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An Outbreak of Online Learning in the COVID-19 Outbreak in Sub-Saharan Africa: Prospects and Challenges

By Michael Agyemang Adarkwah

Southwest University

Abstract- The COVID-19 outbreak stimulated an outbreak of online learning in many institutions in Sub-Saharan Africa. Educational institutions went beyond fighting the COVID-19 through social distancing norms to tackling Sustainable Development Goal Four (SDG 4) with the adoption of online learning as the new modality for instruction. Online learning has the propensity to ensure learners from all geographical regions have access to education, thereby addressing the inequalities in education. However, the disparities in the access to digital infrastructure had a negative impact on the online instruction in Sub-Saharan Africa. The online learning experience is best described as a “challenge-ridden online learning” with many teachers suffering from burnout and students lamenting on limited ICT resources, inadequate access to affordable and reliable internet, power outages, and anxiety over academic outcomes. Despite the challenges, the COVID-19 has presented a silver lining to online learning in Sub-Saharan Africa. Aside the attempt to massify online learning, many institutions have come up with novel technological innovations and inventions to bridge the digital divide in the region. The review gives an overview of the challenges, prospects, and practical implications of online learning in Sub-Saharan Africa.

Keywords: *online learning, e-learning, distance education, COVID-19, sub-saharan africa.*

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Michael Agyemang Adarkwah

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I. INTRODUCTION

As at January 2021, the world is still suffering from the unprecedented threat of the COVID-19 pandemic even in the prospect of a potent vaccine (Kwok, et al., 2021; Lovelace, 2020; Mahase, 2020). The novel coronavirus, SARS-CoV-2, also known as the COVID-19 was first identified in Wuhan City of China in the latter part of December 2019 (Chen, et al., 2020; Karasmanak & Tsantopoulos, 2021). Since its declaration as a global pandemic on March 11, 2020 (WHO, 2020b), the COVID-19 crisis has threatened healthy lives, the world economy, and the education sector (Goyal, Daipuria, & Jain, 2020; Pan & Zhang, 2020). The global disruption in education as a result of the COVID-19 pandemic rendered the traditional face-to-face (F2F) learning not only impractical but also unlawful (Meulenbroeks, 2020). In an effort to reduce the spread of the virus and abide by the health protocols (WHO, 2020a), many educational institutions migrated

from the synchronous F2F learning to synchronous and asynchronous online learning (Aguilera-Hermida, 2020; Azu, Adegboye, & Quadri, 2020; Bacher-Hicks, Goodman, & Mulhern, 2021; Lorusso & Shumskaya, 2020). The sudden closure of schools in 188 countries worldwide impacted over 91% of the student population in the world (UNESCO, 2020). The COVID-19 outbreak has therefore triggered the current online learning outbreak (Wotto, 2020). However, learners have expressed distress in their online learning experience across the globe (Aguilera-Hermida, 2020; Bhagat & Kim, 2020; Meulenbroeks, 2020). Zhong (2020) mentioned that the COVID-19 pandemic has exposed the digital divide in education confronting most countries. The digital divide in Sub-Saharan Africa is a threat to the Sustainable Development Goal Four (SDG 4) and the No Child Left Behind Act (NCLB) (Spanbauer, 2020). Preez & Grange (2020) mentioned that only a third of the population in Africa have access to broadband connectivity. The unique effect of the COVID-19 crisis on the education system in Sub-Saharan Africa is worth writing about (Adarkwah, 2020; Anifowoshe, Aborode, Ayodele, Iretiayo, & David, 2020; Azu, Adegboye, & Quadri, 2020). Over the years, majority of developing countries have become accustomed to F2F mode of learning where students attend lectures in constructed lecture halls (Bans-Akutey, 2020). Online learning is a challenge and not effective in Sub-Saharan Africa as compared to the West (Kizilcec & Halawa, 2015). This is because online learning thrives on ICT resources (Adarkwah, 2020) which have not significantly evolved in Sub-Saharan Africa (Ilonga, Ashipala, & Tomas, 2020). The absence of ICT resources has affected the growth of low-income countries in the context of education (Yaw Asabere, Agyiri & Nachanja, 2020). Muftahu (2020) asserted that universities in Africa are still faced with unique challenges such as the provision of ICT gadgets/services (laptops and internet access) to learners who lack ICT resources, resistance to online learning by students and academic staff, and lack of ICT literate skills of users. He added that the COVID-19 crisis has stretch higher education institutions beyond their limits. At the same time, the COVID-19 pandemic can be a catalyst for a positive change in the educational system of schools in Sub-Saharan Africa through

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innovative ways of instruction and learning (Adarkwah, 2020; Bans-Akutey, 2020; Muftahu, 2020; Yaw Asabere, Agyiri, & Nachanja, 2020). This essay adds to the conversations on the impact of COVID-19 on education. Specifically, it focuses on the prospects and challenges of online learning in Sub-Saharan Africa as a result of the COVID-19 crisis to inform policymakers, educators, and researchers on the future of education in Sub-Saharan Africa.

II. HISTORY OF ONLINE LEARNING

Wong (2020) defines online learning as a form of education that occurs on the internet whether synchronously or asynchronously. Scholars conceptualize online learning to mean e-learning/online teaching/blended learning/remote learning/distance education (Adarkwah, 2020; Aguilera-Hermida, 2020). Online learning is not a new approach to instruction (De Freitas, Morgan, & Gibson, 2015). Paul & Jefferson (2019) reports that the earliest distance education program begun in the mid-1800s by the University of London. In 1873, the "Society to Encourage Home Studies" was established in Boston, Massachusetts as the first official correspondence school in the United States of America. The World Wide Web (WWW) was unveiled in 1991, and the University of Phoenix became one of the pioneers in online education (Kentnor, 2015). Early online mode of instruction started by 1994 and was followed up with content and learning management systems including WebCT, Blackboard, and Moodle. However, De Freitas et al. (2015) reports that these virtual learning environment were not pedagogically driven tools but served as depositories for digital content. The earliest learning environment that was totally different from the traditional F2F modality of instruction was Fathom.com which was first initiated in 2000 and led by Columbia University. Yet, it was faced with technical issues such as broadband connectivity and instructors lacked the motivation for pedagogical

change. Hence, its establishment as a learning tool worldwide was hindered. MIT Open Course Ware programme emerged around the same time in 1999 to provide web-based education to students. Online learning gained it impetus in 2002 when 50 courses were published online by the MIT, and was followed by the UNESCO's initiative of "open educational resources" to provide universal education for all humanity. The MIT published 2150 courses by 2012 and recorded a visit of 127 million. Since then online learning has been recognized as a mainstream and not a trend.

In Sub-Saharan Africa, the World Bank in its quest to advance cyber education established the first online university in 1996 (Kotouaa, Ilkan, & Kilic, 2015). The university had its headquarters in Kenya but was established in Ethiopia together with six other African countries including Kenya, Ghana, Zimbabwe, and Uganda. This online university operated from the University of Kenyatta. The mode of delivery was through satellite broadcast in the form of videos, MPEG 4, and email conversations between lecturers and students. The principal objective of this online university was to enhance the quality of education in Africa. The university targeted secondary school leavers and the working class who could not enter university because of limited spaces. Initially, the courses that were taught were business, science, and engineering. Since its inception, a lot of courses have been added. The only fully online universities in Sub-Saharan Africa are African Virtual University (AVU), Kenyatta Digital School of Virtual Learning, and University of Rwanda e-learning platform. However, Sub-Saharan Africa faced insurmountable challenges ensuring massification of online learning and is unable to achieve participation rates like in Europe and in North America (Trines, 2018). Despite the technological barriers, current trends suggest there is an improvement in the massification of online learning in Sub-Saharan Africa.

