School on Cloud: Towards a paradigm shift

Kostis C. Koutsopoulos[1], Yannis C. Kotsanis[2]
koutsop@survey.ntua.gr, kotsanis@doukas.gr

[1] National Technical University of Athens, Greece
[2] Doukas School, Athens, Greece

Abstract. This paper presents the basic concept of the EU Network School on Cloud: Namely, that present conditions require a new teaching and learning paradigm based on the integrated dimension of education, when considering the use of cloud computing. In other words, it is suggested that there is a need for an integrated approach which is simultaneously pedagogic (i.e. new role of teachers), technical/technological (i.e. use of the internet), administrative (i.e. new role of school administrators), social (i.e. a different disposition of parents towards school), political (i.e. a different approach of government to school) and cultural (i.e. new role of students), being in dialectic harmony and respecting all aspects of teaching and learning, an integral part of which are pupils, teachers and school administrators. As a result, the principal tasks in the area at the interface between education and cloud technology, which are presented in this paper, are to determine and describe the nature of the basic education stakeholders: i-Students, i-Teachers and i-Administrators.

Keywords: Cloud computing, education, paradigm, competences

Introduction

As we are well into the 21st century, important changes have occurred in the way we view education and ICT, resulting in the idea of cloud computing. But understanding such an approach to education is possible only through an examination of the evolution of education, which in turn determines the way we perceive education as well as how we practice it using ICT methods. However, these two dimensions (perception and practice) have recently been involved in changes representing what epistemologist Thomas Kuhn (1962) referred to as paradigm shifts and which are not rare events in subjects like Education. As a result, it is necessary to examine the current consideration of Education and the approaches of using ICT in accomplishing pedagogical goals.

In order to have an overview of recent considerations on educational issues, it is necessary to examine what is happening in the interface between education and cloud technology termed in this paper as School on Cloud (SoC). It is the only way to become aware of the cosmogony changes and the transitions that are taking place in education today. A good point to start is the basic principle of epistemology which states that the way we practice our science is limited almost exclusively by our 'myths'. As Talbot Parsons (2007) has said these myths work as lights that illuminate our areas of perception, allowing us to have a clear picture of actual problems only and not seeing the others, while simultaneously they give us the intellectual serenity we need, since the judgments we make are revealed in our minds as reflections of the objective reality.

If this is the case, then a major concern in any scientific endeavour are the sources of its myths. That is, scientists and educators alike accept the notion that sciences should satisfy certain functional conditions that qualify their nature and require systematic ways in order to satisfy basic methodological needs. From this perspective, it should be clear that if we are

to establish the right approach in considering the use of ICT in education or in following the SoC approach, it is necessary to face the reality of our myths. Because in this way we contribute creatively in the achievement of our scientific objectives, which in turn constitutes an inseparable part of our scientific envisagement of Education as well as of our methods used, which in this case relate to cloud computing. What we need therefore is the means to determine the scientific approach that will clarify our myths and provide us with the framework to face the issues encompassed in the term SoC. As a result, the question that we need to ask in the current academic and technological situation is: what are the "myths" with which we have to scientifically approach the School on Cloud concept?

The need of a new paradigm

It is the unambiguous and categorical position of this paper that at the centre of the scientific approach towards the School on Cloud should be the concept of *integration* (an integration operating within, between and outside the classrooms as a result of the nature of Cloud computing which allows its use by all stakeholders of practically most technologies and platforms). And this constitutes the source of our myths not only in terms of the way Education is regarded, but also with respect to the methods used in teaching and learning and in particular in utilizing cloud computing. However this inevitably leads to the basic proposition of this paper that the present approach to education, which can be termed as the *traditional teacher-centered* paradigm, is now absolute and we find ourselves in the period of the *cloud student-centered (or personalized)* teaching and learning paradigm.

It should be noted that even a cursory review of the literature shows that for the last fifteen years student-centered or personalized teaching has been the cry of educators worldwide (Conole, 2010; McLoughling et al., 2010; Siemens, 2003). Yet learning continues to be delivered within a teacher-centered approach, using teacher-centric tools in a traditional twelve or thirteen week format. While at the same time society demands and learners' needs are changing requiring a holistic approach (Gialamas et al., 2013). This apparent antithesis is the result of a very important deficit in the literature's challenge of the prevailing model for learning. Namely, that the answer to being able to better attend the modern varied characteristics of the learning process is simply to use multiple approaches, orchestrated within a technological - ICT or internet/Web 2.0 - framework (Jimoyiannis et al., 2013).

On the other hand, the position presented here is simple in its explanation, but radical when considered in terms of the current practices in education. That is, educational processes such as openness, sharing, interpersonal relationships, discourse, personal motivation, tacit over explicit knowledge, as well as the sharing and reusability of learning resources on the web cannot be addressed in the traditional way. In other words, these processes cannot be dealt with unless we accept the fact that they represent different manifestations of "*a whole*", which is the dialectic entity of the *School on Cloud*. That is, the focus is neither on what we are learning nor on how we are learning, both aspects are very important (Brown & Adler, 2008), but mainly the approach to achieve them (integrated/holistic). This concept is not new, the difference is that the holistic thrust is not only towards the learner, according to the situated learning approach (Lave and Wenger, 1991), but mainly towards the education system (a process for all educational stakeholders).

