The Potentials of Using Cloud Computing in Schools: A Systematic Literature Review

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ABSTRACT
Cloud Computing (CC) refers to the physical structure of a communications network, where data is stored in large data centers and can be accessed anywhere, at any time, and from different devices. This systematic literature review identifies and categorizes the potential and barriers of cloud-based teaching in schools from an international perspective. This study applied the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology for determining the articles and reporting analysis. A total of 510 articles were identified from ERIC, IEEE Xplore, Science Direct, and Primo. After screening and eligibility checking, 13 articles focusing on "cloud computing and school" were included for qualitative and meta-analysis. The papers are coded, devising 31 themes grouped into five categories. The adoption of CC in schools is associated with five factors: 1) globalization (easier access to education, data access everywhere/accessibility/infrastructure, 21st Century Skills), 2) educational benefits (motivation, teacher-parent communication, collaboration, flexibility, productivity, creativity, self-organized learning, communication, sharing of knowledge, problem-solving, responsible students/peer review/no bad excuses), 3) administrative benefits (economy—operations, computer lifetime, licenses, timesaving, BYOD, software diversity), 4) barriers (technical barriers, cultural barriers, security, privacy, laws and regulations for schools, age restrictions/parent acceptance, and opacity), and 5) implementation (management support, paradigm shift in education, incongruence between implementation strategies).

INTRODUCTION
Information communication technologies (ICTs) have led to a paradigm shift in schools in recent years, influencing teachers' roles, learners' roles, content, and practices (Faroese, 2012). ICT is now an integral part of the daily practice of schools around the globe, with teachers being expected to adopt and integrate ICT into their teaching. The Danish Ministry of Education defines the role of ICT as "collecting, processing, storing, and disseminating information" (EMU Denmark's learning portal, 2015, translated). In recent years, the use of ICT in schools has largely focused on the Internet's potential for collaboration, production, and the reproduction of digital products. Specifically, the adoption of Web 2.0 applications and Cloud Computing (CC) has become an essential factor for modern education.

The concept of Web 2.0 first appeared in the article "Fragmented Future" (DiNucci, 1999), but it was made popular in 2004 by Tim O'Reilly and Dale Dougherty at the Web 2.0 Summit in San Francisco. This concept implies a new approach to the Internet, whereby users work together to create and edit content. Web 2.0 primarily refers to a changed mindset regarding how to use the Internet. On the other hand, CC refers to the physical structure of a communications network, through which data is saved and stored in large data centers and can be accessed anywhere, at any time, and from different devices.

Since 2004, Web 2.0 and CC have made their main entry with services like Wikipedia, Facebook, YouTube, and, later in 2010, with Google Drive, which was a groundbreaking development for its use in education. Jeppe

Bundsgaard (2010) divides digital teaching resources into six categories, with CC fitting into the category of *shell/utility programs*, which are primarily used to produce and store data online. These new Web 2.0 services have revolutionized the way the Internet is used by moving the user from a passive role as the recipient of information to an active role as a player in the content's co-creation. This modified approach to the use of the Internet has spread to schools, where teachers have begun using CC in their teaching. In 2013, 42% of the K-12 schools in the United States were in the process of implementing or already using CC to store data. There was a 15% nationwide increase during the period of 2011 to 2013 (Carahar & Nott, 2013). In Danish schools, many municipalities have chosen to discontinue the use of shared drives in favor of CC. Contrary to this trend, the municipality of Odense, like several municipalities in Sweden, opted not to use Google Drive, as the service did not live up to the municipalities' data processing requirements (Madsen, 2014). It is clear that there are some underlying reasons for the adoption of CC and the discontinuation of alternative ICTs, which can be interpreted as the greater potentials of CC and its functions or values that circumvent or even solve some of the existing challenges posed by other forms of educational technologies.

The objective of this systematic literature review is to identify and categorize the potentials of cloud-based teaching in schools from an international perspective. The underlying research question is: from a globalization perspective, what are the reasons behind the integration and adoption of cloud-based applications in teaching activities of schools?

METHODOLOGY

This section provides an overview of the methodological approach used for the literature selection and the method applied for analysis. This literature review is conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, which is used to create a systematic, precise, and reliable overview of the literature (Moher, Liberati, Tetzlaff, & Altma, 2009). The process of collecting articles for analysis is guided by a flow-chart that includes four phases, and the process for reporting a literature review includes a 27-step checklist. PRISMA defines a systematic review as "a review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyze data from the studies that are included in the review" (Moher, Liberati, Tetzlaff, & Altma, 2009).

