

Towards Building Cloud Education Networks

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Abstract – The article outlines the trends and prospects in higher education happening as a result of internationalization, as well as the possible risks and challenges. The training capabilities of cloud computing are examined. A review has been done of specific cloud services suitable for organizing and conducting educational and administrative activities. Some trends have been outlined, such as the probable consequences of building institutional education clouds and the opportunities for interoperability between them. The opportunities for building cloud education networks and their main characteristics are explored.

Keywords – cloud education networks, internationalization of higher education, education cloud, cloud training.

1. Introduction

One of the topical issues in the European Union (EU) in recent years is the modernization and internationalization of higher education (IoHE). A number of organizations and institutions are focused on conducting surveys and analyzes, developing strategies and projects related to higher education (HE) - Rethinking Education: Investing in skills for better socio-economic outcomes [3], Internationalization in European higher education: European policies, institutional strategies and EUA support [1], Internationalization of Higher Education [2], Making European Professional Higher Education a Key Player in the Development of a Fastly and

Unpredictably Changing Society [5], Trends 2015: Learning and Teaching in European Universities [6], Standards and Guidelines for Quality Assurance in the European Higher Education Area [4], etc. They are all focused on the development of higher education as a basis for the training of highly qualified staff to build a knowledge-based economy in order to achieve smart, sustainable and inclusive growth.

Internationalization in HE is done in different ways. The following forms are widely used: student and teacher mobility, internationalization of the curricula and the programs, joint programs, dual degree programs, internalization at home, where students from a higher education institution (HEI) are trained on foreign programs (borrowed from foreign universities) etc. They have a positive impact on various objects and subjects of the educational process. Generally, they are based on long-term agreements between the educational institutions, regulating specific relationships and focused on cooperation without stimulating competition.

The main challenges faced by educational institutions are the establishment of new (open and more flexible) forms of cooperation which:

- **provide opportunities for improving the quality of offered educational products and services** by pooling HEI resources to replace, improve or integrate educational components;
- enable the **creation of innovative, business-orientated educational products** through flexible short-term cooperation between HEI, business organizations and research centers, depending on the specific needs and situations;
- **provide opportunities for attracting learners** by offering educational products in an international environment;
- **are technologically supported**, which allows **pooling and sharing of available educational resources and technologies**, thus it is possible to provide additional resources - software or infrastructure for a certain period of time, in unlimited quantities, with a pay model according to consumption (pay-as-you-go) etc.

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2. Internationalization of higher education. Benefits and risks

European University Association (EUA) is the largest and most representative organization of universities in Europe. By early 2016, it brought together 850 members from 47 countries. A study conducted by EUA in 2013, involving 175 HEIs from 38 countries, has highlighted the tendency of HEIs to turn to internationalization. 56% of educational institutions have indicated that they have a strategy for internationalization, 13% are planning to develop one and about 30% respect internationalization in other strategies. Another interesting result is that all institutions except one report that their strategies have had a positive effect on the internationalization of their institution, especially in terms of developing partnerships, outgoing student mobility, teaching English, attracting foreign students and the development of opportunities for staff mobility [1].

A survey commissioned by the European Parliament's Committee on Culture and Education and conducted in 2014-2015 outlines some key trends in higher education. There is **growing importance of internationalization at all levels** (broader range of activities, more strategic approaches, emerging national strategies and ambitions). Governments are beginning to see the IoHE as part of a larger strategy for positioning the country, improving the economic situation, giving new impetus to the higher education system or making the necessary changes. In HE we can observe an **obvious shift from (only) cooperation to (more) competition, the focus being on internationalization of curricula, transnational education and digital learning** [2].

Internationalization brings many benefits to educational institutions. This includes increasing the qualifications of teachers and administration, raising the level of educational and research output, having a positive effect on the quality of training, motivating the improvement of curricula, helping to build a better image of the educational institution etc. [13]. From the point of view of the learners, the benefits are improvement of overall training, increasing of language skills, opportunities to learn in a multicultural environment. Developed countries can benefit from brain drain and the generation of additional revenue [12].