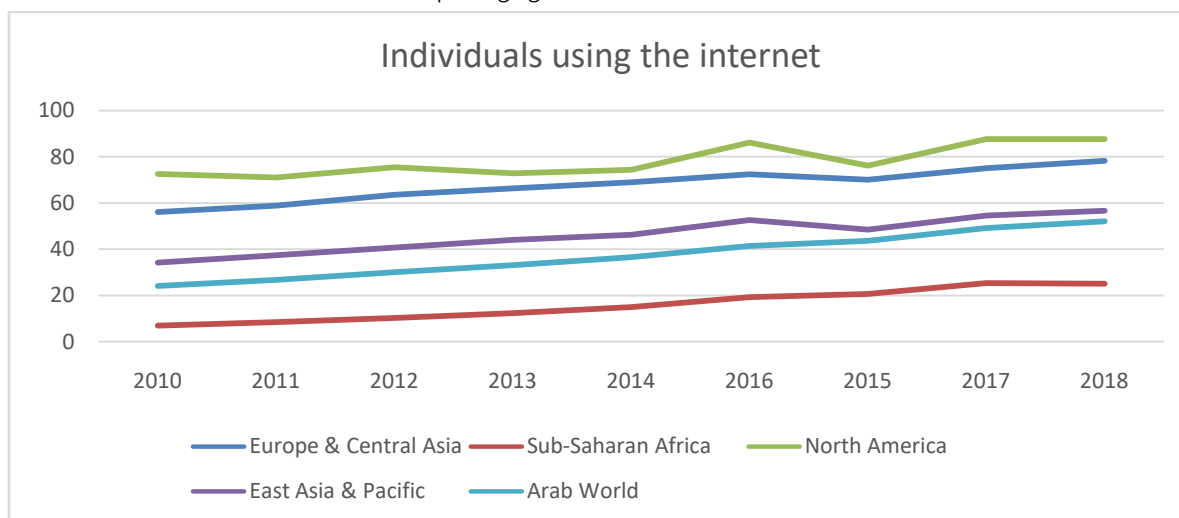


Figure 1: Individuals using the internet in Sub-Saharan Africa, Source: World Bank

III. ONLINE LEARNING IN SUB-SAHARAN AFRICA DURING COVID-19

Pre-pandemic instruction in most educational institutions required both teachers and students to be physically present in a classroom for the purposes of teaching, examinations, thesis defense, and seminars in Sub-Saharan Africa. Oyediran et al. (2020) acknowledged that there is a pervasive crisis in the teaching and learning development systems in Sub-Saharan Africa and this problem was compounded by the COVID-19 pandemic. The closure of schools as a result of the COVID-19 crisis revealed how educational institutions adapt to meet the needs of students and education staff (Muftahu, 2020). Most educational institutions in Africa joined the league of developed countries by migrating to the online modality of instruction to ensure lifelong education (Adarkwah, 2020; Agormedah, Henaku, Ayite, & Ansah, 2020). Thus, the COVID-19 stimulated the appetite of most African institutions for coming up with educational innovations to counteract the disruption in education (Mukute, Francis, Burt, & Ben, 2020). Diverse delivery of instruction were adopted including web-based learning, e-learning platforms, CD-ROMS, television, radio, emails, and SMS services (Azu, Adegboye, & Quadri, 2020; Mulenga & Marbán, 2020; Tadesse & Muluye, 2020). According to Tadesse & Muluye (2020), only 11% of countries in Sub-Saharan Africa provided solely online learning mode of instruction while 23% of countries provided a blend of broadcast and online learning. Also, since the transition to the online modality was emergent, most institutions couldn't provide training to their teachers and students were not adequately oriented (Adarkwah, 2020; Tadesse & Muluye, 2020). In some countries, instruction was delivered using social media applications like Facebook, Skype, WhatsApp, and Wechat (Sintema E. J., 2020; Tadesse & Muluye, 2020). However, Gangwar & Bassett (2020) in their report published by the World Bank suggests that the sudden transition from F2F to online exposed the digital divide in tertiary institutions in Sub-Saharan Africa. In most African countries, learners from rich socioeconomic households had more access to quality online learning experience than their counterparts from poor households due to limited resources (Adarkwah, 2020; Azu, Adegboye, & Quadri, 2020). Thus, the digital divide resulted in inequality in the access of online learning platforms. For Example, in Ethiopia, over 80% of the student population is estimated to live in the rural areas with limited access making it difficult for such students to access radio and television contents (Tadesse & Muluye, 2020). The same authors revealed that about 56 million of students in Sub-Saharan Africa do not have access to mobile networks. Ethiopia and other Sub-Saharan African countries (Mali, Niger, Senegal, Ghana, Nigeria, Malawi, Zambia, Uganda,

Kenya etc.) have partnered with National Research and Education Networks (NRENs) to promote internet connectivity in the region but this goal is yet to be realized (see Fig. 2). Also, since e-learning is focused mainly in higher education, school children became the most vulnerable in adopting the sudden shift to the online mode of instruction (Sintema E. J., 2020). Parents and caregivers therefore had a unique duty to help school children to study online at home (Abdullahi, Sirajo, Saidu, & Bello, 2020). Students with parents who had no formal education or background in online learning had to navigate their own path to study. In some countries, such as Ghana, some educational institutions tried to bridge the inequality in access to e-learning platforms by the provision of data bundle incentives to students but this was not enough (Adarkwah, 2020). Tadesse & Muluye (2020) reported that some schools also provided textbooks, study guides, radios and other equipment to students coming from poor homes. Some institutions also considered setting up virtual laboratories for students who needed to do experiments where feasible (Gangwar & Bassett, 2020). Electronic libraries also made it possible for some schools to engage their students in academic work during the lockdown (Ladan, Haruna, & Madu, 2020).

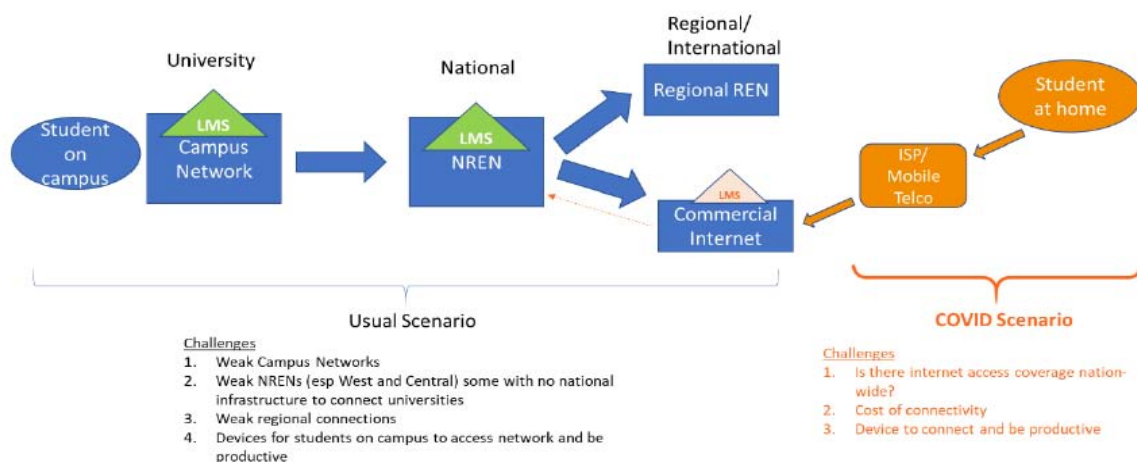


Figure 2: Connectivity in Sub-Saharan Africa using NRENs, Source; Alex Twinomugisha, World Bank Senior Education Specialist

Table 1: Online learning experience of some selected Sub-Saharan African Countries

Country	Mode of Instruction
Côte D'Ivoire	<ul style="list-style-type: none"> Usage of radio, television, and SMS services to deliver instruction
Ethiopia	<ul style="list-style-type: none"> Radio lessons for primary students, and digital technology for secondary and tertiary students
Ghana	<ul style="list-style-type: none"> Broadcasting teaching content e-learning systems Radio and Television services for instruction
Kenya	<ul style="list-style-type: none"> Publication of "guidance for teaching and learning" to 15 million students Partnership with Kenya Broadcasting Corporation Uploading instruction on YouTube Sharing of Electronic textbooks
Liberia	<ul style="list-style-type: none"> Initiating "Rising-On-Air" program that delivers instruction using radio services and SMS. Availability of teaching content on Orange Campus Africa which partners with Khan Academy (Wikibooks, Wiktionary, and Wikipedia were also made available)
Libya	<ul style="list-style-type: none"> "Compulsory lessons" for middle and secondary schoolchildren via television stations.
Madagascar	<ul style="list-style-type: none"> Instruction via Radio and TV Channels Hosting educative programs on "RTA Official" YouTube Channel Usage of "recruitment" drive to hire more designers to produce educative content for students
Mauritius	<ul style="list-style-type: none"> Sharing Radio Programs on WeTransfer platform Television programs for primary students E-learning platforms for secondary level students Zoom and Microsoft Teams Platforms for tertiary students.
Rwanda	<ul style="list-style-type: none"> Instruction via Radio, TV, and CD-ROM. YouTube Channel called REB e-learning Web-based learning via REB online learning sites
Sierra Leone	<ul style="list-style-type: none"> "Rising on Air" initiative to deliver lessons by SMS and radio
Somalia	<ul style="list-style-type: none"> "Google Education" for online learning.
South Africa	<ul style="list-style-type: none"> Web-based learning with multimedia sources such as audio, videos, or interactive workbooks
South Sudan	<ul style="list-style-type: none"> "Distance learning" programs via radio, television, and SMS.
Tanzania	<ul style="list-style-type: none"> Instruction via radio and television channels
Uganda	<ul style="list-style-type: none"> Via radio services (97% had access) Publication of Education Sector response and study materials online.
Zimbabwe	<ul style="list-style-type: none"> Usage of digital platforms such as partnering with a private firm, "Higher Life Foundation to distribute learning content", but with limited access due to internet connectivity.

