# Massive Open Online Courses: A Success of Cloud Computing in Education

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#### **ABSTRACT**

Cloud computing is fast becoming the major computing paradigm in every aspect of teaching and learning. This computing paradigm supported the emergence of new learning and teaching platform called Massive Open Online Course (MOOC). MOOC is mainly delivered via the cloud and it uses the Internet to make education infinitely available to an unlimited scope of participants. This paper focuses on exploring MOOC as the success of cloud computing in education. A qualitative approach of data collection, selection and analysis were used to systematically review 149 literature for the study. The results of the study showed Infrastructure as a Service (IaaS) and Software as a Service (SaaS) as the major cloud service model used in education. Additionally, Coursera, edX, Udemy, Udacity and FutureLearn are the major MOOC providers using cloud services and resources to globally promote qualitative teaching and learning. Finally, the study outlined the characteristics, types, problems, and prospects of MOOC for education delivery.

# **CCS Concepts**

• Applied computing~Distance learning

#### **Keywords**:

Massive Open Online Courses, Education, Cloud Computing, Technology

#### 1. INTRODUCTION

Cloud computing is a promising business model[1] for remotely delivering IT infrastructure, software and platforms as services on a pay-as-you-use basis[2]. Cloud computing is considered as the only cost efficient technology[3] that has revolutionised and restructured education through its complete support for online teaching[4], learning and research [2]. Today, cloud computing provides an effective solution for addressing the scalability issues, financial crises, insufficient qualified staff, low standards and unstable policies faced in education[5].

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The promising technology used by cloud computing gave birth to various educative platforms [6], such as MOOC[7], communities of practice[8], eLearning[9], social networking[10], mobility[11], informal learning management[12], and learning analytics[13]. These platforms are now scholarly cited as the prominent cloudbased applied solution for restructuring education in the 21<sup>st</sup> century[14], [15].

A relatively new and the most notable form of these cloud-based learning and teaching platform, capable of addressing the scalability and sustainability challenges of education is MOOC[2], [16]–[18]. MOOC is "massive, with theoretically no limit to enrollment; open, allowing anyone to participate, usually at no cost; online, with learning activities typically taking place over the web; and a course, structured around a set of learning goals in a defined area of study"[19]. MOOC is considered as the "gold rush" of higher education[20] and used by universities as a prestige marketing tool[20].

Considering the hike in the cost of schools and low adoption of cloud services by schools, a research of this nature will help introduce students to low or free cost education through MOOC. Likewise, sensitise school administrators about the use of cloud service models in schools which in turn reduces the cost of school administration. Hence, this paper sought to review MOOC as the major success of cloud computing in the education sector. The paper begins by reviewing related literature. It then goes on to establishing the methodology, cloud computing service models used in education, the state of the art of MOOC in education, characteristics, types, benefits and challenges of MOOC, discussion, and conclusions.

### 2. LITERATURE REVIEW

The educational system suffers from small and unequipped classrooms, insufficient qualified staff, low standards and unstable policies[5]. These problems coupled with the exponential demand for qualitative education and diversified enrollment of students[21], [22] placed significant pressure on educational institutions[23]. Prior studies suggested the use of technology for cost efficient[23] and quality education delivery[24]–[30], thereby addressing the aforementioned challenges. However, the complexity attached to IT (acquisition, maintenance, license, virus attacks, delay, etc) has

restrained several educational institutions from its implementation[31].

With the emergence of cloud computing, IT services and infrastructures are now accessed as services rather than acquired as assets[32]. For this reason, educational institutions now focus on research and teaching rather than IT implementation[21], [23], [33], [34]. Consequently, cloud computing leads to delivery of qualitative education [23], [35], [36], enhances the access to quality educational materials[4], reduces the cost of investment[37] through the elimination of locally-hosted infrastructures[38] and will solve the future scalability and sustainability demand of education in the digital era[39]–[41]. Moreover, today, the significant spread of education is credited to distance learning [42]–[44] and distance learning is supported by cloud computing[45]. In related studies [5], [26], [32], [35] it has been shown that cloud computing services are a necessity for every educational institution.