Therefore, an integrated approach towards education is required, an approach, however, that is not possible without the help of the Student-centred paradigm. A paradigm that is based on the integrated dimension of education, when considering the use of cloud computing. But more importantly, a paradigm where the importance of the integrated

efficiency of cloud computing implies a tautological integrated approach in considering education. Therefore, the position suggested is:

> *a need exists for an integrated approach which is simultaneously pedagogical (i.e. new role of teachers), technical/technological (i.e. use of the internet), administrative (i.e. new role of school administrators), social (i.e. a different disposition of parents towards school), political (i.e. a different approach of government to school) and cultural (i.e. new role of students), in dialectic harmony and respecting all aspects of teaching and learning an integral part of which are pupils, teachers and school administrators.*

In other words, in the new paradigm the aim is not to simply narrow the existing division between education and cloud computing, but to shift the education process in ways that alter the approaches we catalyse learning and innovation as well as the ways which complement and enrich the individual's personal learning space. The proposed paradigm, however is a lot more and well beyond a constructivist approach to learning, where simply using various tools "...learners actively participate in the environment (educational process) in ways that are intended to help them construct their own knowledge, rather than having the teacher interpret the world..." (Jonassen et al., 1998). More specifically, the application of the new integrated educational approach encompasses beyond tools, all stakeholders in different ways so that it:

- Transforms the role of edu**c**ators and *pedagogy* with services tailored to students' needs in individual classrooms.
- Changes the roles that *teachers* and *educators* play, so that time with students can be focused towards helping students understand, use, and build on information that is easily available on the cloud.
- Eases the burden of teachers on *knowledge transfer*, while at the same time understanding the information in context or using it to solve problems (i.e. critical thinking).
- Creates *new knowledge* with skills that will most often come through interactions between students as well as with teachers/educators.
- Provides *students* with a variety of services and hands over control to them to select and use them the way they deem fit.
- Empowers *learners* to regulate their own learning, thus greatly enhancing their learning outcomes.
- Provides Leadership and *institutional* change for a new administrative strategy on learning
- Provides *administrative* support for a digital society in teaching and learning.

In other words, determines and formulates *i-Students*, *i-Teachers* and *i-Administrators* which are the principal tasks of the SoC and will be briefly presented below. Moreover, by developing a SoC approach, Van den Brande et al. (2011) recommendation to proceed "*towards a new learning paradigm*" is fully met and unquestionably justifies Doukas School's efforts in developing and operating the *SoC Network*.

i-Students

Society is changing due to globalization and the requirement for complex functioning in many diverse and multiple dimensions. That is, people need to work, develop and seek happiness locally under a global influence. As a result, there is a demand for a different type of citizen, which in turn requires a different student in our schools. In other words, the development and nurturing of the new local but under the global conditions adult require

from our students different competences, new types of skills as well as to learn how to operate with a more complex set of rules.

But how do we prepare young people for such a different approach to life? What kind of an educational experience should they receive? And what are the appropriate sets of values that must guide our educational programs? Within the proposed new paradigm the answer is simple and straightforward: According to Pearlson and Saunders (2006) schools have to be successful in transmitting knowledge in ways students assimilate and turn it into a tacit knowledge. But if this is the case then "…learning must be student cantered where students engage in critical thinking, which means that students do more than reproduce knowledge; they question and challenge the ideas of others and forward their own opinions and ideas." (UTAS, undated). Furthermore, given that nowadays it is not efficient, productive and mainly sensible for students to: "sit in a small space for five hours a day while a teacher talks about the past and present" (Wiles, 2007), the availability to students of gadgets such as iPods, PC's, MP3's etc. is inevitable. In sum, the formulation of i-Students using a SoC approach is the only way to meet present demands and future requirements.

i-Teachers

The programme Beyond Current Horizons (2009) clearly stated that in today's changing teaching and learning landscape the most important factor is to determine the right balance of how class time is used, which represents the basic tenant of teaching. In that model instead of the teacher using class time to lecture and dispense information, work is done by each student, and could take the form of collaborating with their peers in online communities, curetting online content, watching video lectures, listening to podcasts, and more (in this Horizon Report is termed "flipped classroom"). That is, the i-Teacher concept promotes a shift in practice to student-controlled learning in which teachers can foster through the use of tablets and similar devices, apps for note-taking and content creation and in general learn by working in a virtual teaching and learning environment. In this way they are becoming facilitators rather than determinants of student education. In other words, this new role of teachers enables them to cover more content leading towards an improvement in children's engagement and performance. Of course this effective model of education reaffirms that technology such as Cloud Computing presents an opportunity to introduce new structures and roles in order to support the necessary changes required at several levels of the educational system.

Across the world, many successful i-Teacher classroom models are already underway. A Representative approach is in the South Bend Career Academy (2014.), an independent charter school in Indiana USA. In that program students watch videos at home and then complete computer simulations during class to showcase what they have learned. A science teacher there described his new function as "a classroom guide and coach, walking around the room and having individual discussions with each student". However, this application as well as all the others are concerned only with the student-teacher interaction, indicating a clear lack of integration with the rest of the education stakeholders (administrators, parents, politicians etc.) substantiating the necessity for an SoC approach.

i-Administrators

Given the complexity and peculiarity of the contemporary world (diverse local activities in a complex global setting), education institutions and mainly school leaders/administrators inevitably have to follow the basic tenant that knowledge is individually constructed and should lead to active observers of the world, active questioners and able problem solvers. In order to achieve these goals successful schools and administrators must grow "from the

inside out" (Drago - Stevenson, 2009) and the approach to teaching and learning "must be holistic" (Gialamas et al., 2013).

That is, a present day leadership/administration should see the school as a learning community that promotes and supports in every component of the institution a holistic approach that puts the student at the center of his/her own learning as well as at the center of all institutional decision making. Therefore, the new school leader/administrator should provide leadership for institutional changes leading to new administrative strategies on learning and mainly provide administrative support for a digital society in teaching and learning. In other words following the new education paradigm becomes an i-administrator applying a SoC approach.

In sum, the proposed paradigm is in accordance with most issues that research has shown to express in contemporary education life as well as provide successful applications. That is, it satisfies on one hand the European Framework of "*Key Competences for Lifelong Learning*" (European Communities, 2007), which sets out eight key competences, defined as a combination of *knowledge*, *skills* and *attitudes*, which all individuals need for personal fulfillment and development, active citizenship, social inclusion and employment. On the other hand, it addresses the need for students (and in generally life-long learners) to acquire the *21st century skills* (e.g. Partnership for 21st Century Skills, 2009), attitudes and *key qualities* (e.g. Six Cs, Fullan & Langworthy, 2013), related on the widely accepted standard framework of cognitive skills, as defined in the new *Revised Bloom Taxonomy* (Anderson & Krathwohl, 2001), as shown in Figure 1.

Cloud computing

In order for someone to appreciate the SoC approach to education he must fully understand the concept of cloud computing and how its components can be utilized in the operation of such an approach. Despite the many definitions and the various terms suggested by many computer experts and cloud users, the concept of cloud computing can be described as an ICT technology that can be fully determined in a three dimensional space consisting of the characteristics axis, the type of service axis and the form of deployment axis (Figure 2), axes that are integral parts of SoC.

