Implementing Cloud-based e-Learning Systems: potential benefits and practical results.

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WHAT IS CLOUD COMPUTING?

Cloud-based computing is arguably the most talked-about recent trend in the field of information technology (IT). Claims in the IT literature include significant financial and operational benefits. The literature also reports some concerns, for example, with the security of data that is stored and processed on servers not owned or controlled by the organization that owns the data. However, there is a growing trend towards the use of cloud-based IT services of all kinds, including educational services such as cloud-based hosting of courses. Rather than investing in its own technology infrastructure, the school or university may launch online courses hosted on servers owned by external providers, paying on a pro-rata basis related to the intensity of use. New courses – and costs – are added in proportion to student demand – and the fees received. The courses are often so designed that students are able to access the materials and interact with tutors and with each other by means of available mobile devices, such as smartphones and tablets.

Five "essential" characteristics of cloud computing are:

On-demand self-service. A consumer can "rent" computing capabilities, such as server time and network storage, as needed;

Broad network access. Capabilities are accessed through any internet-enabled device (e.g. mobile phones, laptops, desktops, tablets and PDAs);

Resource pooling. The provider's computing resources are pooled to serve multiple consumers, with resources assigned and reassigned according to consumer demand;

Rapid elasticity. Capabilities can be rapidly and "elastically" provided to quickly scale up or scale down the size and scale of services provided;

Measured Service. Resource usage can be measured, monitored, controlled, and reported, providing transparency for both provider and consumer of the service.

WHY CLOUD COMPUTING IN THE CONTEXT OF E-LEARNING?

In the literature there are few studies that describe, analyze or evaluate aspects of the implementation of cloud-based eLearning systems. This paper contributes by presenting two case examples, discussed from the project implementation perspective.

Case 1: Organization X

At the request of the company who is the "star" of this case study, we will refer to it as **Organization X** or just plain "**X**". To set the context, here are some basic data:

- **"X"** manufactures / distributes heating, ventilating and air conditioning systems;
- **"X"** is a $12.5 billion company with over 40,000 employees serving customers in about 170 countries worldwide;
- All the employees of **"X"** are potential trainees at some point in time;
- Also, there are large numbers of potential "external" trainees – the technical, maintenance, sales and other staff of its network of dealers and representatives;
- **"X"** has factories in USA; Canada; Europe; Brazil; Mexico, China; India; etc. – so both the external and the internal trainees are distributed around the globe.

For some years, **X** has been using e-Learning to train this large and distributed body of adult trainees. Three e-Learning programs are now regularly used by about 6000, soon to reach 7000, trainees per year. The HRD department of X is located in a town where there is a university with experience in designing, developing and implementing technology-based training systems, so when **X** first started to use e-Learning, it asked the local university for help. As a result, the courses were first developed for and used on Blackboard, the LMS platform used by the university, with all the course materials and data stored on a university server. However, **X** was fully responsible for management, upgrading, updating and backup of course files, as well as all learning management aspects of the courses.

As the number of eLearning courses and number of students using them expanded, **"X"** faced some challenges to contain the overall costs: by reducing up-front investment in producing and implementing new courses; by reducing the recurrent per-student operational and maintenance costs. The company was faced with increasing costs for the server space rented from the university to host its increasing portfolio of courses and data generated by the growing number of students. It was also faced with the prospect of increasing the number of technical staff devoted to maintaining the eLearning systems. At the same time, the local university entered into a downsizing mode, some staff reductions were made, and the remaining IT support staff were no longer as able and willing as before to help the staff of Organization X to learn how to upload and maintain courses on the Blackboard platform and assist them if they had any problems with the server.

This apparent ***problem*** situation was seized upon as an ***opportunity*** by some of the university staff members who were being laid off or were feeling threatened in their job. A small company was formed by two ex-university staff members who had in the past acted as consultants to **"X"**. They prepared a proposal which **"X"** accepted. The new company performs these specific services:

- maintains the data on servers it rents from another provider "in the cloud";
- uploads and maintains all course materials and data, as directed by **"X";**
- looks after all security aspects (including daily backups of all files);
- provides online technical support to over 6000 trainees, 24/7, worldwide.

For these services, the Provider charges **"X"** an all-inclusive annual fee, which was $30,000 when "X" had in the region of 4,500 active trainees and was raised progressively to $40,000 as trainee numbers grew to 6,000. This annual fee represents less than $7/student/year.

However, in order to evaluate the cost-benefit, we need to also examine the cost savings:
- There was an estimated one-time saving of about $10,000 associated with not buying and/or replacing equipment at the offices of **"X"** that would have been necessary for the projected additions of technical staff as use of eLearning grew;
- A significant saving was elimination of LMS platform rental charges (Blackboard) which had previously been paid to the university - $6,000/year;
- However, the greatest saving was obtained by a reduction of technical support staff employed by **"X"** to keep its eLearning courses running - $60,000/year.