One of the most scholarly discussed and cited high-scale[25]distance learning platform is MOOC[2], [16]–[18], [46]–[48]. Dave Cormier coined the term MOOC in 2008[49]–[51]. MOOC efficiently provides out of classroom education[5], [52] and community forums to support interaction among geographically dispersed participants[24], [49], [53]. It uses the Internet to bridge the teaching and learning distance, thereby ubiquitously collaborating participants and providing open access to educational resources via cloud [17].

In an investigation of MOOC in education, Devgun[54] revealed that MOOC platforms are offering free or low-cost education to students. Another study by [24] found enhanced and effective learning performance among MOOC participants. In another major study [55] discussed MOOC as efficient value and skills acquisition initiatives capable of democratising the education sector. Additionally, [56] posited that certificate acquired through MOOC are not as recognised as certificate acquired through traditional university degrees.

In view of all that has been mentioned so far, one may conclude that cloud computing and MOOC are disruptive innovation capable of seamlessly transforming or destroying education. Also, most of the literature presented thus far has dealt with either cloud computing in education or state-of-the-art of MOOC. The majority of the studies are devoid of reviewing cloud computing in education with an emphasis on MOOC, hence the focus of this study.

### 3. REVIEW METHODOLOGY

This study primarily adopts software engineering systematic guidelines for reviews suggested by [57] and previously adopted in [25], [58]–[60]. Additionally, the study employs Creswell (1994) review guidelines to highlight yet to be resolved issues, hence challenges of MOOC. Literature for the study was sourced from conference proceedings (IEEE and ACM), books (Amazon) and databases (ScienceDirect, Google Scholar, IEEE Xplore, ACM Digital Library and Springer). Inclusion criteria required studies to be published in English and contain specific keyword(s) as the title. Strictly, these keywords include "cloud computing" AND "MOOC" AND "education". On a more general search, the keywords were searched as "cloud computing" OR "MOOC" OR "education". Using this search criterion, various related and

unrelated literature was found which was systematically filtered based on the inclusion criteria. At the end, 149 works were found to be related and relevant to the study. For the purpose of analysis, abstract and main findings of the studies were systematically extracted and analysed based on Glaser (1965)constant-comparative qualitative method of data analysis, previously used by[48], [61], [62].

# 4. CLOUD COMPUTING IN EDUCATION

Cloud computing is an emergent technology[32] that offers the medium for seamlessly creating, collaborating[23], [63], publishing and networking[23] educational resources. Basically, cloud computing encompasses three (3) service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) [64]–[66]. These service models respectively handle the storage, development platforms and application requirements of every educational institution [65].

IaaS handles the on-demand processing, storage, networking and basic computing requirement of students, lecturers and researchers[5], [22], [25], [30]. Examples of IaaS are Google Compute Engine, IBM cloud academy, Amazon Web Services (AWS), Microsoft Azure Virtual Machines and Google Cloud Storage. Similarly, PaaS is built upon IaaS[25] and it provides the frameworks for programming and deployment of applications[30]. Examples of PaaS are Google App Engine, Heroku and Force.com. accordingly, SaaS has been a popular model for education since the mid-1990s[5]. SaaS primarily uses web client and network to remotely provide applications, multimedia and web services to users[6]. In essence, it leverages the burden of locally installing applications and license acquisition from the user[39], [66] to a Cloud Service Provider (CSP). Examples of SaaS includes Microsoft Office 365, Google Apps for Education, etc.

Prior studies[5], [22], [25], [30], [32], [33], [38], [39], [66] have shown that IaaS and SaaS are the top enterprise services in the education industry. Educational institutions uses IaaS to provide storage and processing of educational contents[5], [25], [33], [38]. Additionally, SaaS addresses software needs to create contents, provide virtual worlds, collaboration; simulations, resource sharing, video streaming, etc [15], [22], [30], [39], [66].

Nonetheless, around the benefits of cloud computing lies various issues of performance [25], policy control [32], privacy and trust [67]. Yet, the benefits of cloud computing have appeared to overshadow these issues [5].