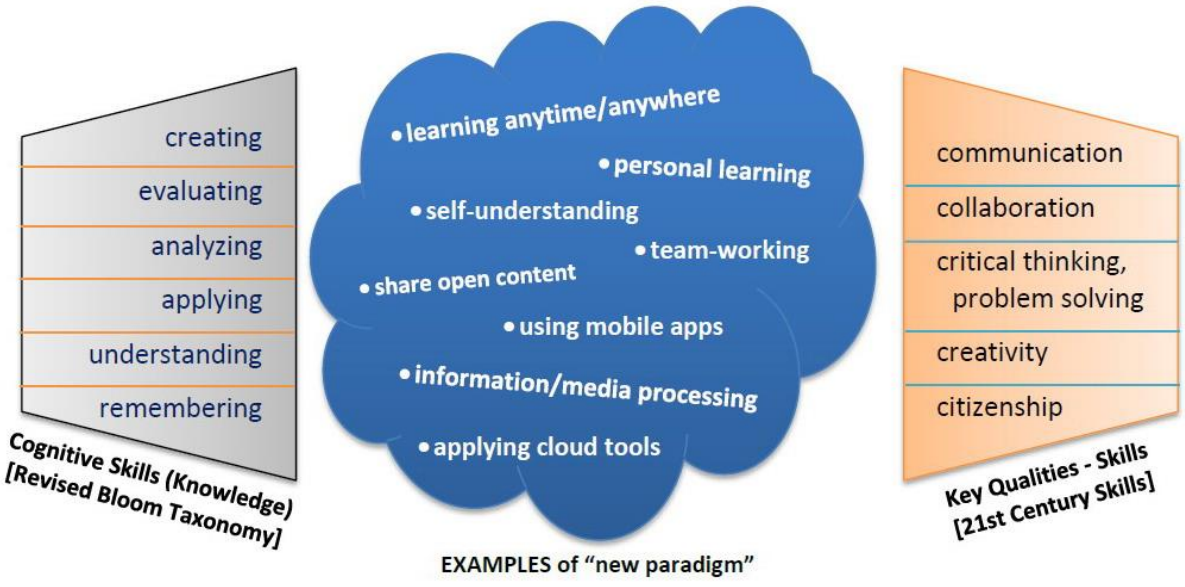

Figure 1. Examples of new paradigm's related to skills

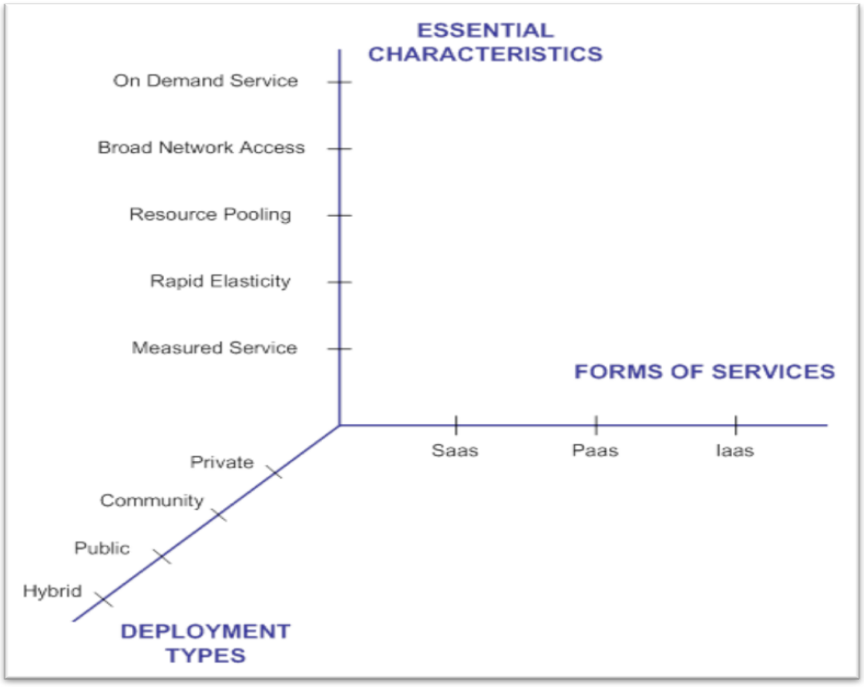

Figure 2. Cloud computing framework

More specifically, cloud computing is a new ICT approach (Figure 2) which by possessing five essential characteristics (*On demand service, Network access, Resource pooling, Rapid elasticity and Measured service*) can provide ubiquitous, rapid, convenient and with minimal management effort or service provider interaction, three forms of services (*Infrastructure* service, *Platform* service *and Software* service) that can be deployed in four fundamental types of the Cloud (*Private, Community, Public and Hybrid)* (Mell & Grance, 2011). That is, a framework which can successfully serve and support the SoC approach to education.

Essential Characteristics

Cloud computing poses the following five, termed by the US NIST, essential characteristics:

On-demand self-service: A customer can obtain computing capabilities, such as server time and network storage, as needed (on demand) automatically without requiring human interaction with each service provider.

Broad network access: Capabilities are available over the network and accessed through standard mechanisms that promote use by various platforms (e.g., mobile phones, tablets, laptops, and workstations).

Resource pooling: The provider offers computing resources that are pooled to serve many customers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to customer demand.

Rapid elasticity: Capabilities can be elastically provided and released, in some cases automatically, to respond to demand. To the customer, the capabilities available may appear unlimited and can be appropriated in any quantity at any time.

Measured service: Cloud systems automatically control and optimize resource use appropriate to the type of service needed (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and the customer of the service.

It should be evident that all these characteristics have direct application to the SoC approach, for e- education cannot be achieved without: multitasking, the ability to handle a large number of users and applications, the need for flexibility as well as the ability to meet changing demands.