This paper reviews the potential of cloud-based applications in schools. Therefore, various combinations of the following keywords were used: cloud, K-12, classroom, benefits, pros, potentials. The search was restricted to peer-reviewed texts and was conducted in English to obtain a global perspective on the topic and avoid too-narrow searches. The search was limited to the period between 2010 and the search date (September 24, 2015). This restriction was implemented because Google Docs, a CC frontrunner in education, went from the beta version to the official in 2010. Furthermore, in 2010, the arrival of iPad revolutionized the development and adoption of could-based educational applications through different platforms. In consultation with a librarian and after testing different combinations of keywords, four databases were selected, and different combinations of the keywords were used. ERIC returned 23 results, IEEE Xplore returned 266, Science Direct returned 171, and Primo returned 50.

Figure 1, the PRISMA flow diagram, shows four phases: "identification," "screening," "eligibility," and "included." The "identification" phase returned 510 results via the four databases. In addition, six texts were included as the result of chain searches, which is where known literature is used as a starting point for finding additional literature related to the topic. In the first part of the "screening" phase, five duplicate articles were removed. Furthermore, 476 texts were excluded because the title, keywords, or abstract did not contain the desired themes. The criteria used to reduce the number of texts were as follows: 1) the text has no connection to schools and 2) the text does not refer to any kind of cloud service.

In the third phase, "eligibility," 35 texts were left, and of these, an additional 22 texts were excluded because they did not contain a sufficient connection between schools and cloud services. In the final phase, "included," there were 13 texts remaining to be included in the quantitative synthesis and analysis.

This study applied a coding technique presented by Tayler-Hewitt (2001). The articles were encoded according to themes and then divided into categories. During this process, the coded sections were regularly compared to similar parts of texts containing the same codes. The intention was to create a connection between the texts and ensure the continuity of the codes' definitions (Strauss & Corbin, 1990; Hewitt-Taylor, 2001).