Source: World Bank

IV. CHALLENGES OF ONLINE LEARNING IN SUB-SAHARAN AFRICA DURING COVID-19

Schools in Sub-Saharan Africa are more vulnerable as a result of the COVID-19 pandemic (Muftahu, 2020). Most educational institutions are comfortable with the traditional onsite instruction and are not accustomed to the online modality of instruction (Bans-Akutey, 2020). Some higher education and colleges are also now in the process of transforming and improving and the COVID-19 crisis has threatened this vision (Muftahu, 2020). The emergence of online learning seemed to be the only solution for schools but its emergent adoption has resulted in myriads of challenges (Abdullahi, Sirajo, Saidu, & Bello, 2020; Aboagye, 2020; Adarkwah, 2020; Bhagat & Kim, 2020; Mukute, Francis, Burt, & Ben, 2020). For example, in Ghana the National Union of Ghana Students (NUGS) referred to the online instruction as a "challenge-ridden online learning" (Adarkwah, 2020). The exceptional challenges emanating from the COVID-19 pandemic involves all stakeholders in education (administrators, teachers, students, parents) who are required to do unexpected things relating to online instruction if education will continue (Agormedah, Henaku, Ayite, & Ansah, 2020). According to the authors, educators are not adequately prepared to teach with technology, let alone to use technology for remote teaching. Some of the recurring challenges pertinent to all Sub-Saharan African countries and identified in literature during the COVID-19 pandemic are discussed below;

ICT infrastructure/tools: In his qualitative study, Adarkwah (2020) revealed that one of the main barriers to tertiary students engaged in online learning in Ghana was limited ICT resources/facilities. Nigeria also experienced the challenge of procuring ICT hardware to power online instruction in the country (Oyediran et al., 2020). The authors mentioned that ICT facilities in schools are ill-equipped to foster e-learning. There was no supply of ICT tools such as computers or phones for schools to foster online learning in Kenya (Ngari & Ndung'u, 2020). Mabeya (2020) added that the lack of supportive structure in Kenya served as a hindrance to children in the access of online content. Students in poor homes also lacked digital tools for accessing study materials and the online instruction in Ethiopia (Mengistie, 2020).

Lack of Funding: The negative impact of the COVID-19 on the economy of most African countries affected the supply of funds to many institutions (Muftahu, 2020). Limited funding can hinder institutions from hosting online instruction since money would be needed to purchase and maintain ICT gadgets (Adarkwah, 2020). Some institutions were forced to seek for alternative funding because of limited financial support from the government in Ethiopia (Tamrat, 2020). The lack of

financial capacity of some schools has hindered their successful transition from traditional onsite instruction to online instruction (Azu, Adegbeye, & Quadri, 2020).

Internet Access: In Ghana, teachers and students lacked access to digital devices and high-speed broadband (Aboagye, 2020; Adarkwah, 2020; Agormedah, Henaku, Ayite, & Ansah, 2020). Students in Nigeria also complained about insufficient data bundle to access their online classes (Abdullahi, Sirajo, Saidu, & Bello, 2020). The implementation of online learning in Ethiopia became a hurdle because of the high cost of internet (Mengistie, 2020). Belay (2020) reported large inequalities in the access of radio and TV services meant for digital instruction and also internet for web-based learning.

Electricity Supply: Rural students are often faced with power outages and limited supply of electricity (Adarkwah, 2020). Students who use mobile devices and computers often experience a flat battery, and hence, are not able to complete the online instruction (Abdullahi, Sirajo, Saidu, & Bello, 2020). It was found in Zambia that electricity load shading had a negative impact on the academic outcomes of students (Sintema & Singogo, 2021). In the case of Zambia, the authors revealed that every household do not get access to electricity for at least eight hours daily which means that students sometimes are unable to access instruction delivered on national televisions described the supply of power in Nigeria as barbaric, worrisome, erratic, and embarrassing serving as a hindrance to the e-learning implementation.

Acceptance and Adoption: The unfamiliarity of the online instruction to some faculty staff and students makes them develop a negative attitudes towards the acceptance and adoption of the online learning (Adarkwah, 2020). Some of these academics and students perceive the online delivery as too difficult and are therefore not ready to embrace this drastic change (Muftahu, 2020).

Supervision: Muftahu (2020) reports that some higher education institutions are faced with some managerial issues such as supervision of the online learning. According to Oyediran et al. (2020), there are less ICT experts to supervise e-learning platforms and instruction in Nigeria. Also, less training support are provided for users. In Kenya, there was minimal supervision for learners by teachers (Ngari & Ndung'u, 2020). Parents were not able to properly supervised their children on the online instruction (Mabeya, 2020).

Table 2: Overview of studies on the challenges of online learning in some selected Sub-Saharan African countries

Articles	Country	Challenges
(Belay, 2020) (Mengistie, 2020) (Tamrat, 2020)	Ethiopia	Expensive and limited internet, Lack of ICT gadgets and facilities, Students' parents lack ICT literacy, Inadequate access to reading materials, lack of concentration of female students engaged in house chores, poor school-parent relation, little preparation of students and teachers, negative attitudes towards the adoption of e-learning, lack of funding for institution, especially private higher education.
(Aboagye, 2020) (Adarkwah, 2020) (Agormedah, Henaku, Ayite, & Ansah, 2020) (Owusu-Fordjour, Koomson, & Hanson, 2020)	Ghana	High cost of delivery, glitches in with e-learning platform, lack of study materials and ICT tools, less prior knowledge of users, low access to electricity and internet, anxiety over academic outcomes.
(Ngeywo, Maizs, & Egesa, 2020) (Mabeya, 2020) (Ngari & Ndung'u, 2020)	Kenya	Lack of preparedness, inconsistency in syllabus coverage, less supervision by teachers, limited access of online instruction by students, disparity of content offered from one program to another, lack of learner assessment, and lack of support for parents/guardians and teachers of students, limited access to internet and technological resources, low parental supervision, perception that online instruction is time-consuming.
(Abdullahi, Sirajo, Saidu, & Bello, 2020) (Ifijeh & Yusuf, 2020) (Oyediran, Omoare, Owoyemi, Adejobi, & Fasasi, 2020)	Nigeria	Problems with teacher delivery method, poor teacher-student communication, electricity shortage, insufficient data bundle, lack of understanding, difficulty in solving math-related questions, difficulty in submitting assignment, poor technological infrastructure, ICT illiteracy, lack of funding, high cost of ICT accessories, inadequate resource personnel, difficulty in conceptualizing e-learning.
(Sintema & Singogo, 2021) (Sintema E. J., 2020)	Zambia	Inadequate preparation of parents to respond to children's academic needs, problems with electricity, difficulty in procuring curriculum materials, limited access to e-learning facilities.

V. PROSPECTS OF ONLINE LEARNING IN SUB-SAHARAN AFRICA POST COVID-19

Necessity is forcing changes in many educational institutions in Sub-Saharan Africa. The COVID-19 crisis has served as a catalyst in the massification of online learning in Africa which has being a challenge. Adedoyin & Soykan (2020) mentioned that the online learning has given educators a clear roadmap to engage other stakeholders in education to produce a novel market for the delivery of instruction. They added that the more the COVID-19 persists, the greater the probability of worldwide acceptance of online learning as the mode of teaching and learning. Additionally, institutions across the globe have went beyond fighting the COVID-19 pandemic to tackling the SDGs with education inclusive (Pan & Zhang, 2020). Thus, if carefully implemented and managed, online instruction can grant learners from all geographical regions access to education (Adarkwah, 2020). In the age of COVID-19, many faculty staff and students are showing less resistance to the adoption of online learning in some African countries (Mulenga & Marbán, 2020). This will

foster the digital competence of users and will subsequently aid in e-learning acceptance and adoption in the future. There is no doubt that the COVID-19 crisis have resulted in technological and academic innovations (Adedoyin & Soykan, 2020). For example, the crisis resulted in technological inventions and innovations in such higher education institutions in Africa such as Valley View University (VVU), Ghana (Murugesan & Chidambaram, 2020). While majority of institutions adopted already established applications such as Google Classroom and Zoom, VVU established their own server called the "Big Blue Button" for the online instruction. The server application enabled students to access educational contents without a cost to them in terms of data bundle while at the same time keeping a storage of all live videos and study materials for the perusal of students. The success that attended their online learning experience attracted national attention such as being invited on a national television station (TV3) to recount how they were able to provide "non-stop learning" to their students at a cheaper rate. The University of Ghana was also able to swiftly transition to online learning with the introduction of the

Sakai Learning Management System platform (Gangwar & Bassett, 2020). Telkom Kenya also launched a customized a dependable mobile phone for staff and students of University of Nairobi to ensure education continues despite the COVID-19 pandemic (Gangwar & Bassett, 2020). Moreover, the pandemic present an opportunity for libraries in African that operates on only the traditional mode of delivery of books to go digital/online with the provision of electronic books like in developed countries (Ifijeh & Yusuf, 2020). Schools and internet service providers have the opportunity to provide socio-economic interventions such as the construction of more ICT facilities with free/subsidized internet data bundle for staff and students.