Forms of Services

The providers of Cloud computing offer three fundamental forms of services: the *Infrastructure as a Service (IaaS)*, the *Platform as a Service (PaaS)*, and the *Software as a Service (SaaS)*. Between them there is a pecking order, where IaaS is the most basic and each higher form of service abstracts from the details of the lower form as shown on Figure 3. Of course in the literature many other services have been proposed such as: Strategy-as-a-Service, Collaboration-as-a-Service, Business Process-as-a-Service, Database-as-a-Service, Network as a Service (NaaS) and Communication as a Service (CaaS) some of which have been accepted by the ITU (International Telecommunication Union). However, all of these are derivatives and not fundamental as the following:

Software as a Service (SaaS): It is the most basic form of cloud services and offers users computers (physical or more often virtual machines as well as other resources) Basically, by using software as a service (SaaS) applications are accessible from various users devices such as a client interface (e.g. web-based email), or a program interface.

Platform as a Service (PaaS): In this form of service cloud providers offer the users the capability to deploy onto the cloud infrastructure consumer-created or acquired applications. This way users as application developers can develop and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware and software layers.

Infrastructure as a Service (IaaS): The providers of IaaS services offer the user capabilities such as processing, storage and networks as well as other fundamental computing resources. This way the user is able to deploy and run arbitrary software, which can include operating systems and applications software on the cloud infrastructure.

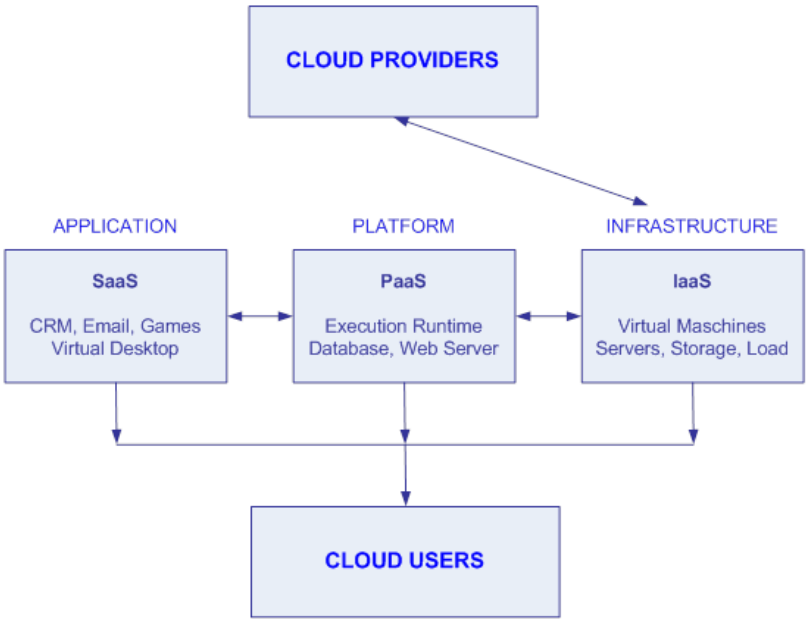

Figure 3. Forms of services

Given that Cloud Computing allows all categories of education users (students, teachers and administrators) to access stored files, e-mail, database and other applications from anywhere at request (Nicholson, 2009) it reaffirms that the forms of services provided by cloud computing can be successfully utilized by the SoC approach to education. However for a successful application of SoC access to software and databases on-demand, as well as capabilities such as provision of processing, storage, networks and other computing resources are not common to all the participants of the education system (see Figure 4). As a result it is necessary to identify the form, the type and the provider of service, in order to be efficient from the point of view of costs and capabilities, but mainly in terms of satisfying the specific needs of students, staff and administration of the institution.

Deployment or Cloud Computing Types

Cloud deployment is a composition of at least four distinct cloud computing types (private, community, public and hybrid, Figure 5) that represent unique cloud infrastructures which theoretically are bound together by standardized or proprietary technology so they can provide data and application portability (however, much more needs to be done to achieve true portability).

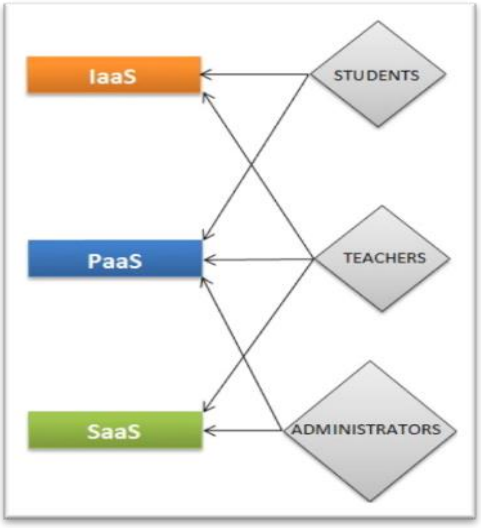

Figure 4. Capabilities of education stakeholders

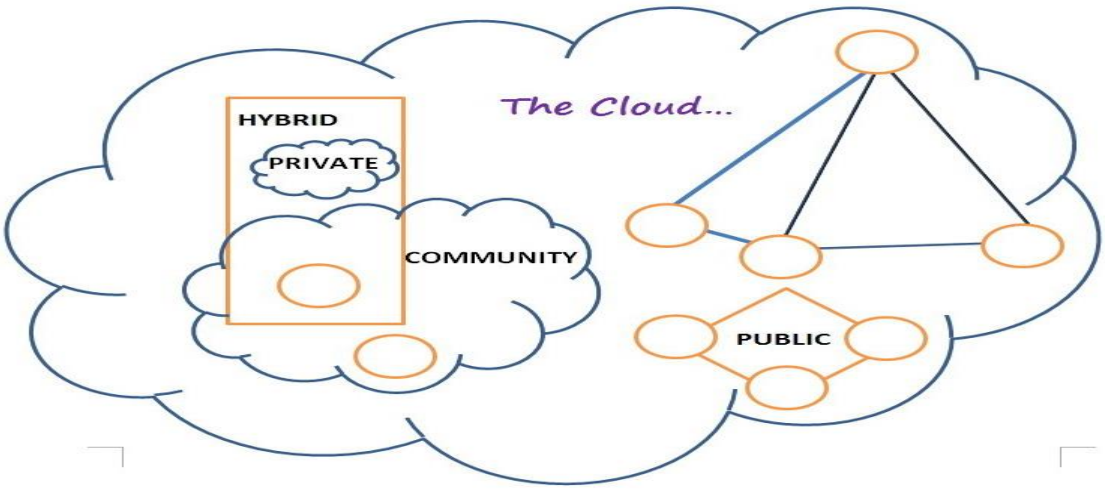

Figure 5. Deployment or Computing Types

Private cloud: A private cloud is a computing type infrastructure provisioned and operated for the exclusive use of a single organization, comprising multiple consumers (e.g., business units) operating in different flexible ways. That is, it can be managed internally, by a third-party or some combination of them; hosted internally or externally; operated by the organization or a third party.