It should be noted that these last savings were reductions in actual costs at the start of the changeover, before the later growth in the use of eLearning. Therefore, the substitution of previous internal staff costs ($60,000) by the cost of similar services offered by the small company formed by ex-university staff ($30,000) represented a 50% saving in operating costs. In addition, there was a further immediate annual saving of $6,000 in rental charges of space for hosting its courses on the university's server. So the overall savings in operational costs during the first year after changeover were about 60%. From that point onwards, the provider's fees increased in proportion to the number of users of the services. Since the changeover, the annual trainee numbers have increased by about a third and the service providing company has increased its annual fee by a third.

One final, less tangible but no less important, benefit obtained by Organization X as a result of the changes is that the management and other staff of the HRD department now concentrate on instructional improvement of the courses in terms of curriculum and/or learning materials, and also on the effectiveness and efficiency of the "academic" trainee support services (guiding, tutoring, moderating and evaluating learning), without concern about the "technical" support services also required by the trainees, but now provided by the services company.

So far, in almost two years of operation since the changes at Organization X, no security risks or major unexpected costs have been encountered. The small cloud-computing services provider, formed by some ex-consultants has now acquired several other clients and has designed, developed and implemented several similar cloud-based eLearning systems.

USING CLOUD COMPUTING FOR ODL IN A DEVELOPING COUNTRY CONTEXT

This second case study is not an account of an already implemented solution, but rather a plan or proposal for the implementation of cloud-based eLearning at university level in the type of resources-starved organizational context that may be found in educational institutions all over the world, but most frequently and most obviously in some developing nations. The "star" of this case study is the National Open University of Nigeria – NOUN.

Case 2: NOUN.

One of the major problems for NOUN is the existing technology infrastructure. The headquarters in Lagos has a basic IT infrastructure, but this is not adequate for intensive and large-scale deployment of online courses. Funding restrictions are the main reason for this state of affairs. As early as 2002 a study was performed and a "blueprint" for an advanced technology infrastructure, capable of deploying online learning systems and solutions, was prepared. Over a decade has passed and little progress has been made to implement the proposals. In the meantime, the IT world has gone through not one but several "revolutions", so that the proposals of the 2002 blueprint are a long way from reflecting the "best" way to address IT infrastructure needs of the university and to exploit opportunities offered by recent innovations (including cloud computing).

Other challenges are external: deficiencies in the national infrastructure (e.g. affordable broadband Internet); unreliability of the power supply almost everywhere across a large country. The unreliability of the power supply and the frequent drops and surges in voltage pose severe problems for any institution wishing to use sensitive electronic equipment and offer a constant and reliable technology-based service. NOUN, as a distance-learning university in the process of moving towards online course delivery, has to work with, or around, such external constraints in addition to improving its internal infrastructure.

So, why move the university towards an eLearning model?

The original reasons for NOUN embarking on the use of online resources were to simplify, speed up and in general improve the end-of-course examinations process. Current developments have, for similar reasons, extended to online completion of tutor-marked assignments (TMAs) included in each study module. But there is one important difference: whereas the e-exams occur at a predetermined time and place which all students attend and NOUN staff supervise and invigilate, the TMAs are completed "anytime, anywhere" in typical ODL fashion, which implies that all students should have access to the Internet throughout their course, preferably without the inconvenience of visiting a specific place at a specific time.

Thus, the transition to e-TMAs has created a student-need for flexible and affordable access to the Internet, which in turn opens the opportunity for more extensive use of online learning. An immediate possibility is the online study of the basic course materials that are already available in

electronic format on the university severs. And once students move towards the study of course materials online, it makes sense to enrich the materials with video, animations, simulations and other ICT-based enhancements, thus moving further towards a full eLearning model. But given the infrastructure deficiencies, why move to eLearning?

One part of the answer is the amount of material available on the Web, the powerful tools available for repurposing it, and particularly the Open Educational Resources (OER) trend to share learning materials freely and allow for the integration of parts of different existing materials to create new derivative materials (as described in Creative Commons licensing agreements). This has transformed the nature of ODL course design and development. "Writing" has been replaced by "repurposing" or "mashing". So, one suggestion to course designers in general, and at NOUN in particular, is: enrich both existing and new courses with repurposed online study materials.

Second, the emphasis on "*course writing*" (as practiced in the case of NOUN and many other ODL institutions) has reinforced, rather than reduced, the emphasis on the mere communication of content from teacher to student. Course materials may be outstanding examples of content presentation, but often lack relevant learning exercises or are low on interactivity. Therefore, the second suggestion to course designers at NOUN is: adopt a course design process which encourages not the authoring of **all** the content of a course, but rather the writing of lesson guides replete with questions, exercises and assignments, which will allow students and facilitators to judge whether effective learning is taking place from existing relevant online resources.