VI. PRACTICAL IMPLICATIONS

The online instruction during the COVID-19 pandemic has unveiled the digital divide in most Sub-Saharan countries. Although all learners are faced with the challenges associated with online learning, the review indicate that the situation of children from poor households is worse (Adarkwah, 2020; Azu, Adegboye, & Quadri, 2020; Ngeyo, Maizs, & Egesa, 2020). This inequality in education is a threat to the SDG 4 and NCLB Act which has its goal to ensure lifelong education for all by also addressing gender gaps (Adarkwah, 2020). Policymakers in education and governments in Sub-Saharan Africa should partner with international bodies like UNESCO in addressing the digital divide which serves as a barrier to e-learning. Also, it was found that female students suffer from more stress as a result of household chores and are unable to concentrate during digital/online instruction. It is advocated that school leaders, especially teachers ensure adequate supervision of the online instruction to involve all students irrespective of gender It behoves on parents too to liaise with their children's schools to ensure smooth delivery of the online courses. School institutions should partner with the government to supply ICT tools/devices to both staff and learners since online learning depends on ICT tools. Adarkwah (2020) recommended schools to establish e-learning centers which charge a minimum fee to generate funds solely for the functioning of learning management systems (LMS) and other issues related to online learning. The additional pressures on teachers and students as a result of the COVID-19 (Pan & Zhang, 2020) serves as an indicator for educators to address issues related to psychological health. Not addressing the aforementioned issues can widen the gender, poverty, education and ICT literacy in Sub-Saharan Africa. This is the time for Sub-Saharan Africa to catapult its vision for a "knowledge and technology-driven" society to boost its economy. Gangwar & Bassett (2020) recommends that the weak NRENs in Sub-Saharan Africa should be strengthened to promote internet access by liaising with

telecommunication companies in the region such as MTN, Vodaphone, and Orange (see Fig. 2). Overall, educators, curriculum experts, researchers, governments, parents, and students should all work in unison to transform the education system to keep at par with other advanced countries across the globe (Tadesse & Muluye, 2020).

VII. CONCLUSION AND RECOMMENDATION

The COVID-19 pandemic affected all aspects of lives but can be an impetus for digitalization of education in Sub-Saharan Africa. The review suggests that the COVID-19 crisis has served as a stimulus for most educators in the region to embrace online learning as the mode of instruction. In the pre-pandemic period, only a few universities had online learning platforms and distance education centers. However, the COVID-19 crisis spurred even pre-tertiary institutions to adopt digital technologies and/or online learning to ensure the educational careers of learners are not jeopardized. Despite the fact that online learning is set to grow at a high speed in this pandemic era, the huge disparities in the access of internet and technological tools has negatively impacted the online instruction. Most educational institutions are still not adequately equipped to implement and ensure the sustainability of the online learning. Although Sub-Saharan Africa is one of the largest regions in the world, World Bank report indicates that access to internet or technology is a great challenge; only 25% of the population has access to internet and only 0.44% have access to a fixed broadband (Gangwar & Bassett, 2020). Since online learning thrives on ICT tools and reliable internet access, it is recommended that policymakers and educators ensure equitable distribution of ICT gadgets and resources to all schools. Partnering with other donor/international bodies can help schools get adequate funds to sustain the e-learning in Africa. ICT integration can be a way of increasing the self-efficacy and digital literacy of staff and students for e-learning acceptance and adoption. Findings from the review also suggest that there are opportunities for schools to come up with novel inventions and innovations to massify online learning in Sub-Saharan Africa. A clear example is the shift from traditional libraries to electronic libraries and the development of reliable and affordable e-learning platforms in Ghana and Kenya. Since many countries across the world with Sub-Saharan African countries inclusive are experiencing a second wave of the COVID-19, online learning may be the "new normal" and "legally" accepted way of instruction. Sub-Saharan Africa has to brace itself for the sudden shift to digital technologies in education. The author recommend that future researches should conduct a similar research on Sub-Saharan African countries with focus on stakeholder/organizational experiences in online

learning and support it with a large scale empirical evidence.

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Investigating Digital Marketing Technologies usage Extent in the Nigerian Telecommunications Industry: A Study from the Consumers Perspective

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Abstract- Digital communication technologies have become an important part of our daily lives with billions of users on the Internet and social media. This study examined the types of digital marketing technologies available in the telecommunications industry in Nigeria, and determined the extent of usage of the technologies. The study employed a survey method. The Cochran formula was used to calculate an ideal sample size since the total population size of online consumers is infinite. Based on this calculation 500 respondents were surveyed due to the researcher convenience, cost and accessibility to the respondents. Data were collected using both primary and secondary sources. An online well-structured designed questionnaire (Google survey) was attached via online platforms. The questionnaire elicited information on telecommunications service consumers' characteristics, consumers' knowledge on different digital marketing tools, and the extent of use of the digital marketing technologies among telecommunications consumers in Nigeria. The results showed that social media marketing 142 (29.3%) was the most commonly used digital marketing technology by telecommunications service consumers.

Keywords: *digital marketing; technologies, consumers, internet access, service providers, usage.*

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Strictly as per the compliance and regulations of:



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Abstract- Digital communication technologies have become an important part of our daily lives with billions of users on the Internet and social media. This study examined the types of digital marketing technologies available in the telecommunications industry in Nigeria, and determined the extent of usage of the technologies. The study employed a survey method. The Cochran formula was used to calculate an ideal sample size since the total population size of online consumers is infinite. Based on this calculation 500 respondents were surveyed due to the researcher convenience, cost and accessibility to the respondents. Data were collected using both primary and secondary sources. An online well-structured designed questionnaire (Google survey) was attached via online platforms. The questionnaire elicited information on telecommunications service consumers' characteristics, consumers' knowledge on different digital marketing tools, and the extent of use of the digital marketing technologies among telecommunications consumers in Nigeria. The results showed that social media marketing 142 (29.3%) was the most commonly used digital marketing technology by telecommunications service consumers. From a general standpoint, with an average weighted mean of 2.69 and maximum rating of 5 shows that Nigerian telecommunications service consumers use digital marketing technologies moderately, with social media networking sites being the most prevalent digital marketing platform used by the consumers with the highest mean value (Mean=3.16, SD=1.37).

Keywords: digital marketing; technologies, consumers, internet access, service providers, usage.

I. INTRODUCTION

The Nigerian telecommunications service has brought historic and economic growth which cannot be undermined as well as other positive development to the nation. The Nigerian Communications Commission (NCC) emphasized on the growth the enactment of the "National Telecommunication Policy" in September, 2000 has brought to the industry. The formulation of national telecommunication policy produced great changes in

the Nigerian telecommunications services with the arrival of several telecommunications servicing firms such as visafone, 9mobile, MTN, M-Tel, Glocom, Airtel, Starcomms and Multi-links (Oghojafor et al., 2014). According to the Nigerian Communication Commission (2006) report on strategic management plan, the report states that the fastest growing industry in the world remains Nigerian Global System for Mobile Communication (GSM) although the industry is still far behind among other industries as regards to "customer satisfaction" and "loyalty".

