platform allowing customers to develop, run, and manage applications. Examples for such services are Microsoft Azure, Apprenda Platform and Apache Stratos.

- Software as a Service (SaaS) - in this model the cloud tenants pay for the use of certain software application hosted in the cloud. Examples for such services are Salesforce, Microsoft Office 365 and Google Apps.

The development of these services makes it possible to use them in education using innovative models of teaching, training and evaluation, including quality (Hadzhikoleva & Hadzhikolev 2016: 368) by creating learning environments that can integrate different cloud services and resources into learning. Such services are known as E-learning Software as a Service (E-Learning SaaS).

E-Learning SaaS can be defined as a model of offering e-learning applications and services to multiple users over the Internet using remote data centers. The model provides a number of benefits especially for medium-sized educational institutions, such as low total costs, rapid return on investment and a very short implementation period in the training process.

Today there are many providers of E-Learning SaaS services, but not Bulgarian. Bearing in mind this background, some of the problems (quality, accessibility, availability, independent assessment, etc.) in the education in Bulgaria can be solved by some financial investment of either by the Government or the educational institutions (why not?) for
development of a single national Cloud-based e-learning platform. Because of the specifics of the educational system in Bulgaria, such a platform can quickly find a place in secondary education as it has a high degree of regulation. The higher education system is also applicable, but paid applications can also be used due to institutional autonomy. The main advantage of developing and implementing a unified system is the ability to negotiate preferential prices with cloud service providers or the lower cost of private cloud support.

**E-learning systems**

E-learning systems are software systems designed and built to provide online training services. They are used to plan, conduct and evaluate a learning process. In other words, software used for online learning that helps in administering, documenting, tracking and analyzing the whole learning process. Another feature is the support of online collaboration through the Internet. Both educational institutions and companies use them to provide online training. Businesses use them for training purposes as well as for keeping records / employees' portfolios. Educational institutions use them to offer training courses that provide students with access to study materials, assignments, evaluation, and more.

In addition, they are also used to enroll and administer courses, analyze learner achievements, track the training, assess the quality of learning (Totkov et al. 2016: 21), statistics and more.

For example, e-learning systems are successful in applying and assessing the knowledge, skills and habits of learners in our country. The experience of the University of Plovdiv shows that physics (Atanasova & Totkov 2015a: 45) and English (Atanasova & Totkov 2015b: 362), for example, are used by integrating test units (TEs). Currently, lecturers create tests and TE based on their professional and personal experience. E-learning systems provide the opportunity to create banks with templates that will facilitate the process of generating tests and reduce the subjective factor. The proposed databases with test questions allow for facilitating teaching and refining the evaluation process.

E-learning systems can be used successfully for training in all scientific fields. In our country, they are successfully used in almost all higher education institutions, with some using open source systems, e.g. Moodle (Totkov & Doneva 2014: 107), and other commercial software, e.g. Blackboard (MU-Varna 2017).

**Advantages and limitations of using Cloud-based e-learning systems**

Here we will try to identify the main advantages and limitations of using Cloud-based e-learning systems. The presented material here is not considered to be thorough, but an attempt has been made to look through the prism of the Bulgarian educational system with its specificity.

**Advantages**

Perhaps the most significant advantage lies in the fact that the cloud provides *access to all data at any time.* Cloud services are characterized by the fact that they offer practically constant services. In eLearning systems, such data concerns the institution itself, the faculty, the administrative staff, the training department, etc. for students such as learning materials,
assessments, administrative documents of any kind (academic notebooks, requests, assurances, academic references, etc.), including personal and others, such as emails or messages. In Bulgaria, most of this data is still paper-based or not available on the Internet. In our country, secondary school textbooks are on paper, which involves students carrying them from home to school and back every day. Let us give another one simple example. For many students who live in big cities, they have to prepare school and university assurance every year in order to use them when they receive discount urban and rail transport cards. If current student and student data is available, by a cloud-based web service for example, the necessity to issue paper assurances is reduced. This access also allows more effective use of learning time as materials are available at any time, working on assignments or projects from different locations, which further enhances collaboration.

Cooperation is one of the main paradigms in education. It allows working in a heterogenic group, thus assisting in the training of each individual learner. Learning through collaboration leads to a positive interdependence of group members, accountability of individual contributions and appropriate use of cooperative skills (Schaffert et al. 2006: 8). Learners who work in teams achieve higher levels of information retention than those who work alone (Johnson & Johnson 1986: 32). In the Bulgarian context, this learning approach is not as well integrated as in other countries and is often underestimated often and for objective reasons as (Simone 2017) notes.

In a cloud environment, collaboration is extremely well-developed using various software tools such as Alfresco hybrid cloud, CollaborateCloud, Adobe Buzzword, Dropbox, or Google Docs. It may consist of working on a project, document, presentation, course work, scientific publication, etc. Some of these tools are free or low-priced for academic institutions and can be used by anyone with a basic knowledge of information technology.