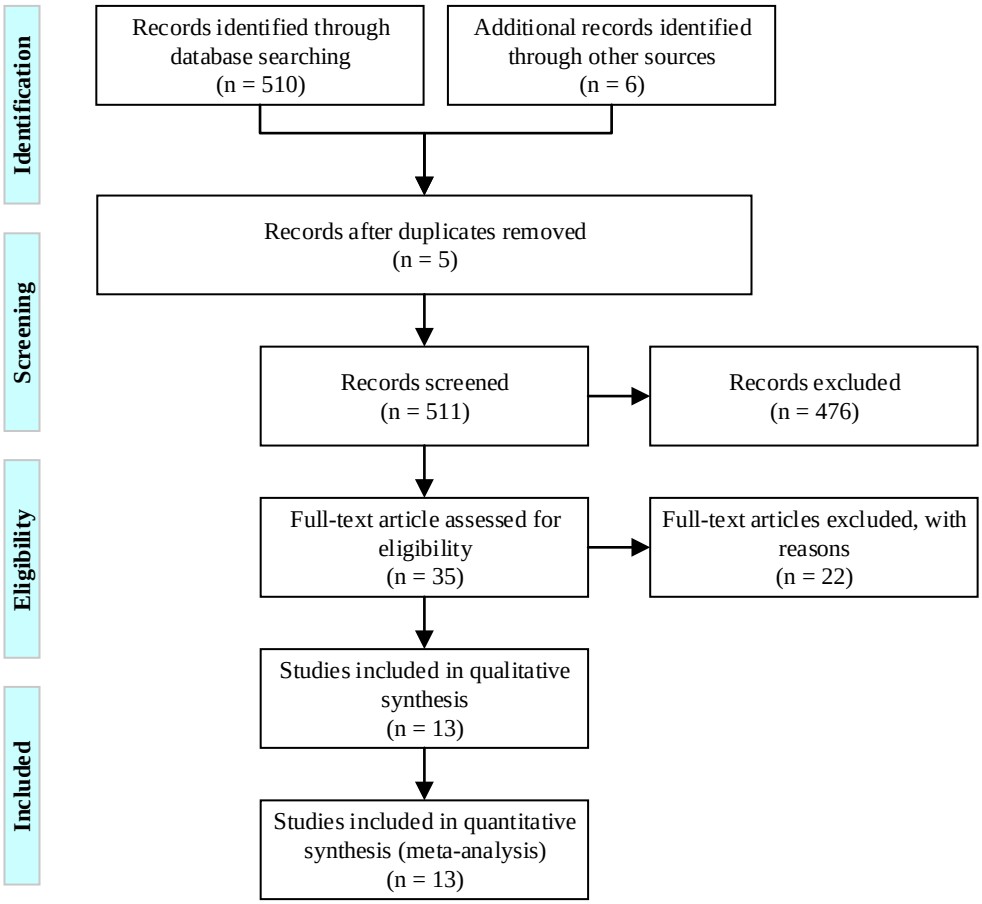

Figure 1. PRISMA Flow-Chart

Globalization in the Context of Education

Globalization in the education context includes a number of intertwined discourses and processes worldwide. Spring (2008) refers to globalization and education as involving discourses concerning knowledge, economy, technology, and lifelong learning. Such factors in a global context influence a variety of practices in a local context. Under the influence of major intergovernmental institutions, such as the OECD, the global education policy forms a so-called "super structure" through various international networks and processes that influence the school system at a national level. The authors also talk about a global super structure, which refers to when multiple nations adopt a political agenda on the basis of a global policy in order to comply with the global economy. For example, Denmark's National Learning Festival, held in September 2015, put a special focus on 21st century skills. These skills were originally formulated by global public and private organizations in 2002 in order to create a learning model that would prepare students and citizens for the new millennium, where the development of these skills would support international competitiveness (P21, 2015). Spring (2008) expands on this by examining the extent to which the world's governments discuss how to invest in training for human capital development for the sake of promoting economic growth, sayng that, "As a consequence, educational discourses around the world often refers to human capital, lifelong learning for improving job skills, and economic development" (Spring, 2008, p. 132). He also accounts for technology's role in this context, explaining that, "Information and communication technology is speeding the global flow of information and creat[ing] a library of world knowledges" (Spring, 2008, p. 132). This paper thereby considers the term globalization as a product of the discourses and trends of international and intergovernmental institutions that influence the national school practice for the sake of developing training and human capital that can promote global competitiveness. At the same time, ICT acts as a generator of this development.

Competence

The term competence can be defined as a complex fusion of knowledge, skills, and abilities, and the use of these in a given context. The European Network KeyCoNet (2012) selected eight key competences that were considered necessary for achieving personal development, active citizenship, and social inclusion in the 21st century. These included digital, social, and civic competences and the skill to communicate in the mother tongue (Looney & Michel, 2014). The educational focus has shifted from teachers' teaching approaches to students'

learning approaches. Additionally, competence is described as the context-oriented skills of a student—namely, the skills that make him or her able to cope in specific situations in real life and capable of working in certain professional fields. Competence is even formulated as concrete learning. For example, the students' ability to solve problems would be the goal (Egelund, 2014). Therefore, one of the objectives of this paper is to explore what the existing literature says about the use of cloud services in this characterization of 21st century competency.

Lifelong Learning and Educational Development

Spring (2008) presents lifelong learning as a part of the discourse on the knowledge economy. Since technology changes rapidly and continuously, there is a continuous change in the knowledge economy. Therefore, it is important to prepare students for lifelong learning. This focus has a substantial impact on curricula (Spring, 2008). It is not just the technologies that are constantly changing, but also the global job market, and that is why Spring (2008) discusses the essential skills that students have to learn, namely: communication, interpersonal, and collaboration skills; the capacity to assume personal responsibility; and the ability to learn new subjects. At the same time, Castell presents the concept of "self-programmable labor" (Levinsen, 2011), which refers to the labor in the network society that allows self-initiated lifelong learning. This type of labor, unlike "generic labor," succeeds in the context of global competition. Castell suggests that the education system must accept the task of fostering self-programming students (Levinsen, 2011). Thus, in this study, one of the viewpoints is to inquire as to how CC contributes to lifelong learning and educational development.

QUALITATIVE SYNTHESIS

This section presents the qualitative synthesis of the 13 articles on using cloud computing in schools.

To begin with, the 13 texts were read and the relevant concepts were coded. The codes were generated from the text material. Accordingly, the analysis has an inductive starting point (Hewitt-Taylor, 2001). These codes represent different themes associated with the overall subject. A total of 31 themes were generated by the codes to reflect the context of the 13 texts. These 31 themes were then synthesized under five broad categories, which cover all the themes. Subsequently, all texts were read again, and the themes, in the form of selected quotes, were distributed across the five categories. Finally, the citations were processed according to whether they were central points, convergent statements, or divergent statements. The final qualitative synthesis was performed on these five categories. Hewitt-Taylor's (2001) approach was regularly inspected to obtain the criteria: *reliability*, *credibility*, and *transparency* (Lincoln & Guba, 1985; Hewitt-Taylor, 2001). The themes were distributed across the following categories:

Category 1: Globalization
- Easier access to education, data access everywhere/accessibility/infrastructure, 21st-century skills

Category 2: Eductional benefits
- Motivation, teacher-parent communication, collaboration, flexibility, productivity, creativity, self-organized learning, communication, sharing of knowledge, problem-solving, responsible students/peer review/no bad excuses

Category 3: Administrative benefits
- Economy (operations, computer lifetime, licenses), time saved, BYOD, software diversity, documentation

Category 4: Barriers
- Technical barriers, cultural barriers, data security, privacy, school laws and regulations, age restrictions/parent acceptance, opacity, reliability

Category 5: Implementation
- Management support, paradigm shift in education, incongruence between implementation strategies, cloud implementation

Table 1 presents an overview of the articles and a matrix for the identified themes in each of the papers.