The main risks of internationalization are commercialization of educational programs, increase in the number of foreign "degree mills" performing low-quality education, as well as brain drain. Other risks are the loss of cultural and national identity and the unification of curricula [9]. The pursuit of educational institutions for a better rating in many

international and regional rankings has led to a shift in focus – from building capacity for conducting qualitative training to building an image of an institution that conducts qualitative training. The acquisition of joint degrees in some cases is simply a double count of training in certain courses, without leading to rich international academic experience or opportunities for better professional realization of learners [10]. Some researchers even believe that the internationalization age is coming to an end [11].

Despite the potential risks, **internationalization provides a number of tools to improve the educational space of higher education**, which directly or indirectly improve the quality of training and research. This includes: enhancing the qualifications and language competencies of academic staff and learners; increasing professional contacts and the opportunities for conducting joint research and research projects; improving the quality of educational resources, curricula and programs etc.

3. Cloud computing as a tool for supporting education

In recent years, more and more educational institutions have started using cloud computing. This is a model that allows pooling of the physical resources and their virtualization, whereby the available physical resources can be used and managed more efficiently and more flexibly.

The US National Institute of Standards and Technology (NIST) defines cloud computing reference architecture which includes 5 types of actors: Cloud consumer, Cloud provider, Cloud broker, Cloud auditor and Cloud carrier. A cloud provider delivers different types of cloud products and services, a cloud consumer uses them, a cloud broker mediates between the provider and the consumer, adding value to the services, a cloud auditor performs an independent audit of cloud services, and a cloud carrier is responsible for the transport of the cloud services [15].

NIST defines **3 basic models of cloud computing usage** - Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) [14]. **IaaS** is a model where users can hire virtualized hardware resources - virtual machines, virtual memory, virtual infrastructure - and use them according to their own needs, leaving the service provider to look after the hardware resources involved. **PaaS** enables users to hire virtual machines with different operating systems, applications, application development environments, databases, etc., and also to install and develop their own applications. The **SaaS** model has the highest level of integration and allows hiring of software applications. The user has the right to use the

software, and the service provider takes care of everything else - from infrastructure to the proper functioning of the application.

There are many and varied **cloud services suitable for organizing and conducting the educational process**. Some of them are free, which leads to their extensive use. Table 1 shows services suitable for use by educational institutions.

Cloud computing gives new perspectives for education in the developing countries (third world countries). Their main problems are related to poor government funding of the education sector, lack of buildings and infrastructure suitable for conducting HE activities, high migration of qualified teachers, lack of educational materials (books, software, technical means) etc. [17].

Table 1. Cloud services suitable for training

Features	Product Name
Office tools – working with documents, spreadsheets, presentations, diagrams	Google Docs, Sheets, Slides and Drawings; Zoho Writer, Sheet and Show; MS Office Online: Word, Excel, PowerPoint; Prezi
Storage and sharing data	Google Disk, Docs.com, OneDrive, Dropbox, aDrive, Box (Box.net)
Video and image hosting	Youtube, Picasa, Yahoo Flickr
Surveys and analyzes	Google Forms, Zoho Survey
Creating websites	Google Sites, Zoho Sites
Video and voice communication	Google Hangouts, Zoho Meeting, Skype
Translation in different languages	Google Translate
Project management	Zoho Projects, Replicon, Easy Redmine, eXo Platform, Basecamp, Freedcamp, Inflectra
Team collaboration network	Zoho Connect
Programming environments and database management systems	Amazon AWS, Google App Engine, MS Azure, Red Hat OpenShift, AppFog, Engine Yard, Heroku
Administration of virtual machines and networks	Amazon EC2, Vmware, Google Compute Engine, IBM SoftLayer, Oracle VirtualBox, MS Azure, Rackspace
Learning management systems	TalentLMS, Mindflash, Docebo, Litmos, LatitudeLearning, Haiku

An interesting successful experiment in this direction was conducted by Sugata Mitra. He created "School in the cloud" (<https://www.theschoolinthecloud.org>). He was guided by the humane idea of providing opportunities for education in poor regions where there are no schools and children have no chance to attend educational establishments. The main concept is to enable children to learn from each other by actively using cloud services.