So, the reasons for moving an institution like NOUN towards an eLearning model are as much to do with the improvement of course design, development and evaluation as with course delivery or cost factors. Given the situation at NOUN with respect to IT infrastructure and lack of sufficient funds for investment in its modernization and expansion, there seems to be no alternative (other than desisting altogether) to seeking the cost-benefit advantages of a cloud-based solution.

OK, but how can NOUN "leap on the cloud"?

The main phases of implementing a cloud-based solution would be as follows.

- Outsource the technical tasks of online course uploading/ updating, distribution/ delivery, and monitoring/ management to an experienced and "credible" cloud services provider, leaving the academic staff with the pedagogical/andragogical tasks of course design, development, implementation and evaluation.

- Continue to distribute the printed components of courses that have already been designed and modules written (provided the modules pass pre-defined quality standards), but seek to make materials also available in electronic formats that can be easily accessed and studied via the Internet.

- Design and develop further courses, wherever possible, on the basis of adopting or adapting existing materials – and support and enrich both existing and future courses with digital learning materials available via the Internet.

- Focus the implementation of online study initially through learning exercises – an extension of the current "TMAs" – which should include both student-tutor and student-student interaction and collaboration during the whole learning process.

- Design the presentation formats of these exercises so they can be conveniently accessed and learning activities performed on internet-accessible mobile devices that typical university students already own and use (i.e. smartphones).

- Initially implement online courses where the study materials exist in both print and electronic formats, so as to facilitate access and use either on paper or by any internet-enabled devices (desktops / notebooks / netbooks / tablets / eReaders).

- Plan and promote **a BYOD** (Bring Your Own Device) policy in the institution, to promote a culture of student ownership of the ever-cheaper and ever-more-powerful mobile devices. Today's cost of a tablet or netbook computer is much less than the annual amount any serious university student would be expected to spend on books, so the access then provided (and organized by the institution) to free online versions of the same content completely offsets the investment in just a few months of study – and an institution with thousands of students could become a viable commercial supplier of appropriate digital devices to its students at lowest-on-the-market prices.

- Plan and promote a "**digital native**" culture among the students - such cultures are already growing in the younger generations of all countries – an ODL institution will do well to use them as a powerful means of achieving its educational goals. Rather than opposing or ignoring the social trends towards digital entertainment, video-gaming, or social networking, let's seek to integrate these trends into the institutional structure, through **edutainment, serious gaming and online communities of practice**.

The above advice does not imply the abandonment of the existing network of study centers where students can continue to meet with their facilitators or study together in collaborative groups. However, it does imply that in order to reap the many benefits of moving to an e-Learning culture, one does not need to wait for the day when there are funds available to equip the study centers with computers and access to networks. One can start to implement full e-Learning courses, albeit initially on a small scale, well before that day by "leaping to the cloud" and keep within the current budgetary restrictions by tailoring the size of the courses to the size of the available budget.

Finally, let's be careful about investment in IT infrastructure. If the infrastructure has the requisite size and power needed to handle peak demand periods, it will almost certainly be under-utilized most of the time. Rather, promote a BYOD policy and then complement it with investment at the study centers in special purpose technology that students will need occasionally (e.g. virtual laboratories for science experiments). Couple this implementation model for the peripheries of your eLearning network with a cloud-services-provider-based pay-according-to-use model at the central hub and you are on the way to implementing a viable and sustainable eLearning system.

CONCLUSION: LOW COST, HIGH IMPACT E-LEARNING IS NOT "CLOUD CUCKOO LAND"

This paper started by reviewing the potential benefits of cloud computing, as they are presented and discussed in recent IT literature. Then, through the analysis of two very different case studies, we have tried to turn the discussion around, from one that smacks of "solutions seeking problems" to a more systemic, problem-solving-based, approach. In the first case study, we saw how an organization already running an effective program of training by means of eLearning could implement it much more cost-effectively by "leaping to the cloud". In the second case study, we saw how, in addition to such cost-effectiveness benefits, a leap to the cloud may help to overcome many other systemic problems and deficiencies, both internal and external to the organization.

Leaping to the cloud, as implied by the Organization X case, may bring cost-effectiveness and enhanced sustainability to any eLearning project. However, this leap may be more crucial to success in educational contexts that share some of the characteristics, problems and risks that were illustrated by the NOUN case. But as the saying goes, "every case is a case". Like previous technology innovations, cloud computing will not be a panacea for every educational problem. However "leaping to the cloud" is far from being some crazy idea from "cloud cuckoo land" and so should be seriously considered during the design and implementation of e-Learning systems.