### 5. MOOC IN EDUCATION

The latest development in distance education is MOOC[47], [48], [68]. New York Times declared 2012 as the year of MOOC [69], [70] due to the emergence and contribution of several MOOC platforms providing effective free or low-cost education for all [71]. MOOC perfectly depicts a technology enabled and open out-of-

classroom learning, teaching and knowledge sharing [68], [72]–[75].

Openness and collaboration are important developments in the academia. This brings forth the opportunity for everyone to engage in university level learning[68]. The openness, massiveness and limitless scope make MOOC different from other online education[76], thus attracting a larger audience than traditional education[77].

The major focus of MOOC is to provide qualitative education to all. To achieve this, MOOC platforms provides elite universities and leading educational practitioners the tools to create, research and network educational resources freely via Internet [51], [78], [79]. Accordingly, MOOC allows institutions to market themselves

to the world, thereby seamlessly reaching the developing and underdeveloped countries [80]–[82]. Additionally, [47] stated that MOOC provides open and free access to participants, thereby providing education to people irrespective of their geographic location and financial status[83]

The mode of engagement between instructors and participants of MOOC includes video lectures, assessment, discussion forums, readings, live video sessions, lecture transcript and learning tasks [72], [84]–[86]. In addition, MOOC uses the social network, video podcasts and the

Table 1. Characteristics of MOOC

Characteristics	Description			
Massiveness and scalability	MOOC accommodate large number of participants with no constraints to class size[54], [71], [87]–[91] MOOC addresses the geographic location and time requirement of traditional learning and teaching[71], [91]–[93]			
Open access	MOOCs offers enhanced accessibility and flexibility by providing open learning environment [44], [82], [94] MOOCs are typically free or low cost [47], [51], [54], [88], [91], [94]–[97] MOOCs are open in terms of pace, place and time [98].			
Internet mediated	All aspects of MOOCs are online using semantic web[48], [51] All MOOCs are accessiblevia Internet [48], [93], [99]			
Connectivism	MOOC promotes out-of-class autonomy, interactivity and diversity[100], [101] MOOC uses the connectivity of social networking platforms[51], personal networks and communities of practice[15], [102]			
Course	MOOC offers both technical and non-technical courses e.g. Sciences, Humanities, Social Sciences, etc[103] MOOCs eliminates the need for pre-requisites and strict entry requirements [71] MOOC courses have defined start and end date[92], [104] MOOC Courses have predefined study guide and syllabus[98], [105]			

Internet to provide cost effective portable courses that attract unlimited participation by seamlessly reaching the globe [72], [106]. The emergence of MOOC gave birth to several speculations and debates about the future of higher education[72]. Elite universities and practitioners in the academia are the leading advocates of MOOC [51]. They consider MOOC as the future of education [48], [72], [82], [107], [108]. They also outlined that, MOOC emerged due to the current globalfinancial crisis, educational budget cuts and the need for the education sector to utilise technology for research, learning, teaching, content delivery, access and collaboration[15], [90], [102]. On the other hand, opponents of MOOC consider it as a disruptive innovation[109]-[111], a repetition of online distance education[112], a downfall to education system[72], [113] cited in [92] and a platform suitable for academically inclined students[114]. However, on the neutral [93] considers MOOC as a "disruptive technology with an unclear future".

# 5.1 Characteristics of MOOCs

Every letter in MOOC is negotiable[98].M=massive, O=open, O=online, C=course[93]. In this study, MOOC is characterised in terms of massiveness, openness, Internet-mediated, connectivism and courses[71], as described in table 1 above.

# **5.2** MOOC Providers

Several MOOC platform providers emerged prior to, in the, and after the year of MOOC. Coursera, edX, Udacity, Iversity, MiriadaX, Futurelearn, Rwaq, Udemy, FUN, Edraak, Open2study, Khan Academy, XuetangX, are few among the MOOC platforms. The table 2 below shows the various MOOC platforms and describes them in terms of their origin, year of establishment, category and their access points.