Developers also have the opportunity to use the cloud services presented above, embedding them in their own eLearning applications, through the tools available such as the Google Docs API, as demonstrated by (Al-Zoube 2009: 62).

Since there has always been a trace in such systems, which user and when has worked on the documents, the concerns that some teachers have in terms of the contribution of everyone, can partially be eliminated.

The cloud allows information to be easily stored for a prolonged period (potentially forever) of time and be updated and analyzed at any time. So e-portfolios can be created for everyone.

The e-portfolio is a repository of information about the individual learner provided by him / her or an organization. This information may be documents or other objects that can be presented as an evidence of the learner's claims for his / her knowledge, achievements or skills (Lorraine et al. 2007: 9). The publication of the e-portfolio or part of it in the web space also enables potential employers to get acquainted with the acquired knowledge, skills and competences of the trainee. In our country, maintaining an e-portfolio for each student or student can help with relocation / transfer between educational institutions and / or other organizations of this information without the learners having to provide it on paper (there is a risk of falsification or it may be Already obsolete) and often pay a fee.
Taskstream offers the Learning Achievement Tools (LAT) software solution, which includes a cloud-based e-portfolio service which allows lecturers to collect and evaluate students' work and report on learning outcomes; Academic programs and departments are able to evaluate curricula and meet institutional assessment needs, and students can store, select and present their works that can be stored and published in the e-portfolio (Taskstream 2017).

Next, a great advantage is the ability to access the system by any type of device. In modern environments, where every pupil or a student has a smartphone or tablet, mobile access is extremely important. The use of mobile applications in training is now a necessity and they are used not only for access to learning materials but also for reports, collaboration, feedback and quality evaluation. According to a study by (Statista 2017) in the US about 60% of students use smartphones in class.

Cloud-based solutions are characterized by the fact that they offer mobile access in general without having to develop separate applications. There are also many mobile applications like Google Drive, Dropbox, SugarSync or iCloud that offer mobile access to digital resources.

Next, what is being increasingly discussed and considered as a main priority, is security. The security of information and information systems today is critical. Every day, both large organizations and regular users are often attacked, with significant consequences. In the sphere of education, a large amount of information is collected, stored and processed, including those protected by law. These are the personal details of each teacher, student, or others. A brief reference to the organizational structures of the educational institutions in Bulgaria shows that there are no specialized information security units to develop and implement policies for the protection of information and systems and to transfer these activities to the system administrators. This approach leads to dilution of responsibility and serious risks. A sparse proof of this is the case that has recently become popular, when a student has tested the Ministry of education information system of the Ministry of Education and Science and received unauthorized access to accounting documents, the personal data of all students, diplomas, assessments, and other documents (Segabg 2017).

Cloud-based systems are also susceptible to various attacks, such as phishing, service shutdown, data loss, or password weaknesses (Yanpei et al. 2010). However, they are significantly more secure than a breakthrough for several reasons. Let us first look at the security of so-called DoS and DDoS attacks. Many cloud service providers offer safe protection against this type of attack, as noted by (Chen-Chi et al. 2016: 28). Another reason is purely technical, namely that they offer, service and maintain within 365 days, 24/7 of highly qualified professionals who can react immediately. Next comes the timely updating of systems, guaranteed backup and fast recovery.

Last but not least, their data is often encrypted on the servers (Google Cloud Storage 2017, Dropbox 2017, Tresorit 2017). It can be encrypted with embedded media API, or allow the use of third party tools such as Cloud Encryption Gateways (CipherCloud 2017).

Using cloud-based services also leads to resource efficiency and cost reduction (Jadeja & Modi 2012: 879). For some estimates, Total Cost of Ownership (TCO) may decrease to 1/3 (Longoria 2016). The use of this type of training in Bulgaria can lead to cost reductions
(capital, operational and indirect) in several areas. At first, what you need is only paid and, if
necessary, additional resources are paid only for the increase. On the other hand, the situation
is the same if temporary resources are not needed at present, but a lower tariff plan may be
used. In Bulgaria, many educational institutions in projects, donations or through state
funding acquire hardware and software, which in many cases are not fully utilized. In a few
years, these assets have become obsolete and new ones have to be acquired, which increases
capital costs, as opposed to cloud-based systems where the service provider invests in new
hardware and software. Operating costs may also decline - from electricity, security and
administration costs for maintenance and repair. In addition to capital and operating expenses,
organizations also have other costs that affect their operations. Such costs are related to
downtime due to system denial, increased time for going online or missed benefits.

Other benefits that can be derived from the educational institutions in our country are:

- Easy deployment and maintenance - no need for each institution to have its own IT
department;
- Increasing the efficiency of the work of the administration, academic department,
teachers, etc.;
- Standardization - import / export support for industry standards SCORM, AICC, xAPI
;  
- Reliability - proven technologies, rich experience and growing applications.