To improve higher education by means of cloud computing, HEI needs to take several steps. This includes stepwise introduction of cloud computing courses to increase learner skills in this area, usage of cloud environments and virtual Labs for eLearning, and measuring the effectiveness of the training [7]. In 2011, Mircea & Andreescu proposes a cloud adoption strategy for higher education which summarizes the experience gained in this area and includes the following activities [8]:

- developing the knowledge base about Cloud Computing;
- evaluating the present stage of the university from the point of view of the IT needs, structure and usage;
- experimenting the Cloud Computing solutions;
- choosing the Cloud Computing solution;
- implementation and management of the Cloud Computing solution.

It is important to note that **cloud computing adoption** hides a number of risks and challenges. The main ones are summarized in [16]:

- **Security.** Cloud providers must ensure security, including availability, confidentiality and integrity. It is necessary to define security policies that meet the requirements of the educational institutions.
- **Privacy.** It is necessary to protect against unauthorized access to sensitive data.

- **Lock-in.** Danger of vendor lock-in, which makes it very difficult to switch to another cloud service provider or to on-premises traditional IT systems.
- **Reliability.** Reliability is a key factor in the success of a technology. Failure of a system or service may affect the learning schedule for the classes.
- **Internet bandwidth.** The quality of the internet connection is an important factor for the successful use of technology. The lack of an Internet connection may fail the education process.

Despite the many risks, cloud computing has revealed very attractive perspectives to education. The opportunity to use software, platforms and infrastructure as a low-cost service enables low-budget HEIs to compete with major universities. **The advantages of using cloud computing in learning are many**, the more important ones being:

- no need of major initial investment, for example for purchasing hardware, software licenses, operating systems, etc.;
- opportunity to use the latest software and hardware technologies without having to own them;
- cloud services can be requested and used at any time in unlimited quantities;
- services are only used for a certain period of time - when the educational institution needs them;
- payment is according to consumption, based on the resources used - memory, processors, virtual machines, etc.

4. Educational clouds. Interoperability of educational clouds

A study of research papers on "cloud in education", published from 2012 to 2015 in IEEEExplore, ACM, Science Direct and Springer, outlines the most researched macro themes. These include: Virtual laboratory; E-learning, models proposal; M-learning; Virtual environments for collaboration; Digital campus; Assessment and others [23]. The variety of these topics outlines the various perspectives that are of interest to the HEI.

What is an educational cloud? Here we will give an informal definition without claiming to be exhaustive. So:

An **educational cloud** is an environment that **uses cloud computing to provide different participants**, incl. university management, administrative and academic staff, students, QA agency staff, QA experts, business representatives, etc., **with various**

administrative and educational services, such as administrative services, learning management, educational resources, assessment & evaluation, quality assurance, user management, etc. (fig. 1).

Educational institutions use clouds differently, supporting different types of services.

Interoperability between educational clouds provides various opportunities for interaction between educational platforms and systems. This allows providing of various online services and computing resources to students and teachers, providing the most appropriate educational service or resource, distributing educational services to foreign clouds etc. [18].

One approach to ensure interoperability between educational clouds is through the use of an integrated framework where cloud brokers collect and manage information about the available clouds and the educational products and services they offer. This may include information about price, reliability, type of service, metadata for the education object, and more. On the basis of this information, the framework redirects student requests for services to the most appropriate educational cloud [19, 20].