**Table 2. MOOC Providers** 

MOOC	Origin	Yea	Categor	Website
		r	y	
Khan	Califonia	2006	Prior	https://www.khanacademy.or
Academy				g
Udemy	San	2010	Prior	https://www.udemy.com/
-	Francisc			
	0			
Coursera	USA	2012	In	https://www.coursera.org/
edX	USA	2012	In	https://www.edx.org/
Udacity	USA	2012	In	https://www.udacity.com/
FutureLear	UK	2012	In	https://www.futurelearn.com
n				
FUN	France	2013	After	https://www.fun-mooc.fr
Iversity	Germany	2013	After	https://www.iversity.org
Mirada X	Spain	2013	After	https://miriadax.net
Edraak	Jordan	2013	After	https://www.edraak.org/
Open2Stdu	Australia	2013	After	https://www.open2study.com/
у				
XuetangX	China	2013	After	https://www.xuetangx.com
Rwaq	Middle	2014	After	https://www.rwaq.org
-	east			

Empirically, Coursera, edX, Udacity, and Udemy are the most prominent MOOC providers [115]. Accordingly, [116] reported Coursera, edX, and Futurelearn as the most prominent MOOC portals, with Udacity considered as an important MOOC portal. Additionally, [96] positioned Udacity, Coursera, edX, Udemy, and the Khan Academy as the most important MOOC platforms. Furthermore, [83] considered Coursera, edX, and Udacity as the major MOOC providers. Despite these diversities in scholarly views and opinions, it is evident that all MOOC providers focus on harmonising geographically dispersed participants for the purpose of learning and teaching.

# 5.3 Types of MOOC

What determines a MOOC is the mode in which it is delivered[93]. There are two (2) basic types of MOOCs vizcMOOC and xMOOC[51], [96], [111]. However, in recent times, other types have evolved and emerged. This includes: pMOOC (project based MOOC), LOOC (Local Open Online Courses)[93], SPOC (Small Private Online Courses)[117]. Others includes Wrapped MOOC[118], White label MOOC, Mini MOOC, DOCC (Distributed Open Collaborative Course)[119] and SMOC (Synchronous Massive Online Course) [112].

In cMOOC, the c denotes connectivism or connectivist[112], hence they are based on connectivist[47], [100] and informal learning theory[51]. Connectivism is best explained by peer and social learning models. They promote knowledge seeking, sharing[16] and learners autonomy[120], thereby enhancing interaction among participants. Several controversies still surround the acceptance of connectivism as a philosophy of learning in this digital age[121], [122].

cMOOC are structured to include video presentations, tests and short quizzes[91]decentralised over a network[49]. In cMOOC, the instructor provides the course outline and students define the course materials and course contents. Thus the participants of cMOOCs are active, while the instructors are seen more as moderators rather than tutors[100]. cMOOC uses Open Education Resources [93], hence making its learning resources open rather than proprietary. Examples of cMOOC include Personal Learning Environments, Connectivism and Connective Knowledge, MobiMOOC, and EduMOOC[100]. Currently, edX uses the cMOOC pedagogy for content delivery.

Recently, Havard University instigated the term xMOOC to depict courses offered offline [49] with online discussion forums. The x in xMOOC denotes exponential or extension, thereby focusing on massive participation [112], through the use of proprietary learning resources [93]. xMOOC perfectly exemplifies the digital version of a traditional education course.

An xMOOC is structured to include at least one instructor, an instructor predefined course content and a participant self-paced syllabus [48], [81], [123]–[127]. Therefore, unlike cMOOC, xMOOC participants are considered as passive learners. However, xMOOC is more engaging than cMOOC. It incorporates gamerelated elements and online simulation to keep learners focused and motivated [125]. Additionally, xMOOC ensures quality delivery through the integration of quality assurance protocols[93].

The duration of xMOOC video lectures ranges from 3 to 15 minutes and are structured in terms of weeks. Each week contains video lectures, reading materials, online discussion, quizzes and

assignments[126]. Currently, Coursera and Udacity are examples of third party vendors delivering xMOOC contents.