The advent of the Internet has brought revolutionary development in conducting businesses and transactions; digital marketing involves application the Internet and other digital technologies to carry out advertising processes (Bolaji, 2018). Technological advancement has no doubt recently brought about flexibility, speed and cost-effectiveness in executing marketing activities with the emergence of modern synchronous internet-based communication technologies via the Internet. Introduction of digital devices and technologies such as cell phones and mobile applications, email facilities, world-wide-web (www), social media sites, database systems to mention but a few focused on delivering integrated targeted communications, achieving profitable marketing services and building effective customer relationship that match their individual needs (Amruta, 2014). Digital marketing is the major innovative applications of the Internet with other digital infrastructures for marketing activities, and have indeed transformed the different sectors of the society, including marketing telecommunications products and services. Digital marketing includes a widespread variety of products, brands or services advertising strategies which primarily utilize the Internet as a main promotional means in addition to traditional TV, radio or mobile advertisement.

II. BACKGROUND

The modern telecommunications service industry in Nigeria started in the 1990s and this was characterized by the tremendous entrants of new investors into the market. Fransman (2001) notes that as

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more entrants enter into the market, it presents threat and competition among the telecommunications service providers. The 1990s breeds of entrants were far more belligerent in their competition due to technology advancements, change in income and increase in economic activities. This has made the industry to be highly competitive as telecommunication service providers build strategies to retain their old subscribers and attract new consumers on their network. These competitions have driven the current global improvement in telecommunications service. In Nigeria, there are four major telecommunications service providers which include MTN Nigeria, Globacom Nigeria, 9mobile and Airtel Nigeria competing for survival. The numbers of subscribers have been the major key to assess Nigeria telecommunications service providers' success and performance. According to the Nigerian Communication Commission (NCC) industry statistics report published on the Internet for the month of April 2019 indicates that, MTN remains the telecommunications service firm with the highest number of subscribers both for call and Internet services with 64,732,167 subscribers, followed by Globacom Limited in the second largest consumer based with approximately 46,380,756 subscribers, Airtel Limited in the third place with 45,433,300 subscribers and 9mobile with 16,720,146 consumers on the network (Table 2.1).

Obasan and Soyebó (2012) identified competition as a key that forces organizational changes, especially among telecommunications service providers. The simplicity and similarity rate of telecommunications products and services is the major fuel to the intense competition within the telecommunications industry. Therefore, the telecommunications service rendering firms need to develop new strategies to differentiate their products and services among their peers. Mendzela (1999) supports that, the incessant struggle for consumers share made telecommunications service providing firms to develop online strategies for consumers' loyalty, satisfaction and retention of potential consumers using the newly emerging digital marketing strategies. Karjaluo et al. (2005) stated that mobile communication markets are one of the fiercest markets today because of its high expanded challenge and change. As a result, it is of growing concern to see customer purchasing choice procedure and illuminate the components that finally determine consumer choices among the various mobile communications networks. The sustainability of today's modern telecommunications firms depends on how they handle and treat their consumers.

Digital communication technologies have become an important part of our daily lives with billions of users on the Internet, social media, and other mobile apps (Stephen, 2015). The biggest market share of Internet users in the mobile telecommunication industry

are subscribers on 1G, 2G, 3G and 4G mobile technologies. The number of people accessing the Internet has increased tremendously over the years in Nigeria according to statistics. For instance, Internet World Stats (2019); reported that Internet users as at March 2019 have increased to 111,632,510 on global system for mobile communications (GSM) and code division multiple access (CDMA) networks. Today's market witnessed an extreme competition in the Nigerian telecommunications industry and telecommunications service providers are moving extensively to catch the attention of consumers by investing in digital marketing. Modern technology emergence has made Nigerian telecommunications service providers to appreciate more the importance of digital marketing especially in tracking the need, want, suggestions, trends, and behaviors of their consumers. Consumers have become more sensitive to the characteristics and attribute of telecommunications products and services rendered (Rahman et al., 2010). On the other hand, consumers' behavior in response to telecommunications service offerings remains a point of attention to the telecommunication service providers. Hence, digital marketing in the telecommunications industry is of great concern to the telecommunications service consumers and the telecommunications service providers.

Globally, marketing is defined as set of actions employed by companies to fuel claim and acquire consumers. Popoola (2013) emphasized that some business firms match marketing with selling, while others see marketing as those processes carried out when the products or services are created and rendered to consumers (Nwokoye, 2004). Therefore, it is important to describe what marketing is from a comprehensive point of view. Popoola (2013) relates marketing to a society from the macro-economic perspective where marketing is said to be business process of a company to replace economic goods and service from the micro-economic view (Nwokoye, 2004). As technological know-how advances, consumers need and wants also change. The widespread uses of Internet technologies have changed how firms communicate its products or services to consumers. To publicize products and services, firms employ marketing activities that inform distinct features and benefits, build understanding as well as facilitate the formation of positive brand images (Shimp, 2007). Digital marketing has revolutionized the conventional ways of marketing products and services to modern technological, which may pose many threats and challenges to the telecommunications service providers in this highly competitive market.

The purchasing behavior of consumers in the telecommunications service industry is largely influenced by numerous factors, and these factors often affect the firms to match the needs of the consumers.

Telecommunication service firms is not new to changes in technological development and rising globalization; availability of advanced technologies as well as wide accessibility of digitally sourced information has driven many industries to digital change (Stephen, 2015) and the Nigerian telecommunications service industry is not excluded. These technological advancements have made outstanding influences on marketing theories and practices which include; emergence of capturing improved quality customer data, enhanced providers-consumers relationship, promote consumers insight and customer resource management (CRM) in the Nigerian telecommunication industry. Hence, with numerous advantages digital marketing has presented telecommunications service providers now have all that is required at their disposal to merge data from numerous sources for better understanding of the telecommunications networks, consumers and how consumers behave towards the different telecommunications products and services (Chen, 2016). Furthermore, the importance of improved digital experiences continues with the emergence of Internet marketing, enhanced online experiences have promoted customers' journeys to be more engaging.

a) *Digital marketing technologies*

Mobile marketing: It includes set of practices that allows firms or brands to interact and engage their customers in a more innovative, interactive and significant manner via any mobile device or network. These include the use of mobile devices such as mobile phones, personal digital assistant, media devices, moveable gaming consoles and tablet computers for marketing activities. The interactive and mobility nature of mobile marketing differentiates it from other marketing mediums like TV, radio and newspapers (Mobile Marketing Association, 2009). In addition, its continuous access to users whenever and anyplace set it apart from web (Lamarre et al., 2012). The types of marketing techniques accessible on cell phones are; short message service (SMS), multimedia message service (MMS), quick response (QR) codes, location-based services (LBS), brand's mobile applications, and push notifications (Onobrakpeya and Mac-Attama, 2017). SMS has been identified as the most widely used messaging vehicle for mobile marketing. The unique features of mobile marketing are ubiquity, personalization, localization and two-way communication (Clark, 2001). Furthermore, the use mobile marketing seems to be increasing in the telecommunications service industry with the advent of mobile applications (such as brand's apps downloadable on play store; MTN app) for marketing activities. With brand's mobile application, telecommunications service providers can manage their consumers better no matter how diverse and far they may be.

E-Mail marketing: It involves sending electronic mail to promote products or seeking for consumers (Techopedia, 2016). Additionally, it is utilized for drawing in new customers and encouraging the current ones to make instant purchase by sending promotional e-mails; upgrading customers' relationships by adding notice to other company's e-mail to pick up introduction in another market (Georgiva, 2010). Typically, this form of marketing strategies is not commonly used in Nigeria settings to communicate to brand's consumers. Telecommunications service provider's employing the use of e-mail marketing must compile the email address list of all its subscribers and prospective consumers which seems difficult due to service or network switching. E-mail marketing involves sending commercial e-mails to a group of people that have subscribed to a mailing list but can also be directed to an individual. Often, a company employing e-mail marketing develops an email list to reach or inform established and prospective consumers, which is almost an unlike practice among the Nigeria service providers. Forootan (2008) identified in his study that any email message that aids building of customer loyalty, trust in a product or service, brand recognition can be regarded as e-mail marketing (Onobrakpeya and Mac-Attama, 2017). E-mail is effective as a marketing tool when consumers out of their own volition sign up to receive e-mails from companies. It means e-mail marketing is permission based or dependent. Currently, in Nigeria, mobile technology has made email marketing to be a lot easier and better because products or services are promoted directly to a particular target group through the use of an email.