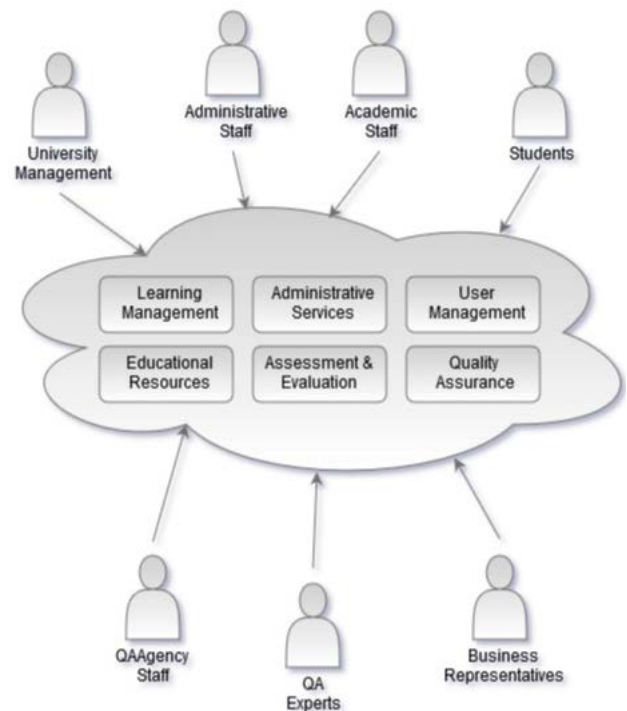


Figure 1. Educational cloud

Another possible solution is to create cloud-based e-learning components as "Task as a Service" (TaaS) to interoperate among educational clouds. These components can be represented in different clouds as "tasks" (for example online test, assignment, lecture, etc.) that can be composed and used repeatedly so that they can be utilized by learners in the best possible way [21].

Rizzardini offers an interesting solution for **Cloud interoperability service architecture for educational environments** [22]. The architecture allows operational compatibility with external tools through defining a semantic description of the tools' Web API using linked data. This makes it possible to automatically detect a Web API, i.e., no custom system interfaces for interoperability are required. This simplifies the plugging of new external tools and the support for integrated services.

5. Education networks in the cloud

Interoperability of educational clouds reveals new perspectives for the educational space. Sharing services between institutional clouds has the potential to lead to the building of cloud education networks (CEN) that would raise HE to a higher level.

The main features of CEN are:

- **Cloud infrastructure.** Educational clouds and CEN use cloud computing to reduce the costs for software, platforms and infrastructure; to make it possible to purchase resources at any time in an unlimited amount; to outsource infrastructure maintenance outside the university; to delegate the responsibility for a reliable and continuous work to a specialized firm.
- **Innovation of the educational product.** The university offers an innovative educational product that significantly outperforms traditional ones. The opportunity to use software, platforms and infrastructure as a service, with a consumption-based payment model, allows universities to use the latest technologies without owning them. The attraction of foreign experts with competence and experience in various fields is also a great advantage. Learners are not simply trained on pre-designed curricula and programs. They have access to the latest technologies and mechanisms to influence the learning process.
- **Uniting the capabilities of organizations.** More and more universities use various models of partnership, not only with educational institutions but also with business organizations. This includes, for example, development of joint bachelor's and master's programs, exchange of experience through teaching staff mobilities, scientific and applied development and experiments in industrial enterprises, etc. The advantages are many - value, speed, innovation, quality and selection, and they outweigh the risks of partnership. It is much easier to give up an ineffective partner than a weak internal department.
- **Cooperation and competition.** While competing to attract learners, universities cooperate to create attractive educational products and services. This imposes a model of continuous improvement of the quality of education.
- **Focused on learner.** The main purpose of the universities is to meet the needs of the learners. They must carefully monitor and respond to their individual needs. This can be done in a variety of ways - by offering adaptive training, enabling learners to construct the educational product themselves, analyzing the business sector and trends in science and practice, and creating appropriate educational products, etc.
- **Rules and Standards.** Participants must be united around specific rules and standards. Voluntary adherence to established standards reduces the risk of locking towards private solutions. The rules and requirements for their compliance are determined by the partner universities.

6. Conclusion

The internationalization of higher education is a natural process which is in its maturity stage. It has many forms - student and teacher mobility, internationalization of curricula and programs, joint programmes, dual degree programs, etc. Building diverse and lasting partner relationships between the HEI is a matter of business interests.

Cloud computing has quickly entered the educational institutions and they have begun to build their own educational clouds. Interoperability between the institutional clouds will lead to the building of cloud-based educational networks that will create the conditions for accelerating internationalization in higher education.

The article describes the main features of cloud education networks. They use cloud infrastructure and facilitate the processes of innovating the educational products and services, thanks to the opportunities for uniting the organizations' capabilities. Cloud education networks create conditions for simultaneous cooperation and competition between educational institutions while they remain focused on the learner's needs. Establishing rules and standards is a prerequisite for building sustainable structures and relationships.

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