Community cloud: This cloud computing type shares the infrastructure between several members of a specific community of users or organizations who share common concerns (e.g., mission, security requirements, policy, and compliance considerations). This type of infrastructure, as the previous one, operates in different flexible ways.

Public cloud: This type of cloud computing exists when the infrastructure or the services are rendered over a network that is open for use by the general public. This type may be also owned, managed, and operated by a business, academic, or government organization, or some combination of them. It can also exist on or outside the premises of the cloud provider.

Hybrid cloud: This type of cloud computing is a composition of two or more distinct cloud infrastructures (private, community, or public) from different service providers, which although they remain unique entities at the same time are bound together by standardized or proprietary technology which enables data and application portability.

In terms of the SoC approach with the exception of the private cloud all the other computing types can be utilized. The choice depends on its goals, conditions and requirements. Given that, today's major educational stakeholders represent the first generation to grow up within the digital technology era (Prensky, 2001). That is, in their entire lives were surrounded and were using computers, videogames, video cams, cell phones, and many other digital tools. It should be clear that cloud computing represents the appropriate tool to use in the SoC.

In addition, it qualifies as an ideal environment for the support and development of SoC. That is, although all stakeholders of the education system already use many of the capabilities of cloud technology in their personal life (Ercan, 2010), in their education environment, they require additional capabilities. More specifically, the advantages of cloud computing provides students with the ability of working and communicating without taking into account space and time. The teaching staff in turn receives the benefit of unlimited support in preparing their teaching portfolio (presentations of lessons, conferences, articles, etc.), teaching practice (methods and teaching techniques, study materials, feedback) and evaluating (methods and techniques of evaluation and management of the results) (Thomas, 2009). Finally, administrators are provided with the ability to design, build and test their program applications as well as execute them on the infrastructure of any chosen cloud provider.

In sum, SoC is indeed a technology driven approach (use of cloud computing) requiring "*digital competences*", but it operates within the theoretical framework of the *new paradigm* which in turn projects the very theoretical notion of *integration*.

Preparing SoC: a European Network

Based on this description of cloud computing and its advantages to the SoC, it should be evident that this technology can be a powerful way to apply the new integrated student-centered paradigm we all should be looking for. Indeed as Donert (2013) has declared "With Cloud computing in education, you get powerful software and massive computing resources where and when you need them …" and we may add in any way you desire, in order to apply new educational approaches.

This view was shared by many ICT experts and educators, some of which had an opportunity in a CEDEFOP study visit for ICT in education in Spain on April 2012, to discuss issues and initiatives in their countries related to the emergence of Cloud technologies and the plethora of apps and tools available. These discussions resulted in the idea for the SoC Network proposal by a core group of partners. The group continued these discussions in a preliminary meeting held at the Doukas School (the coordinating institution and an innovative Greek School) in November 2012, in Athens in order to clarify the goals, products and needs the SoC Network should address and how it would operate. Based on these, a proposal was submitted and approved creating The School on Cloud: connecting education to the Cloud for digital citizenship (SoC Network). The Network consists of 57 European partners from 18 countries distributed widely across Europe and includes most types of educational stakeholder and all sectors of education. More specifically, there are 21 Universities and teacher training departments, 9 NGOs, 8 schools, SMEs, research institutes, adult education and VET providers, a European professional association and a library.

A brief presentation of the network that follows, shows that this effort provides the necessary impetus to begin thinking, planning and designing in terms of the new SoC approach or of bringing forward the new education paradigm.

Goals and Objectives of the SoC Network

The SoC Network seeks to explore how education should respond to the new ICT developments in the form of Cloud–based applications that are rapidly transforming our society, including education. The aim is to overcome the existing divide between education and Cloud computing. That is, the School on Cloud Network by exploring this issue aims at developing guidelines, related to the new paradigm for education as well as on encouraging collaboration and knowledge exchange between and within education and ICT. To achieve this goal, SoC Network plans to create a community through which:

- Participants will share knowledge with one another and jointly develop new knowledge.
- Promote innovation and best practice in the implementation of Cloud-based environments for learning and teaching.
- Enable a fruitful exchange of experiences, best practices and visions between the network members.

In addition to this basic objective the SoC Network will evaluate the state of the art, by examining and assessing a wide range of topics related to Cloud education such as: tools, methodologies, pedagogical issues and visions. More specifically, the additional objectives of SoC Network will be to:

- Address the impact Cloud computing will likely have on the management of education institutions (schools, universities, VETs, Adult Education Providers etc.).
- Identify methods and approaches to teaching and learning with the Cloud-based technologies.
- Promote Cloud-based tools and digital educational content, relating its use to key competences.
- Collect, validate and widely disseminate the use of digital content.
- Encourage teachers and educators to innovate, using digital technology and resources creatively.

Moreover, in order to create the necessary conditions to plan and design this desired SoC approach or in bringing forward the new education paradigm, the SoC Network intends (Donert, 2013) to:

- Undertake a diagnostic inventory on the current alignment of education in an attempt to discover the state-of-the-art, successful practices and key challenges.
- Explore the values that give meaning to the new paradigm and share the understanding of current successful practices that reflect it and are captured in schools, universities, VETs, adult and other education stakeholders.
- Advice, influence and implement what has been created by the Network.
- Focus on enhancing, extending and enriching the impact of the work of the Network within and beyond the organization into the future.

SoC Network: Achieving the Goals and Objectives

The fundamental question that any project, including the SoC Network, has to answer is: *can these goals and objectives be achieved?* The unweaving answer of all participants is an absolute YES. The SoC Network by addressing the following two key questions:

- How should education respond to cloud-based technologies?
- What is the impact, now and in the future, on education stakeholders and teachers?