Search engine marketing (SEM): Commonly used form of marketing in many industries of the world. This deals with consumers' probing, investigating, formulating, submitting and positioning of search queries on web pages within search engines to increase traffic referrals from search engines to gather adequate information on the subject matter (Beal, 2013). Onobrakpeya and Mac-Attama (2017) identified Google, Bing and Yahoo search engines as the most commonly used search engine. Often, SEM and search engine optimization (SEO) are used interchangeably, SEO is about optimizing your website to get better improved rankings in the search list results while SEM goes beyond SEO. SEM employs search engines tools like Google Adwords or BingAds to advertise and send more targeted traffic to the website (for instance, advert on yahoo mail platform). Search marketing in general thrives on the platform of content marketing strategies, which are marketing technique that attract and acquire defined consumers by creating and distributing valuable, significant and consistent contents (Steimle, 2014).

Social media marketing: It includes actions, processes, practices, and conducts among networks of individuals

who meet online to exchange opinions, ideas, information, and knowledge via conversational media which can be web based or mobile applications (Heinonen, 2011). The advent of social media based advertising was due to the widespread social media sites and applications usage. Recently, Internet and social media usage has become an element in business and industries strategies to attract potential consumers (Yannopoulos, 2011). Social media marketing involves the use of social network sites (such as Facebook and LinkedIn), blogs, social news and bookmarking (Digg, Reddit), micro-blog (such as Twitter), forums and virtual worlds (Second Life), media sharing (such as YouTube, Flickr), and rating and reviews pages (Yelp) for advertising activities. However of this legion listed above, four major social media networking sites have been identified for their global popularity and availability in the Nigerian telecommunications service industry; these include LinkedIn, Twitter, Facebook and Instagram. Nyekwere et al. (2014) asserts that social media sites Facebook and Twitter are most popular platform among users and advertisers. The advent of advanced mobile phones and personal computers enables buyers to remain associated on long range interpersonal communication via social networking sites (such as Facebook, Twitter, LinkedIn) on daily basis (Raad et al., 2010). Otugo et al. (2015) noted that the emergence of social media sites has introduced "paradigmatic move in the manner advertisers/marketers promote their goods and services". Users-generated content such as product or service reviews and consumers suggestions are created, which help firms or brands understand their consumers needs adequately (Mathwick et al., 2008) and also, gives consumers the chance to interact with firms or brands directly and instantly (Christodoulides, 2009) to express their perceptions on services, brands or products. Furthermore, using social media platforms for advertising activities help saves consumers' time, provide more trustworthy information, improved cost of informing, and facilitate better communication with telecommunications service providers. Social media marketing has bring about consumers' engagement and also provides avenue for brands and firms to stay with their consumers rather than just creating products or services awareness.

III. RESEARCH METHODOLOGY

The study was restricted to only consumers with online presences (Internet users) who are consumers of Nigerian telecommunications products or services. This was because only consumers with online presences can largely access these digital marketing technologies.

Research Questions

The study research questions are has follows;

1. What are the types of digital marketing technologies available in the Nigerian telecommunications industry?
2. To what extent are these digital marketing technologies being used in the study area?

Research Hypothesis

H₀: There is no significant difference between the usages of digital marketing tools available to consumers Sampling Technique

The study adopted the qualitative and quantitative methods of a research, with the aid of an online questionnaire (Google form) for adequate understanding of the phenomenon under study. The convenience sampling technique was employed because of the complexity of the population under study. The Cochran formula was used to calculate an ideal sample since the total population size of consumers with an online presence in the Nigerian telecommunications industry is infinite.

The Cochran formula is:

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where:

e is the desired level of precision (i.e. the margin of error) of 1%,

p is the (estimated) proportion of the population which has the attribute in question,

q is 1 – p.

From the calculation determined at 99% confidence level, assuming half (50%) of the telecommunication consumers are online (this will commute the maximum variability), therefore, p = 0.5 and keeping error margin as 1%, the needed respondents was 557 based on precision and estimation. Due to researcher convenience, cost and accessibility to the respondents only 500 responses were collected. The sample size was draw from all users of telecommunications service in Nigeria (Mtn, Glo, Airtel, 9mobile and others).

Copies of the questionnaire were administered with the aid social media shared across four major social media networking sites namely; Facebook, Twitter, WhatsApp and Instagram via the form link (<https://docs.google.com/forms/d/1IbGWtNHt4IYZCNQY>). The questionnaire elicited information on telecommunications consumers' characteristics, consumers' knowledge on different digital marketing tools and rating the consumers extent of usage of the various digital marketing technologies available to them. A six point extent-Likert scale was used to elicit information from the consumers on rating their usage extent of the different types of digital marketing technologies, various factors affecting the usage of digital marketing technologies, problems encountered, as well as suggestions on how these technologies can

be improved. Secondary data were collected from online publications, journals and website contents. The data obtained was subjected to descriptive and inferential statistics using IBM statistical package for social science (SPSS) tool.

To ensure the validity of the instruments used for this study, the questionnaire was given to experts in the field of Global innovation and marketing whose research interest includes Consumers behavior, digital marketing and E-business. The comment and suggestion of the experts lead to the re-modification of the instrument, helped authenticate the content validity of the instrument, and logical linking of all items on the research instrument used was achieved in line with the objectives of the study. Also, a pilot study was done before the main data collection. This was done to orientate the researcher's on the research project and provide insight into the phenomenon. This also ensures that errors can be rectified at little cost.

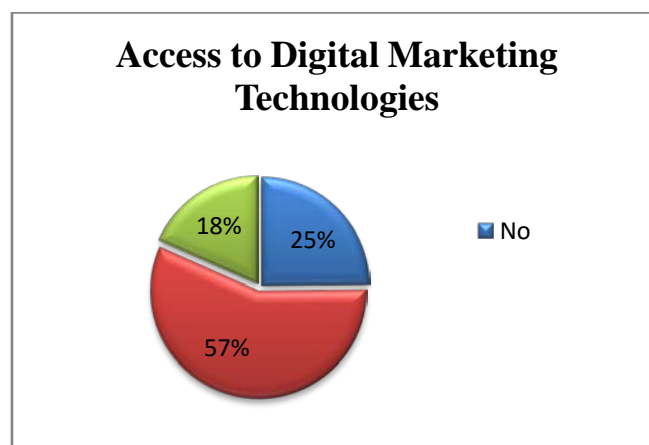
IV. RESULTS AND DISCUSSION

The analysis of the results obtained based on the questionnaire filled by the respondents is presented in this section. A targeted total of five-hundred (500) responses were obtained, although four-hundred and eighty four (484) (96.8%) the respondents' responded adequately and were the valid ones used for the

analysis. The percentage of valid respondent is 96.8%, and it fair representation of the total number of the copies of questionnaire administered. Findings and analysis provides a comprehensive analysis from the data obtained via Google forms and a well detailed discussion on the analysis. Also a hypothesis test is set about as part of study.

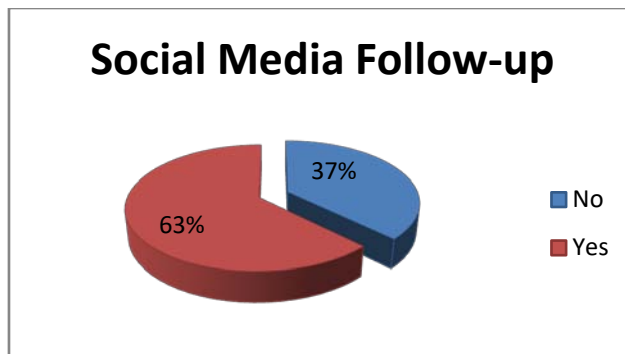
Objective One: What are the types of digital marketing technologies available in the Nigerian telecommunications industry?

From the analysis obtained based on the respondents access to telecommunications service providers' digital marketing platforms presented on figure below (Figure 4.1) The result reveals that the majority of the respondents 272(56.2%) access telecommunication service providers' digital marketing platform to get updates about latest trends on telecommunications products, services/networks and 88 (18.2%) of the respondents are unsure of their access to such platforms while 119 (24.6%) of the respondents don't access telecommunications service providers digital platforms for any form of information at all. Social media follow-up is another way telecommunications providers connect with their consumers on products information, trends and reviews.



Social media follow-up present opportunities for establish a closer relationship with brands and feel ownership of products or services purchase via social media platforms since consumers feedbacks and suggestions can be heard. The findings reveals that majority of the respondents 301 (62.2%) follow up their respectively chosen telecommunications service providers on their social networking sites, blogs and brand's website, 180 (37.2%) don't follow any of the telecommunications service providers while 3 (0.6%) never responded to the question. It shows that there is connection between telecommunications service providers and it consumers (subscribers). Similarly, Onobrakpeya and Mac-Attama (2007) emphasized the benefits of social media follow up. Dinner *et al.* (2014) in

their study reveals that digital ads are more effective than offline ads in driving online behavior. How digital ads are presented in terms of its usability and ease of use influence how and who access such marketing platforms. Therefore, digital ads must be presented in the most efficient way for it users.