Table 1. Schematic overview of the articles

Year of publication	2010	2011		2012				2013					2014
Author	Thomas	Weil	Carroll, Merwe & Kotze	Chandra and Borah	Stein, Ware, Laboy, & Schaffer	Bedell, C.	Masud, Xiaodi & Yong	Alizadeh & Hassan	Hung & Lin	Mahalingam & Rajan	Kovnot, Norton, Cloutier &	Ullman	Bathon
Title	paradigm for practicing the scholarship of teaching and	On Cloud Nine	Secure cloud computing: Benefits, risks and controls	Cost benefit analysis of cloud computing in education	via a Cloud designed for	The state of cloud computing in K-12	Cloud Computing for Higher Education: A roadman	Challenges and opportunities of Mobile Cloud Computing	Integrated Cloud Application in School Knowledge	Affordances of the 21st	Privacy and Cloud Computing in Public Schools	The Case for Cloud Computing in K12	The Fine Print on Cloud Computing
Background													
Geographical distribution	Botswana	USA	South Africa	India	USA	USA	Australia	Malaysia	Malaysia	Dubai	USA	USA	USA
Type of text: Conference article (C) or journal article (J)	J	J	J	C	J	J	C	C	C	C	J	J	J
Themes													
21st century skills	x			x					x	x			
Age Restrictions/parents' acceptance											x		
Responsible students/Peer review/No bad excuses	x	x											
Bring Your Own Device (BYOD)		x		x		x			x	x		x	
Cloud implementation		x		x			x		x		x	x	
Data security	x		x		x	x		x			x		x
Data access everywhere/accessibility/infrastructure	x	x			x	x	x	x	x	x	x	x	
Software diversity		x			x				x				
Documentation	x	x							x				
Reliability											x		
Flexibility	x	x		x		x	x	x	x	x		x	
Globalization	x	x		x		x			x	x		x	
Incongruence between implementation strategies							x		x				
Collaboration	x	x		x		x			x	x		x	
Communication (students/teachers/parents)		x									x	x	
Creativity				x						x			
Cultural barrier		x			x	x	x		x	x			
Management support									x	x			
Laws and regulations for schools	x										x		x
Motivation	x	x											
Easier access to education	x					x							
Paradigm shift in education	x	x				x						x	
Problem-solving										x			
Productivity	x	x		x		x				x		x	
Self-organized learning		x				x							

Teacher-parent communication													
Technical barrier					x			x			x		
Time saving	x											x	
Opacity											x		
Sharing of knowledge	x	x				x	x			x		x	
Economy (operation, computer lifetime, licenses)	x	x			x	x					x	x	

Figure 1: Geographical distribution of the 13 articles

Category 1: Globalization

Some of the most striking examples of CC's influence in the global arena is described in the articles at two levels. One example is the use of CC in an educational context to increase living standards in the world's most vulnerable regions. The other is the inherent potential of CC to support the skills needed in the global community.

Mahalingam and Rajan (2013) give insight into how CC has found its way into education, explaining that, "One such development which is gaining acceptance and widespread adaptation is 'cloud computing,' supported by the notion of 'bring your own device' (BYOD)" (p. 125). The prevalence of CC in areas of great economic diversity is due to their perspective, which is partially the result of BYOD, as this enables the areas to be included in the global education community. Chandra and Borah (2011) adds that there is less of a need to upgrade the software when using CC.

India is described as an example of how education is becoming an important factor for development and the rise in general living standards:

> The development of the education sector is [a] solution for economic growth and improvement in the standard of living. The challenges posed by the growing demand for education requirements are gigantic. India will have about 45 million people in the age group of 18 years to 20 years by 2020 (Chandra & Borah, 2011, p. 4).

Therefore, India wagered on the National Knowledge Network (NKN), whereby the country's knowledge-related institutions were given high-speed networks to make scientists and researchers capable of offering students instructions via CC in areas of growth or deprivation (Chandra & Borah, 2011). Bedell (2014) estimates that CC helps ensure that people in all regions can have access to quality education, something that cannot be done without the cloud. Therefore, in the coming years, CC is predicted to grow globally in its use for educational purposes.