In essence starts the process towards the new education paradigm, which easily and practically can achieve them, for they represent its goal and objectives. Indeed as learning becomes increasingly digital, online access becomes the necessary vehicle for the emerging Cloud-based developments (Donert & Bonanou, 2014) and thus offer a new integrated way to education. An approach that aligns with the way we think, share, learn and collaborate outside the classroom, which in turn allows education to bring into learning: dynamic, interactive, multimedia and learning activities. That is, teachers can track individuals and groups and assess how a topic or lesson has been received, while students are able to work in teams, collect shared data, and organize information – regardless of time, date or physical location. In this way Cloud-based activities offer an opportunity to transform the role of both ends of pedagogy -teachers and students- for *it helps young people to access any learning at any place and any time from any teacher with the right expertise*. And this, as Rajen Sheth, senior product manager of Google has claimed in his interview in Frost & Sullivan's (Sheth, 2010), ''is definitely a new paradigm".

SoC Network: Utilization of Cloud-based technology

The next important question facing the SoC Network project is related to the usefulness of the Cloud based technology to education. Although education has largely been left behind in using Cloud developments, nevertheless the signs are encouraging. Already in Europe the first education Cloud is a reality in Northern Ireland for 1,200 schools and more than 350,000 teachers and students (Meier, 2012).

In addition, many schools and educational organizations are considering adapting their activities to Cloud-based applications (Donert, 2013). That is, demand for the expanded use of technology in education to raise academic achievement comes from virtually all constituents, from European agencies, national governments, local school boards, teachers, parents, and students themselves. Tablets, notebooks and other mobile devices take learning out of computer labs and libraries and put it directly into student's hands.

That is, all the characteristics-advantages of cloud-based technologies are present in educational applications and thus they have the potential to redefine the role ICT can play in implementing an educational strategy and change the whole educational system. And the sighs are encouraging. For example, software companies like Adobe have been quick to create Cloud tools for teachers and learners to curate their own content, while the arrival of easily and regularly updatable eBooks is transforming the textbook industry.

However, selecting, implementing and managing Cloud-based services, school-wide collaborative tools, educational forms etc. are not easy tasks as we might have led you to believe, but they are at least challenging. In other words, although the future of education and learning is expected to be in the Cloud, the landscape is still shifting and there remain many issues to be resolved related to these tasks. On the other hand, Cloud-based applications fully support and justify the need for a SoC approach and provide us with the expectation of a successful outcome, which of course is in the hands of all of us.

SoC Network: The Future of Cloud in Education

The basic dictum that "Technology Changes, Education Survives" signifies the need for paradigm changes within the unchanging role of education. In other words, ICT changes, in the form of Cloud-based technologies, having the power to fundamentally change how education stakeholders' cooperate and collaborate, substantiate their ability to alter the whole system of education. However, if we accept that the SoC presents an opportunity to redefine the role ICT plays in implementing an educational strategy or in starting the process towards a new education paradigm we also have to accept that Cloud-based technologies in education like any other new technology advancement also create disruptive possibilities and potential risks.

As a result, the SoC Network concerned with the current use and the future evolutionary path of cloud-based applications in education will be asking question such as:

- What are the most important current and potential future benefits for education and society?
- What might derail their progress?
- Are the overall benefits worth the risks?

It should be noted, however, that evaluating the degree of maturity that cloud-based technologies have reached, their present and anticipated pace of growth as well as their trends are not easily attainable objectives, but they are achievable. That is, their successful achievement fully supports and justifies the need of the SoC Network.

The four working groups of the SoC Network

Academic and research experience has shown that successful strategies concerning innovation and change (such as the SoC Network) can come through structured discussions, conversation and even arguments for they always lead to an acceptable pattern of shared basic assumptions and guidelines which in turn can provide discoveries, visions, plans and strategies. Based on that, the steering group decided to form four thematic working groups (WG) that will carry the various aspects of the overall goal on the impact of the Cloud-based technologies and its applications on education.

The four WG will manage old and new ideas as well as new and promised in the application activities on behalf of the Network, and thus collectively determine the way the Network will precede in accomplishing its tasks. However, each of the working groups will focus on their own goals, objectives, activities and deliverables, meeting and working to examine the state of the art in their particular areas of interest, produce information, reports and guidelines, but always reporting back to the main Network conference their work and findings. The Working Groups, as shown in Figure 6, are presented below.