The study is aimed at ascertaining the types of digital marketing technologies used by telecommunications consumers in Nigeria. Based on the findings (Table 4.1), it was revealed that the Nigerian telecommunications service providers make use of all the popularly digital marketing strategies/platforms to inform and create awareness on telecommunications products and services, as well as understand their consumers (subscribers) better. The result of this study shows that social networking sites is the most commonly used digital marketing platform with 142

(29.3%) respondents using it, followed by search engines marketing as 108 (22.3%) of the respondents ascertained that search engine marketing technologies cannot be underrated when it comes to informing telecommunications consumers on latest trends in the industry. Also, 28 (5.8%) respondents emphasized on the use of blogs such as Nairaland and 59 (12.2%) respondents accessed Mirco-blog websites and mobile application to gather information on telecommunications products and services and communicate with their respective telecommunications service providers.

Table 4.1: Respondents' types of digital media platforms used

Digital Marketing Platforms	Frequency	Percentage (%)
Blogs/Forums***	28	5.8
Email/SMS platform***	26	5.4
Search Engine***	108	22.3
Micro blogging***	59	12.2
Photo &Video Sharing sites***	40	8.3
Social Media sites***	142	29.3
Others (Jumia, konga etc.) ***	67	13.8
No Response	14	2.9
Total	484	100.0

*** Multiple Responses

Olotewo (2016) credited the explosion of digital marketing to its numerous roles of reaching more consumers and social media fueled the explosion. Employing survey method, Olotewo (2016) revealed that social media activity positively affects brand success and the most commonly used digital marketing technology. Also, the researcher identified Facebook as the prominent social media platform used by many firms and brands. Similarly, Khan and Siddiqui (2013) emphasized the role of social media networking sites to communicate telecommunications products and services efficiently. Helm et al. (2013) proved that value created by online marketing tools are more convincing than traditional methods of communication, and thus, controls consumers' decision making unlike the traditional methods of marketing.

Objective Two: To what extent are these digital marketing technologies being used in the study area? This section is to address the second objective of the study by determining the extent of usage of the various types of available digital marketing technologies used

by the telecommunications service consumers' (subscribers), their preference and why they are being used. This section further analyzed the consumers' thoughts, attitude and understanding of digital platforms with their level of versatility, satisfaction, acceptability and awareness.

Table 4.2 presents the respondents opinions on the extent of usage of the various types of digital marketing technologies provided by the telecommunications service providers when communicating to their consumers. A five-point Likert scale was employed to gather respondents' information ranging from 1-being least used to 5- being most used. Among the 484 respondents valid for this study, 135 (29.9%) moderately use online ads and online media such as blogs (like Nairaland) to gather information before opting for a service or purchase a product within the telecommunications industry. Search engine and social media networking platforms were observed as the most used digital platform by telecommunication service consumers 141 (29.1%) and 127 (25.2%) respectively.

The telecommunications service provider website content is as well fairly used by surveyed respondents as 101 (20.9%) agreed to it moderate usage. The use of TV/Radio ads cannot be underrated as 121 (23.6%) of the respondents make use of it moderately and 131 (27.1%) moderately use Email and SMS notification to gather information.

From a general standpoint, the total scale average weighted mean (2.69, SD= 1.64) on Table 4.2 shows that the Nigerian telecommunications service consumers use digital marketing technologies on the average was to a moderately extent. The findings further revealed that that out of the seven available used digital marketing channels in the Nigerian telecommunications industry, social media networking sites seems to be

averagely the most used digital marketing platform by the consumers with the highest mean value (Mean=3.16, SD=1.37). In summary, table 4.6 revealed that most of the respondents mostly use the search engine and social media networking sites to connect with their various chosen telecommunications service providers. Similarly, Sebastian et al. (2016) confirmed that social media and search engines is most commonly used digital marketing channels and thus interfere with consumer behavior towards products and services marketed via the channels. This therefore suggests social media and search engine marketing are averagely to a moderate extent used by telecommunications service consumers in the course of purchasing telecommunications products or services.

Table 4.2: Use of the digital marketing tools by the telecommunications service consumers

Marketing tools	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Mean	SD	Average Mean
Online Ads/Online Media	152 (31.4)	85 (17.6)	135 (29.9)	46 (9.5)	65 (13.4)	2.56	1.37	
Search Engines	83 (17.1)	80 (16.5)	141 (29.1)	68 (14.0)	111 (22.9)	3.09	1.38	
Social Media	80 (11.8)	74 (14.7)	127 (25.2)	95 (18.2)	108 (21.5)	3.16	1.37	2.69 (SD=1.64)
TV/Radio Ads	115 (17.1)	104 (19.8)	121 (23.6)	64 (13.0)	78 (15.5)	2.76	1.37	
Website	178 (36.8)	122 (25.2)	101 (20.9)	50 (10.3)	32 (6.6)	2.25	1.23	
Email/SMS Notification	133 (27.5)	102 (21.1)	131 (27.1)	64 (13.2)	53 (11.0)	2.59	1.31	
E-commerce platform Ads	126 (33.7)	95 (19.6)	125 (25.8)	53 (11.0)	46 (9.5)	2.43	1.31	

KEY: 1 - Least Used, 2 - Rarely Used, 3 - Moderately Used, 4 - More Used, 5 - Most Used.

Test of Hypothesis

Ho: There is no significant difference between the usages of digital marketing tools available to consumers

Table 4.3: ANOVA test of difference between the uses of digital marketing tools

Source of variation	Sum of Squares	Df	Mean Square	F	t-value critical	Sig.	Decision
Between Groups	289.305	6	48.217	27.539		.000	
Within Groups	5249.119	2998	1.751		0.073		REJECT
Total	5538.424	3004					

p < 0.05 @ 0.05 alpha level

Table 4.3 shows the result of the ANOVA test has a value of 27.539 with a p-value of 0.000. Since the p-value (0.000) is less than 0.05, the null hypothesis is rejected. The result indicates that there is significant difference between the usages of digital marketing tools available to consumers. Further test revealed that there

is significant difference between the usages of social media and other available tools except search engines. There is significant difference between the usages of search engine and other digital marketing tools. There is significant difference between the usages of online ads/online media and website content. There is no

significant difference between the usages of other pairs of tools. This hypothesis simply implies that the use of digital marketing technologies differs based on the technology been used, consumers experience with such technology and consumers willingness to explore more on such technology. Therefore, consumers react on digital platforms based on their preferred online platforms

V. CONCLUSION AND RECOMMENDATION

Interestingly the emergence of social media, search engines, and other digital marketing platforms has changed the way telecommunications service providers reach out to it consumers. The study identified social media as the main fuel of digital marketing. Furthermore, the increase in Internet penetration has enhanced the use of digital marketing among the various industries in Nigeria. The study also concluded that majority of the respondents feel closer to their chosen telecommunications service providers' via digital platforms. Telecommunications service providers are advised to invest meaningfully on digital marketing as to make their products and services well known to the consumers and as a means of communicating consumers' views and opinions.

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Online Classroom Platforms: A Comprehensive Study in the Perspective of Bangladesh

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Abstract- Education is the backbone of a nation. So every nation emphasizes it with their highest value as development is mostly dependent on education. In the modern era, online classroom conditions naturalized through specialized video conferencing applications. There may be students and instructors to take the class as a traditional classroom. There is at least one current tutor present, and the lesson is completed in real-time at a fixed time, with the students being present. Here, students and teachers can genuinely engage in class. However, a class does not always need a live teacher to inspect students; they can also proceed to their desired place. Sometimes there may be no teacher at all. This type of online classroom is an unsupervised online classroom. It is distinguished by ready-made lessons that the students can receive without the help of an instructor. Examinations can also be automated in this system. So, in any situation and place, an online class can be taken. At the time of COVID-19, all over the world, people are in crisis and are locked down in their houses. The traditional educational system is facing more trouble to continue its activities. In the traditional system, some teachers used to teach various subjects in front of their students in an educational institution.

Index Terms: education, online, classroom, COVID-19.