Duffy and Jonassen (in Mahalingam & Rajan, 2013) look at the demands of globalization for the students' skills in the 21st century and how teachers, by utilizing CC, can support the development of these skills among students:

> Teachers in the role of facilitators can leverage the cloud infrastructure built by Google, Box, Podio, Microsoft and several others to practice and prepare the students for the 21st century skills. Students can now create a project report in Google Drive or Microsoft SkyDrive and start collaborating by editing, commenting and engagement in knowledge construction any time anywhere working simultaneously in the same document, which changes the way people look at collaboration in the 21st century (Mahalingam & Rajan, 2013, p. 70).

The inherent affordances of CC that enable a ubiquitous global learning environment can facilitate an educational paradigm shift from teacher-centered to student-centered learning. These changing circumstances require teachers to be better prepared for new technology. CC's potential in education is further elaborated in the following section.

Category 2: Educational Benefits

The literature points to a number of advantages for CC use in education, some of the most prominent being collaboration, efficiency, motivation, universal data access, and unlimited space for data storage.

The widespread use of BYOD in schools, as well as the increase in the use of tablets in the classroom, supports the need to consider CC (Mahalingam & Rajan, 2013). One of the major benefits of CC in education is the potential for collaboration. As Chandra and Borah put it, "In Cloud Computing[,] teachers and students [as well as] students and students can implement collaborative learning such as the online exchange, online document editing, …[and online use of the] concept map tool[s] like [the] Google Collaboration Platform" (2011, p. 2). The intent of collaboration is for all students to contribute, which helps to create a cooperative culture (Hung & Lin, 2013; Thomas, 2011).

Collaboration creates a community in which it is possible for students to receive emotional support while building trustful ties within the student group. This is not restricted to inter-student relations, however, as teacher interactions can also be improved through CC. As (2011) described, "If Mitchell happens to be online while students are working on their assignments, he can simply 'pop in.' Students can communicate with him or with other students via instant message. Mitchell can also give instant demonstration, and the students can follow up immediately with questions" (p. 3).

This kind of "real time" feedback is crucial to students' success. The fact that teachers can collaborate on the knowledge construction with their students enables them to give timely support and comment on their work (Mahalingam & Rajan, 2013). The community this creates will be capable of overcoming the indifference of self-studying and improving interactions between the users (Chandra & Borah, 2011; Hung & Lin, 2013).

Furthermore, cloud computing also creates more efficiency and motivation among students. "Using the application also holds students more accountable; excuses like 'the dog ate my homework' don't fly in the virtual world [...] Students come to class prepared […] That alone creates a more enriching and efficient classroom environment" (Weil, 2011, p. 3). With this technology, teachers can teach more convincingly, and thus create greater enthusiasm and motivation among students (Weil, 2011).

Another major advantage of CC is that it provides access to information anywhere. As Thomas puts it, "Users can reach into the cloud for resources as they need from anywhere at any time. For this reason, cloud computing has also been described as 'on-demand' computing" (2011, p. 218). This creates more flexibility in the school day and allows learning to continue outside of school (Stein, Ware, Laboy, & Schaffer, 2012). The primary advantage of this is that teachers and students have easy access to information and can share documents immediately. This means that we are moving more and more into a future of self-organized learning, according to Bedell (2014). Furthermore, the availability of information outside of school improves communication between school and home:

> Through access to certain information stored in the cloud, teachers can have better communication with parents and students when it comes to projects, tests and assignments. Teachers can post messages. Parents can log in to secure servers to check their child's progress and online cloud forums allow for two-way school-to-home dialogues (Ullman, 2015, p. 3).

By extension, the literature highlights unlimited storage in cloud services as an advantage. "Both Microsoft and Google recently announced unlimited storage, relieving districts of the massive storage requirements associated with digital student portfolios" (Bedell, 2014, p. 3). The advantage of this is that no one needs to make backups or transfer data from one device to another (Thomas, 2011). Groups can also quickly gather a variety of

information in one place and easily share it with another group for viewing or editing, the whole school, or the entire world (Hung & Lin, 2013). The same applies to the teachers:

> Teachers can review what they have accomplished in the past. At the beginning of the year, when teachers make their plans for the upcoming school year, it can serve as a good repository of their experiences and ideas, especially, when different personnel take over new posts. Moreover, they can quickly review past experiences and work tasks (Hung & Lin, 2013, p. 7).