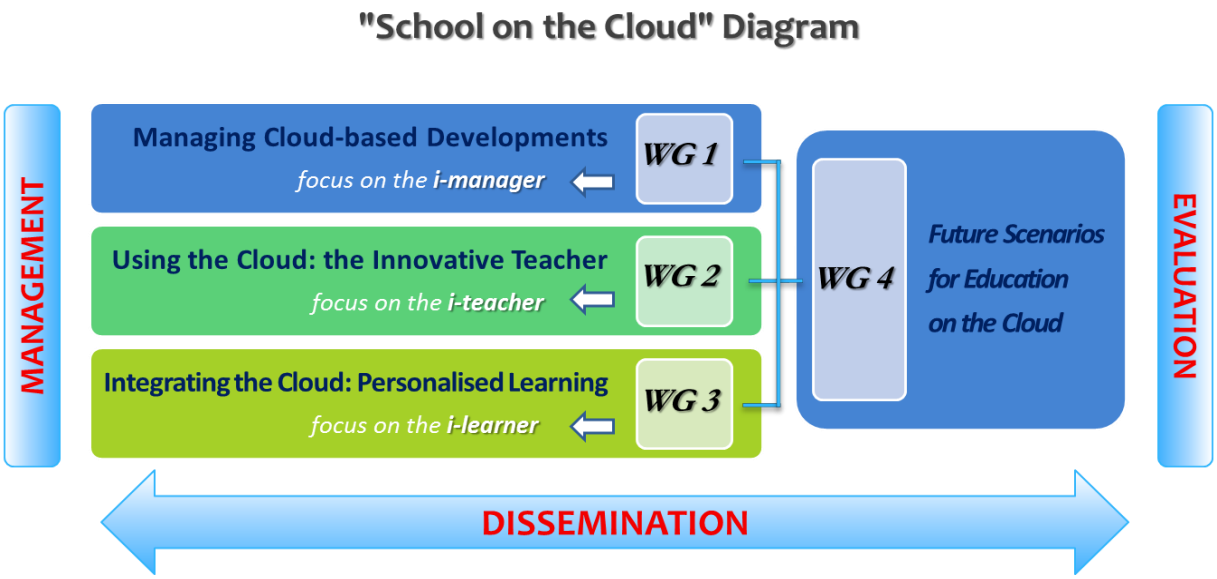

Figure 6. The SoC framework

WG 1: i-Manager – Managing Cloud-based developments

The goal of WG 1 is to identify and share technological, social, economic, cultural and other experiences in different educational contexts, by examining aspects of educational leadership, management and organizational change in an era of Cloud-based developments. In order to accomplish that WG1 will examine aspects of leadership and management, essential if and when educational organizations decide to implement Cloud-based technologies. As a result, the group objective will be to produce a "Cloud-based Technologies Map" that will allow those involved in leading Cloud developments to consider different parameters in order to transfer good practice to their own circumstances.

WG 2: i-Teacher – Using the Cloud: the innovative teacher

The goal of WG 2 is to explore the impact of Cloud computing on teachers and trainers in informal and formal educational environments and the resulting teaching processes. In order to accomplish that WG2 will examine the impact of Cloud-based technologies on the role of teachers and trainers in education by examining the use of Cloud technology and applications as a value-added component in education. That is, examine the barriers and key competences required and provide practical and essential guidance for teachers and teacher educators

WG 3: i-Learner – Integrating the Cloud: personalized learning

The goal of WG 3 is to explore the opportunities provided by the Cloud-based technology in personalising learning experiences "at any time, any place by any one". That is, it will be concerned with teachers and educators, schools, colleges and adult education providers in order to understand how to exploit, using the new technologies, the opportunities resulting from both formal and informal learning situations. In order to accomplish that WG3 will examine the impact of Cloud-based technologies on personalized learning.

WG 4: i-Future – Future scenarios for Education on the Cloud

The goal of WG 3 is to explore future tools, methods and opportunities that can be provided by the Cloud-based technology on teachers and trainers in informal and formal educational,

by providing the exploitation of "Future scenarios for Education on the Cloud". In order to accomplish that WG4 will examine the future impact of Cloud-based technologies on education.

Conclusions

The literature indicates that most members of the education community independent of national conditions, level of education and educational role (Meier, 2012; Gaytos, 2012; Gutta, 2012; Cruz, 2011; Northgate, 2012) have accepted the need for a new paradigm where the integrating role and the advantages offered by cloud computing will provide the framework within which it has to develop. That is, the approach termed in this paper as School on Cloud is a universal response of the education community to Katz's (2008) claim that "*We are in a time of emergence when the best advice is to observe and to be sensitive to areas from which change is emerging.*" Indeed SoC which can be accessed and manipulated by a large number of users in real-time by using mobile devices in the classroom and thus allowing teachers and students to gain access securely, flexibly and with less costs to resources via personal devices such as smart phones, iPads, tablet PCs and laptops.

In addition, the contribution, significance and comparative advantage of the proposed new paradigm and the mechanism to apply it (SoC) is the extremely simple concept of integration. More specifically, up to now the three basic educational actors (students, teachers and administrators) are considered by the education community as independent and sometimes conflicting pedagogical forces (Koutsopoulos, 2008). However, the thesis of this paper is that such an approach is clearly scientifically shallow, logically unsound and mainly lacking the necessary integration required in the complicated and dialectic present day scientific, societal and educational environment. That is, the adoption of new computer technology techniques in teaching is imperative; Dede (2008) considers Web 2.0 as a seismic shift in epistemology and pedagogy. However, technology cannot be utilized alone, ignoring the other educational actors (i.e. teachers with no computer skills or lack of understanding from decision makers). The same is true in terms of the role of teachers. Clearly, nowadays teachers have to be involved in getting away from transferring knowledge to understand available information in context (this paper suggests cloud information) or using it to solve problems. But this cannot be achieved without the help of school administrators and/or public officials. A School Principal or the Ministry of Education can certainly design an innovative program, along the lines of SoC, but if parents and teachers are not convinced to co-operate a failure is inevitable.

Basically, all stakeholders in the pedagogical process are teaching and learning factors, which have as common background their educational dimension. But most importantly, they are closely interrelated and not independent, inadvertently complementary and not conflicting and thus they can be integrated into an educational "whole", termed the SoC approach. As a result, according to this paper, they should be considered as components of an integrated teaching and learning approach representing different manifestations of a holistic methodology, the foundation of the proposed paradigm.

In conclusion, accepting the unavoidable presence of a new paradigm, there is a need to develop a new approach to education based on cloud computing and the SoC Network directed by Doukas School is the first attempt towards that goal.

Acknowledgement

SoC: "School on Cloud: Connecting Education to the Cloud for Digital Citizenship" Project (Coordinator: Doukas School) has been funded with support from the European Commission: Lifelong Learning Program (ICT Key Action 3 European Project 543221-LLP-1-2013-1-GR-KA3-KA3NW).

References

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Longman Publishers.*

Beyond Current Horizons (2009). *6 Future scenarios*. Beyond Current Horizons Programme, Futurelab, Retrieved 4 February 2014, from http://www.beyondcurrenthorizons.org.uk/scenarios.

Brown, J. S., & Adler, R. P. (2008). Minds on fire: Open education, the long tail, and Learning 2.0. *Educause Review*, 43(1), 17-32.

Conole, G. (2010). Facilitating new forms of discourse for learning and teaching: harnessing the power of Web 2.0 practices. *Open Learning*, 25(2), 141-151.

Cruz, L. (2011). *How Cloud Computing is Revolutionizing Education*, Cisco Technology News.

Dede, C. (2008). A seismic shift in epistemology. EDUCAUSE Review, 43(3), 80–81. Retrieved 4 February 2014, from http://net.educause.edu/ir/library/pdf/ERM0837.pdf.