Today xMOOC is termed the modern MOOC and forms the widely known MOOC [15]. It follows the broadcast model of knowledge dissemination[128]. However, [100] reported that no conclusion has been made regarding which is better than the other between x and c MOOC.

#### 5.4 Benefits of MOOC in Education

Prior studies [129], [130] have raised alarm about the continuous increase in the cost of post secondary education. In an investigation, [99] found that MOOC has the potential to lower the cost of earning a degree. Today, MOOCs completely addresses the exponential increase in the cost of acquiring traditional education[131], [132]. This is achieved through the delivery ofcost efficient, flexible and focused online educational practices by MOOC providers [133].

In addition, by removing the distance barrier, MOOC efficiently and cheaply extends the reach of education to every part of the world. Students in underdeveloped and developing countries now take classes directly from elite universities at a less or no cost [134]. This extension in turn increases the prestige of the hosting universities thereby improving educational outcomes and revenues[112]. Hu [93] highlighted the benefits of MOOC in developing countries. The study stated that, the offline learning capability of MOOC enhances the adoption and addresses the network inadequacy in developing countries.

Furthermore, MOOC provides personified education i.e. every student a class and every class its student. This permits students to have control over what they learn, when they learn and how they learn. Thus promoting crowd sourcing which enhances collaboration and social networking among students [69]. In essence, MOOC promotes high level of interaction among students without instructor mediation and moderation which enables students to independently develop their own ideas, skills, knowledge, learning network, enhance self expression [120], [135], [136], deep learning and abstract conceptualization[137], [138].

The course content of MOOCs are mostly facilitated by highly qualified professors and scholars in the academia [88]. Therefore, MOOC imparts qualitative, lifelong cost effective skills and experiences [83], [94], thereby enhancing professional credentials[81], [139] and providing job advancement [55]. Some MOOC providers such as Udacity recommend Nanodegree course participants for job placement. Additionally, several MOOC providers issues certificate that can be showcased on participant LinkedIn profile.

Similarly, MOOC appears to provide an economic solution to universities and also a medium for universities tocompete with their peers[5], thus increasing the number of universities engaged and offering qualitative MOOCs. This enhances the prestige of the university, global

awareness about the university, and increases the rate of student enrollment in the university [73]. A prior study [93] show that MOOC addresses the need for more infrastructural expansions among existing universities. likewise, [116] concluded that MOOC addresses the need for more universities.

Moreover, MOOC goes beyond enhancing students learning experience to enhancing managers and employees skills by providing in-service training courses, thereby upgrading theirskills base and curriculum vitae[93]. Therefore, with MOOC, the campusbased time requirement for working professions are eliminated[134].

Among other benefits, MOOC provides researchers with well-structured data about learning patterns across various MOOCs[55], eases the teaching and learning of several educational areas and topics [93], and finally fosters collaborative research among communities.

# 5.5 Challenges of MOOC in Education

Despite the infancy and various benefits of MOOCs in education, its implementation requires careful attention due to a number of challenges and uncertainties[3][71].

The most discussed challenge of MOOC is high dropout [140], hence low completion rate. Prior studies[55], [128], [141], [142] found that less than 10% of participants completes a MOOC. This brought about MOOC criticism due to 90% dropout rate of enrollees, in essence, 90% of people who signed up for a MOOC do not complete them [51]. Scholarly investigation identified insufficient or lack of incentive, lack of life teacher support and difficulty as the major causes of high dropout rate in MOOC[48], [81], [95], [143]. Additionally, the lack of prior knowledge may contribute to the dropout rate[81].

Cheating is one of the major challenges of MOOC [144]. Virtual student assessment and unverifiable identity of participant contributed to the emergence of cheating among MOOC participants [49], [124]. On this note, [134] stated that MOOC certificates may not be considered by employers due to the unverifiable quality of students skills and experience. To efficiently evaluate students, new assessment methods are required [145], [146]. These methods must efficiently collect, classify and understand in-classroom teaching and learning[147]. On this note, there is an ongoing experiment on the use of computers to grade essays for ensuring effective student assessments [148]. However, [149] reported that this software are unreliable.