Category 3: Administrative Benefits

At the administrative level, CC distinguishes itself by offering a number of benefits to the individual school, the whole school district, and collaboration across schools. The administrative benefits can be divided into: 1) the economic benefits of the use of CC; 2) division of labor, which can be improved by using CC; and, finally, 3) the streamlining of already established school procedures.

Economy

The literature paints a clear picture of a wide range of economic benefits for using CC in schools. For one thing, CC can serve as a more cost effective way to increase productivity and collaborative learning activities in schools (Bedell, 2014, p. 4).

By using CC, there is no longer a need to install software locally on the computer, which is preferable economically since software maintenance is outsourced to the cloud service. As Thomas (2011) describes, "There is no need to buy hardware and software licenses and pay for maintenance. Thus, the cloud model offers a much cheaper way to acquire and use IT services; this is quite beneficial especially for educational institution in these days of appalling economic crunch" (p. 218). In addition to the maintenance savings, CC allows document exchange between teachers and students to be done digitally, which eliminates the need for expensive printing and copying solutions. Ullman (2015) estimates that switching to a cloud service saves up to five times more than the current analog solutions.

The use of CC is also highly scalable, as it is both quick and easy to purchase additional licenses for a cloud service, as opposed to investing in new software installation. It is easy to start small and then buy more licenses when the need arises (Ullman, 2015, p. 6). Furthermore, "By its design, cloud computing is scalable, flexible and elastic—offering IT departement a way to easily increase capacity or add additional capabilities when necessary, without investing in new and expensive infrastructure, training new personnel, or licensing more software" (Thomas, 2011, p. 219; Stein, Ware, Laboy, & Schaffer, 2012). In many cases, different users can use the software licenses at different times. For example, a school of 500 students could buy just 100 software licenses to cloud services and then take turns using them. As Ullman (2015) explained, "With most cloud services, the district pays for only what it uses (in terms of storage and services)" (p. 5). In many cases, a higher price is negotiated for shared licenses to compensate for the increased use, but it is still a significant saving for financial pressed schools (Stein, Ware, Laboy, & Schaffer, 2012, p. 238).

Cloud services are used online, so there is no software installed locally on the school's computers. This releases storage space and allows older computers an increased their life span, as the cloud services are run remotely from a computer with better processing power. As one piece of literature describes, "The Cloud opens the door to low-cost computing power. Because the computational power needed to run applications is provided remotely, schools can save costs through the use of older and less powerful computers. Lengthening the life of hardware substantially lowers the cost of ownership" (Stein, Ware, Laboy, & Schaffer, 2012, p. 238). Chandra and Borah (2011) conclude that the cost of switching to a cloud service is cheaper than replacing older computers.

Division of Labor

By switching to CC, technical barriers such as software updates and system crashes are no longer an issue for the school or the teacher. The cloud service provider ensures that the software is updated and working properly and allows further access to the material anywhere and anytime (Weil, 2011, p. 4). This frees up the teachers' time as they no longer need to take care of technical challenges, but can instead focus on their core mission—teaching (Hung & Lin, 2013; Ullman, 2015).

Streamlining

Teachers can be more efficient by using CC, since "by storing content online, teachers no longer need to spend time and resources printing or copying long documents or lesson plans" (Ullman, 2015, p. 3). In addition, the barriers that some teachers face by working with technology dissapear, as working with CC does not require

special IT knowledge from the teacher, as "there is no requirement for professional programming abilities. We do not need to worry if the School does not have a professional programmer. We can concentrate on our work and responsibilities as long as we can do basic data entry" (Hung & Lin, 2013, p. 7).

Teachers' and students' materials are stored online, which eliminates both the need for USB drives to store data and the need for archives to hold large folders with printed assignments and student information. Thomas (2011, p. 219) describes efficiency as "no need to copy all stuff from one PC to another when buying a new one. It also means you can create a repository of information that stays with you and keeps growing as long as you want them."

Category 4: Barriers

After a review of the educational and administrative benefits of CC, it is important to clarify what barriers the literature highlights. The cultural barriers are most important, while the technical barriers have a less prominent role.

Besides these two barriers, there are also a number of concerns regarding the use of CC in schools. These uncertainties mainly regard confidential agreements, which, among other things, involve privacy, security, anonymity, monitoring, reliability, and responsibility (Thomas, 2011, p. 220).

Cultural Barriers

As the literature describes, "One of the central insights we have gained is that the barriers to adoption are as much, if not more, cultural than technical" (Stein, Ware, Laboy, & Schaffer, 2012, p. 239). Cultural barriers are one of the biggest obstacles to the integration of CC. One of the critical challenges is the mismatch between digital immigrants, who constitute the majority of teachers, and the digital natives, or the students. The challenge for teachers is to manage and follow technological development (Mahalingam & Rajan, 2013).