Donert, K. (2013). *Lifelong learning Programme Application Form, KA3_MN_EL_SoC. Brussels: European Commission.*

Donert, K., & Bonanou, H. (2014). *Education on the Cloud 2014: State of the Art.* Retrieved 4 February 2014, from http://www.schoolonthecloud.eu.

Drago-Severson, E. (2009). *Leading adult learning development in our schools*. Thousand Oaks, CA: Cornin/Sage Press.

Ercan, T. (2010). Effective use of cloud computing in educational institutions. *Procedia Social and Behavioral Sciences,* 2(2), 938–942.

European Communities (2007). *Key Competences for Lifelong Learning*. Luxembourg: Office for Official Publications of the European Communities.

Fullan, M., & Langworthy, M. (2013). *Towards a New End: New Pedagogies for Deep Learning,* Retrieved 4 February 2014, from http://www.newpedagogies.info/wp-content/uploads/2014/01/New_Pedagogies_for_Deep Learning_Whitepaper.pdf.

Gaytos, C. (2012). *Education: Why cloud computing?*. Cloudtweaks. Retrieved 4 February 2014, from http://www.cloudtweaks.com/2012/02/education-why-cloud-computing.

Gialamas S., Pelonis P., & Medeirod, S. (2013). Metamorphosis: a collaborative leadership model to promote educational change, *Thoughtful Mind*. Institute for Innovation and Creativity, ACS, Athens. Retrieved 4 February 2014, from http://issuu.com/acsathens/docs/final_publicity_book_2012/23.

Gutta, S. (2012). *Education in the Cloud: How one school is revolutionizing the classroom. Boxblog.* Retrieved 4 February 2014, from http://blog.box.com/2012/07/education-in-the-cloud-how-one-school-is-revolutionizing-the-classroom.

Jimoyiannis, A., Tsiotakis, P., Roussinos, D., & Siorenta, A. (2013). Preparing teachers to integrate Web 2.0 in school practice: Toward a framework for Pedagogy 2.0. *Australasian Journal of Educational Technology*, 29(2), 248-267.

Jonassen, D. H., Carr, C., & Yueh, H. P. (1998). Computers as Mindtools for engaging learners in critical thinking. *TechTrends*, 43(2), 24–32.

Katz, R. N. (2008). *The Gathering Cloud: Is this the end of the middle?. Educause,* Retrieved 4 February 2014, from http://www.educause.edu/research-and-publications/books/tower-and-cloud/gathering-cloud-end-middle.

Koutsopoulos, C. K. (2008). Teaching Geography: Instructing with GIS and about GIS. In K. Donert (ed.), GIS in Education (pp. 25-37). San Diego CA: ESRI Press.

Kuhn, S. T. (1962). *The structure of scientific revolutions.* Chicago: University of Chicago Press.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

McLaughlin, C., & Lee, M. J. W. (2010). Personalized and self-regulated learning in the Web 2.0 era: International exemplars of innovative pedagogy using social software. *Australasian Journal of Educational Technology*, 26(1), 28-43.

Meier, J. D. (2011). *The Gamification of Education.* J.D. Meier's blog. Retrieved 4 February 2014, from http://blogs.msdn.com/b/jmeier/archive/2013/02/27/the-gamification-of-education.aspx.

Mell, P., & Grance, T. (2011). *The NIST Definition of Cloud Computing*. Gaithersburg, MD: National Institute of Standards and Technology, U.S. Department of Commerce.

Nicholson, J. (2009). *Cloud Computing's Top Issues for Higher Education*. University Business Solution for Higher Education Management. Retrieved 4 February 2014, from http://www.universitybusiness.com/viewarticle.aspx?articleid=1342&p=4#0.

Northgate, D. (2012). *Northgate Managed Services secures £170m contract to provide Education Cloud for Northern Ireland*. Capita Managed IT Solutions, UK. Retrieved 4 February 2014, from http://www.capita-mits.co.uk/News/Northgate-Managed-Services-secures-%C2%A3170m-contract#sthash.VUigImlG.dpuf.

Partnership for 21st Century Skills (2009). *P21 framework definitions*. Retrieved 4 February 2014, from http://www.p21.org/storage/documents/P21_Framework_Definitions.pdf.

Pearlson, K. E., & Saunders, C. S. (2006). *Managing and Using Information Systems: A Strategic Approach*. NJ: John Willey & Sons (third edition).

Pearsons, T. (2007). An Outline of the Social System. In C. Calhoun, J. Gertes, J. Moody, S. Pfaff & I. Virk (eds.), *Classical Sociological Theory* (pp. 421-440). Malden, MA: Blackwell Publishing.

Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, 9(5), 1-6.

Sheth, R. (2010). *Movers and Shakers Interview*. Frost & Sullivan's Unified Communications & Collaboration group. Retrieved 4 February 2014, from http://www.frost.com/prod/servlet/market-insight-print.pag?docid=194716100.

Siemens, G. (2003). *Learning Ecology, Communities, and Networks extending the classroom*. Retrieved 4 February 2014 from http://www.elearnspace.org/Articles/learning_communities.htm.

Thomas, P. Y. (2009). Cloud Computing: A potential paradigm for practicing the scholarship of teaching and learning. Retrieved 4 February 2014, from http://www.ais.up.ac.za/digi/docs/thomas_paper.pdf.

UTAS (undated). Welcome to the Western education system. University of Tanzania (UTAS) Information booklet. Retrieved 4 February 2014, from http://www.teaching-learning.utas.edu.au/__data/assets/word_doc/0015/1167/students_welcome.doc.

Van den Brande, L., Carlberg, M., & Good, D. (2009). *Learning, Innovation and ICT: Lessons learned from the ICT Cluster, Education and Training 2009 Programme*. Brussels: European Commission.

Wiles, J. (2007). *Redesigning Schools-Redefining Education*. DesignShare.Com. Retrieved 4 February 2014, from http://www.designshare.com/index.php/articles/redefining-education-full.

To cite this article: Koutsopoulos, K. C., & Kotsanis, Y. C. (2014). School on Cloud: Towards a paradigm shift. *Themes in Science and Technology Education*, 7(1), 47-62.

URL: http://earthlab.uoi.gr/thete/index.php/theste