Limitations

Although cloud-based systems for e-learning have indisputable advantages they have
some limitations that can be very important in the context of the education system in the
country.

Firstly, we need to pay attention to the quality of services offered by the provider of
such services. As services are offered on remote servers, the system may stop working
suddenly and without warning. Even the largest service providers like Google happen to stop
an everyday operating a service though, like showing the publications of site users
(Downdetector 2017). For some users this suspension of services may prove to be critical. For
example, in a system of e-learning if the student has to do a test Assessment for final
evaluation and it should be done in a limited time period, for example 30 minutes. Stopping
the service even though for a few minutes, it can be fatal and proving such a problem becomes
very difficult. Since distance learning has been introduced, cases like this should be
considered carefully and appropriate regulations should be taken.

Next legal problems may arise. (Van Eecke 2017) outlines six legal challenges:
liability, applicable law, compliance, data protection, copyright and data portability. In a
situation where the service is available from anywhere in the world a number of questions
arise, such as:

- Who is responsible?
- What rules to apply?
- Which is the competent court where legal cases are being solved?
At present, in our country there is not adopted legislation referring to cloud services and relying on regulations across multiple regulations. (Krusteva 2015) gives the example for problems in the protection of personal data stored in the cloud, concluding that there is a risk of disclosure and misuse of personal data and consumers’ rights being impaired.

Paradoxically, the cost can also be an obstacle to the deployment of cloud-based systems for e-learning in the country. These have already been presented as an advantage, but it all depends on the size of the organization. Although it is difficult to be able to calculate with a high degree of reliability, short calculations (see. Table 1) up to three (3) years shows that if the organization is small, its cost can be reduced and this is an advantage. The greater the organization is, the more likely for the costs to be very high, which is a disadvantage. In comparison, the cost will assume that the average monthly subscription in cloud-based system is 2 US dollars per person. For traditional free web-based system (eg. Moodle) for e-learning, as used by most educational institutions in the country, let's assume these costs are also in US dollars:

- Hardware - servers - 10 000, network devices - 2 000, UPS - 3000;
- Software - Linux OS - free, Windows server - 2000;
- Electricity - 6 000
- Salary of 3 administrators - 60,000;
- Maintains - 1000;
- Other – 1000.

<table>
<thead>
<tr>
<th>Number of users</th>
<th>Cloud-based system for e-learning</th>
<th>Web-based system for e-learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>~ 72 000</td>
<td>~ 85 000</td>
</tr>
<tr>
<td>5000</td>
<td>~ 360 000</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Estimated costs in US dollars for three (3) years.

These calculations show that in our country the use of cloud-based system for e-learning is financially profitable for educational institutions of up to 1,000 users (students, teachers, other faculty staff).

**Short comparison of software solutions for cloud-based e-learning**

So far, we have shown what can be the advantages and limitations of using cloud-based systems in the country. Now we will try to do a brief comparison of five well-known used successfully by many organizations. The comparison will be done in terms of teaching: courses and schedules, users, roles, communication, evaluation, standardization, multimedia and more. The results are presented in Table 2. For objective reasons (time, financial, human resources, changes in systems, etc.), this might not be a meaningful comparison of the systems, and Internet sources have been used (GetApp 2017, Docebo vs. Blackboard 2017).
Such comparisons have been found, which are classified for the purposes of the study. The systems are evaluated positively or negatively depending on the quality of the features.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Adobe Captivate Prime</th>
<th>Blackboard Learn</th>
<th>Docebo</th>
<th>Litmos</th>
<th>TalentLMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing users, roles, groups</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Managing courses</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Managing assignments</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Assessment</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Support learning calendars, plans</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Managing activities in course</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Advanced learning techniques (like Collaboration, Gamification)</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Messaging and notifications features</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Generating reports</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Support LMS standards - SCORM, AICC, xAPI</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Multimedia / streaming</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 2. Comparison of cloud-based systems for e-learning

<table>
<thead>
<tr>
<th>Costs / Price</th>
<th>-</th>
<th>-</th>
<th>-</th>
<th>+</th>
<th>+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Social networking</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

**Conclusion**

E-learning enables integration of modern ICT in education. Cloud computing and the services provided by them, suggest a new tool to move training forward into the next level. The specifics of the educational system in our country allows successful introduction of cloud-based systems in the training. The advantages refer to providing high quality educational services anywhere and onto any device, cost reduction, collaboration, high level of security and others. The educational institutions in our country may face some difficulties in terms of gaps in the regulations, high costs if the consumers are a very large in number, the quality of cloud services offered by smaller suppliers and others. A good solution for the educational system in our country would be developing a single cloud-based environment for e-learning financed by public funds, which will be used by everyone. The brief comparison of the market imposed systems of this type, which we have made, shows that they offer similar in number and quality services, but differ mainly in terms of integration opportunities, maintenance of social media and price.

**Works Cited**


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