Another challenge is the use of peer assessment by some MOOC provider. The good side of peer assessment lies in its quality feedback. Feedback depicts instructor's comment or evaluation of learner's context [150]–[153]. However the case of MOOC using peer assessment for performance evaluation to ensure feedback contradicts scholarly views about feedback. Additionally, peer review perfectly exemplifies a novice guiding a novice, thereby resulting in shallow learning. In essence, peer evaluation does not efficiently measure and assess learning achievement [154]–[158]. On the contrary about peer evaluation, [159] opined that peer evaluation encourages and motivate students to learn and collaborate.

In like manner, there is a limitation in the number of fields that can be taught through MOOC. For instance, medicine requires face-toface instructor mediated practice and interaction. Such courses may not appear in the world of MOOC in the nearest future [134] and eventually if they do, the reputation of the participants needs serious verification.

Participation dissatisfaction is another challenge of MOOC. There is influenced by technical know-how requirement of MOOC [55], [107], [128], [160], [161], possible loss of focus in discussion forum and out-ofscope postings by participants[80]. Additionally, it is influenced by MOOC demands for commitment both in time and money [48]. Therefore, MOOC designers need systems real-time for detecting dissatisfied participants[84], moderating discussion forum and reducing the complexity of participating in a MOOC.

Though, MOOC is used by universities as a marketing tool, the provision of low-quality courses through MOOC may significantly damage the reputation and recognition of universities rather than market it [51].

Accordingly, MOOC professors and tutors consider the preparation of course material as very hectic and time demanding[99]. Averagely, the time required to prepare an adequate MOOC is 100 hours.

Among other challenges, [134] considered acceptability, student experience and quality as the major problems of MOOC. Consequently, there are possible loss of cultural values and norms among MOOC participants[68][162].

#### 6. DISCUSSION AND CONCLUSIONS

This study has analysed the most relevant contributions of cloud computing to MOOC and MOOC to education. The study found storage and software as the most used cloud services in education. MOOC is relatively new and considered as a disruptive innovation capable of transforming the educational sector. Literature has shown that previous disruptive innovations came with various challenges. Therefore, the disruptiveness and innovativeness of MOOC must also come with various challenges. These challenges will form the basis for its perfection and stability. Despite these challenges, it is important for universities and educational institutions to value MOOC and cloud computing due to their significant roles in the education sector.

Various challenges have been identified in the study. However, MOOC dropout rate appear to be the most discussed challenge. It should be noted that the dropout rates across different MOOC varies. Therefore, the target audience and purpose of the MOOC determines the enrollment and dropout rate. For instance, a computer science based course may draw more attention and completion rate than a social science based course due to the inclined use of the computer by the former when compared to the later.

Accordingly, with respect to the issue of certificate recognition, it was found that most students engage in MOOC to support lifelong learning, for fun, continence and also for experience[81]. This indicates that the quest

for certification is not the major motivation of various MOOC participants.

One MOOC platform appearing to solve the participant verification is Coursera through its Signature Track. This Signature Track authenticates the identity of the participant by typing and matching a signature phrase. Accordingly, edX offers the Verified Certificate of Achievement service where participants are monitored and supervised through webcam to ensure their performance.

The findings from this study imply that the solvable challenges of MOOC will sum up with its benefits in the long run. Therefore, if the administrators of education do not accept MOOC as an innovation that has come to stay, MOOC may do to education what cloud computing did to business and the lagers will be the one to lose.

In view of this, this study suggests the establishment of MOOC test centres. This test centres will help in the elimination of cheats and impersonation in MOOC. This may also lead to pre and post assessment of participant skills, hence resulting into quantifying the ideal impact of MOOC on participant and enhancing certificate recognition. Additionally, the study recommends the enhancement of MOOC framework, the integration of MOOC in the national curriculum and recognition of MOOC certificates in all nationals. As a future research, interoperability of MOOC providers is an important issue worthy of scholarly consideration. This will enhance service level interoperability among providers thereby eliminating duplication of knowledge.

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