> Much of the resistance to change to adopt these technologies is intrinsic rather extrinsic. Teachers are often comfortable to main the status quo and resist changing due to the fact that these technological affordances are still concidered as optional and often viewed as tech savvy teacher's prerogative (Mahalingam & Rajan, 2013, p. 127).

Teachers must see the benefits of the technology and discover that they can meet their needs more efficiently by using it. In addition, there needs to be training and support in the use of CC from a colleague or an IT professional who can see the potential and is willing to carry the initiative forward (Stein, Ware, Laboy, & Schaffer, 2012). It requires planning and leadership to train these teachers so they can see the value in CC, understand how to use it, and integrate it into their current pedagogy (Bedell, 2014). The potential for sharing knowledge effectively among teachers via CC is obvious, but an organizational culture that supports this method of working must first be established, as this will create a change that supports and encourages teachers to use the technology so empty virtual archives can be avoided (Hung & Lin, 2013, p. 8).

Another barrier is the fact that technology changes rapidly, meaning that once the teachers have learned to use one function, it either evolves or a better competitor enters the market. According to Mahalingam and Rajan (2013), this creates confusion and frustration among teachers, which means that they end up waiting to see what the next change will be and the integration of technological development fails.

Technical Barriers

Previously described under *administrative benefits*, the technical barriers are no longer a challenge for schools, as the providers of cloud services are responsible for updating and maintaining the software. Additionally, it is required that the Internet functions, including its speed, so the practitioner can use CC, and each device must allow this use of it (Alizadeh & Hassan, 2013; Mahalingam & Rajan, 2013, p. 12).

Security

The literature highlights data security as a major concern, since schools have an obligation to treat sensitive student data confidentially (Stein, Ware, Laboy, & Schaffer, 2012, p. 238; Bedell, 2014, p. 4). Barthon (2013) points to this particular issue as a major limiting factor for schools to fully start using cloud services.

In a digital world, data is constantly created, archived, and deleted, and the default setting for the Internet is that it is open, meaning that all data that interacts with the Internet can be shared. This creates a problem for schools, which are under an obligation to keep student information secure (Bathon, 2013, p. 23). For this reason, confidentiality agreements between these cloud services and schools or school districts are crucial (Bathon,

2013, p. 24). As Bathon (2013) phrased it, "It is important that these documents specify that the private cloud company has no ownership interest in the intellectual property contained in the uploaded data" (p. 24).

However, cloud services can be difficult to fully understand, and the confidentiality agreements are no exception. One US study showed that only 25% of school districts inform parents that they use CC, and 20% of districts have no policies regarding online services. In addition, a large proportion of confidentiality contracts contain large gaps or are completely lacking in privacy policies (Reid Berg et al., 2013, p. 5).

This survey also indicated that school districts often surrender control of student information when using cloud services. Less than 25% of the agreements between school districts and cloud services specify the purpose of the publication of student information, and fewer than 7% of the districts prohibit the sale or use of student information for commercial purposes. Despite this, the Family Educational Rights and Privacy Act (FERPA) requires that the districts have direct control over the students' information when they are published to a third party (Reidenberg et al., 2013, p. 5).

Category 5: Implementation

Regarding the implementation of cloud services in educational institutions, the literature presents a number of recommendations, primarily aimed towards considerations related to the chosen implementation strategy. It also gives recommendations in order to clarify and anticipate the various barriers that can occur when CC is used in education.

In preparation for a strategic plan for CC implementation, it is recommended to identify the motives for the change: "Drivers for considering cloud computing solutions for educational institutes should be identified in the context of the institutional strategy and how well they align" (Masud, Yong, & Huang, 2012, p. 555). In order to succeed, it is important that the institutional strategy adapts to the CC needs:

> The success of the strategy implementation depends on the existence of a service-oriented architecture at the level of the institution that offers the necessary infrastructure for cloud implementation. Also, in order to have success, the cloud strategy must be aligned with the institutional strategy (Masud, Yong, & Huang, 2012, p. 553).

Furthermore, it is recommended that this be done early in the process in order to fully benefit from the experiences of pilot projects and to identify solutions to challenges before the full rollout is implemented. Hung and Lin (2013, p. 7) added another relevant consideration: "The most important consideration is the needs of its users." In this perspective, the user requirements should be the main motive in the implementation strategy.

Once a school district has decided to implement CC in education, it is important that it establishes policies and implementation plans for the use of the cloud service, according to Reidenberg et al. (2013). Teachers need training courses, and there must be readily available support to provide advice and assistance to teachers in the handling of data and security. Thomas (2011) points out that most teachers who make use of educational technology simply convert educational content into an electronic format and preserve the traditional knowledge-centered teaching didactics. This may delay the implementation process considerably, as: "the change is very slow or not forthcoming at all for various reasons" (Thomas, 2011, p. 216).

Moreover, the support of school leaders determines whether a new technology such as CC is integrated in the classrooms and used by the teachers (Hung & Lin, 2013). It is important that these leaders promote the importance of knowledge sharing and the creation of a genuine knowledge-sharing culture among teachers.

QUANTITATIVE SYNTHESIS

As a basis for the qualitative analysis, the remaining 13 items were used and described in the chart below (Figure 3). Five of these articles were presented at conferences between 2012 and 2013, and the remainder were published in journals between 2010 and 2015. Six of the thirteen articles describe the conditions of the use of CC in the American school system. Furthermore, articles are included from Botswana, Malaysia, India, Dubai, South Africa, and Australia.

The authors of these articles represent great geographical diversity. The majority of the researchers are based in the universities of the United States, including the Massachusetts Instititute of Technology, Fordham University, and the University of Kentucky. Beyond that, researchers are affiliated with universities in Australia, China, Japan, Malaysia, Botswana, South Africa, and the United Arab Emirates. Therefore, the articles present a wide geographical distribution of contexts for CC use, which enables a globalized look at the use of CC in schools.

Figure 2 is a representation of the keywords that are used most frequently in the 13 articles. This word cloud creates an immediate overview of the essential themes from the articles.

Figure 2: Word cloud of the keywords (generated using www.wordle.net)

CONCLUSION

The purpose of this paper was to investigate and provide an overview of the prospects and problems of cloud computing in schools. Using the systematic review methodology, 13 articles dealing with the integration and adoption of cloud computing in schools were selected and analyzed. These articles cover experiences across seven different countries and four different continents. After a thorough reading of the texts and the use of coding techniques, 31 themes and 5 categories were created as the basis for a qualitative analysis.

This paper has uncovered two distinct potentials regarding the use of CC, from a *globalization perspective*. First, CC allows teaching and learning to be accessed by a larger part of the population, including in countries and regions where distance learning has thus far been problematic. This increased level of education creates economic growth and can thereby increase the living standard in the world's most vulnerable areas. Second, the use of CC supports and scaffolds the current global discourse on educating future citizens with 21st century skills. However, there is still a gap in the literature showing the geographical distribution of CC use worldwide.

On a local level, there are a number of *advantages in education* related to the use of CC in schools. The prominent advantage is that CC enhances student collaboration, which promotes motivation and helps keep the students responsible for their own work within the community. The universal access to data across time, space, and devices allows the teaching, learning, and collaboration to take place anywhere and at any time. Finally, the review points to the advantage of unlimited data storage, which removes the problems of data loss or inaccessibility; these functions enable students and teachers to develop an ongoing portfolio of the students' work and progress in school.

A number of *administrative advantages* are also identified, especially regarding the use of CC in schools and across entire school districts. Among these are a number of economic benefits that the educational institution or the district can harvest by discontinuing local storage and authority and by adopting cloud service. These include maintenance outsourcing, extended hardware life, reduced licensing costs, and savings on expensive printing and copying solutions. In addition to the economic aspect, a number of efficiency improvements exist in the organization of work, which can reduce local resource requirements.

Despite the clear potential, the literature has highlighted a number of *barriers* in implementing CC in schools. Local cultural norms can inhibit to change, and the disparity between the teachers as digital immigrants and the students as digital natives presents an issue. Safety is also a challenge that cannot be neglected when using CC in schools. Schools are subject to national guidelines for data security, and students have the right to the privacy and the security of their data. There is a sharp contrast between the characteristic openness of the Internet and the impenetrable confidentiality agreements that the users and providers of the cloud services require. The literature is still incomplete regarding the security issues, and the results presented in this paper are exclusively based on experiences from the US.

Finally, some recommendations are presented for the future *implementation* of CC in schools. This includes a clear implementation strategy and consistent management support. Moreover, the review presents a great deal of advice for clarifying and anticipating the barriers that can occur when a CC system is implemented in a school. It is important to note that the recommendations for an actual deployment strategy are not reported by existing literature, and such a strategy will differ according to country, district, and school policies.

It is clear that CC should be implemented with careful consideration of the factors associated with each school's context. This is still a new technology concept, though the literature has yet to clarify any undesired outcomes caused by the adoption of CC.

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