GJCST-H Classification: K.3.1



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Online Classroom Platforms: A Comprehensive Study in the Perspective of Bangladesh

A.H.M Saiful Islam^α, Md Sanju Islam^σ, Shaheena Sultana^ρ & Maria Islam^ω

Abstract- Education is the backbone of a nation. So every nation emphasizes it with their highest value as development is mostly dependent on education. In the modern era, online classroom conditions naturalized through specialized video conferencing applications. There may be students and instructors to take the class as a traditional classroom. There is at least one current tutor present, and the lesson is completed in real-time at a fixed time, with the students being present. Here, students and teachers can genuinely engage in class. However, a class does not always need a live teacher to inspect students; they can also proceed to their desired place. Sometimes there may be no teacher at all. This type of online classroom is an unsupervised online classroom. It is distinguished by ready-made lessons that the students can receive without the help of an instructor. Examinations can also be automated in this system. So, in any situation and place, an online class can be taken. At the time of COVID-19, all over the world, people are in crisis and are locked down in their houses. The traditional educational system is facing more trouble to continue its activities. In the traditional system, some teachers used to teach various subjects in front of their students in an educational institution. But there are still a lot of opportunities present to shift the class on the internet platform and continue to proceed. Here we have studied various kinds of online classroom platforms and tools so that both teachers and students can select their platforms as per their requirements in Bangladesh as well as all over the world. For the online platforms, the continuous study is going in a full swing here in Bangladesh from the primary sector to the university sector.

Index Terms: education, online, classroom, COVID-19.

I. INTRODUCTION

Education has changed a lot in the last couple of decades. Technology has completely changed our learning experience and has made it more fruitful. Education must originate with these new learning styles. For instance, a popular way of Accommodating these new learning styles is through virtual classrooms or online classrooms. An online classroom is an educational ambience where users can interlude, convey aspects, and concern with educational resources at the time of performing in a virtual place. The medium is mostly through a video-conferencing application. It allows many participants through the internet to be connected at the same time from

anywhere in the world. An online classroom is also called a virtual learning environment (VLE). With the online environment, concepts and collaborators are never far away. Mobile accessibility also grants participants greater flexibility. Students are working with each other more than ever because of virtual classrooms. One of the identifying features of separating online learning conditions from typical classrooms is the flexibility of the way lessons are offered. In traditional learning, students sit in a classroom, listening to a teacher, and taking notes. On the contrary, virtual classrooms give learners greater liberty to engage with the components creatively and react based on their inputs. Traditional learning tends to be synchronous, where virtual learning seems to be asynchronous. Online classrooms deliver new modes for tutors to give radiating, amusing, and efficient learning resources. So, innovation is the hallmark of online learning-for, both learners and lecturers. Some interactive online classrooms are Gamified lessons, flipped classrooms, and scenario learning. And there are also a lot of virtual classroom options available with both free and cost[3]. Today all over the world people are facing much trouble for the pandemic COVID-19. People are locked down in their homes. And the virus is spreading at high speed. As per the last update of the World Health Organization on 20 April 2020 (06:00 GMT+6), there are 2314621 confirmed cases, 157847 confirmed deaths and 213 countries, areas, or territories are with COVID-19. Every institutional function, excluding emergency services and limited hour bank services, has been closed for an uncertain time. There is no perfect assumption when to get on the daily activities[1]

We have started with the Introduction part in Section I. In the next sections, we have discussed the online classroom and its benefits, limitations, and future. Section III represents the insights of mobile and internet in Bangladesh. Section VI introduces our online educational activities in Bangladesh. In Section VIII, we have made a comparison of various online classroom platforms in detail. Section IX concludes the paper.

II. THE ONLINE CLASSROOM

An online classroom is an internet-based, flexible, afford- able, and non-restricting learning environment that sanctions teachers and students to cohere, interlude, assist and illustrate conjectures. It has tumbled most of the usual obstructions to synchronous

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learning: cost, distance, and timing. An online classroom should have some features[35][3]. Such as:

- Video conferencing capability, so lecturers and learners can see each other.
- Audio conferencing ability to hear each other.
- Real-time text chats, for messaging each other.
- Interactive online whiteboard to interact much more collaboratively and not just rely on video or audio.
- Library of learning materials so that teachers can provide more relevant, rich, and structured lessons to the students.
- Teacher tools and controls just like in a physical classroom to monitor the class and are much more feasible online.

III. BENEFITS OF ONLINE CLASSROOM

There is much coherence between a traditional education system and an online classroom. Learning through an online classroom gives many advantages that the campus-based system doesn't provide. A few have made a list of top benefits [3] [33] [34] [32]. For instance:

- Access to Class from Anywhere: In any situation, classes can be taken online at any place. All one needs is a laptop or other digital device.
- Effective Time Management: Classes can be taken at any time based on any situation. No need to travel and not worry about wasting extra time.
- Sharpened Digital Skills: There are both opportunities for whetting digital skills and gaining more knowledge in the field of online classroom activities. By studying in an online world, one will be not only doubtless but also bold to use interactive online tools like virtual examinations, drop boxes for home-task, assistance gadgets, e-mail communications to teachers, and others.
- Immediate Feedback on Tests: After any test, no need to wait for a long time. It can be obtained within a short time.
- Knowledge Retention: Online education modules are referred to as micro-learning, which helps learners to discover what they require faster, manageable, and notable. It may appear, there are more benefits for propensity and participation in traditional classrooms, but this is not necessarily right. In online classrooms, anyone can inform his teacher through messaging, or one can use the interactive comment and share elements for engaging and connecting. Features, for example, comment, and rating allows tutors to fix the quality of their content and to synthesize accordingly to the efficient learning realization.

IV. LIMITATIONS OF ONLINE CLASSROOM

Online education has many profits to deliver, still unluckily; there are some losses also. Demerits are

not much as the merits without doubt, but there are indeed some views of the online classroom that some sharers might take as inadvertence. Few main limitations have made a list[4]. Such as,

- Higher Internet Cost: Strong internet availability is the foremost thing to be in the online classroom. But it is a matter of sorrow that it is not possible to provide a reliable connection all the time and everywhere. But it cost much to get this kind of connection.
- Additional Digital Training: Additional digital training is another limitation of the online classroom. Perceiving online learning completely is essential for the online classroom. Some of the tutors and students do not maintain proper lessons of using the given e-Learning gadgets. So, they face difficulties to interact and attain these gadgets.
- Infrastructure Challenges: There is a requirement of using advanced technology and proper network infrastructure for establishing an online classroom. We have many affordable and feasible resolutions for the ascending necessity and adaptability of online classes. But some of the organizations might not propose to offer it for its high-cost installation.

V. FUTURE OF ONLINE CLASSROOM

In the upcoming time, we hope for the online classroom to spread more AI and VR. As the virtual classroom is enduring to spread, we expect to have more innovation in emerging technologies. At the forefront are Artificial Intelligence and Virtual Reality. While these are still searching their footing, they are on their way and will have numerous applications across learning platforms in the coming years. There has been much enhancement in the improvement of electronic media from the beginning of the last century. We have surpassed the obstacles of costly and speedy internet. So, many neoteric organizations have manifested to fully incorporate e-Learning through an online classroom. So that they can simplify learning and development for both employees and learners. Now we can have field visits just by sitting in a classroom. Nevertheless, tech organizations such as Google have now made it true with their virtual reality system. Technological advancements are now switching educational stages. It is also making them free from time and physical location. Today, online classrooms have already stepped into the learning world. A lot of innovations are on their way of coming to the education sector with these. There will be a classroom scenario treating an e-Learning framework with absolute exactness. It will anticipate the learners to forget about their actual presence and the long distance between them and the instructor in the future.

VI. INTERNET AND MOBILE INSIGHT OF BANGLADESH

Bangladesh is a south-east Asian country with a small area. But it has a large population where its literacy rate is rising day by day. And it is a land of opportunities where digitalization is making its way into the deep. Traditional and online activities are both active in the field of education here. Anyone with a desktop or laptop or mobile can be connected to the virtual world with an internet connection. In Table??, we can see the internet and mobile connection statistics of Bangladesh concerning its population. A good number of people are present to use the internet in Bangladesh. Though most of them use mobile internet broadband connection is also impending. So it is not impossible to implement online class activities in Bangladesh regularly. And we can get the information from Table 2 about it.

Table 1: Bangladesh Key Digital Statistical Indicators [31]

Total Population	167.2 million
Internet Users	91.2 million
Active Social Media Users	34 million
Mobile Connections	157.2 million
Active Mobile Social Users	32.2 million

Without having a strong internet connection it is not possible to get into Online Classroom. Though it is costly to get a better one here a good one can be got within a reasonable rate here. From the perspective of Bangladesh, we can see the internet speeds in Table 3.

Table 2: Internet Users in Bangladesh [31]

Description	Number
Total number of active internet users	91.82million
Internet Users as a percent of total population	55percent
Total number of active mobile internet users	86.42million
Mobile Internet Users as a percent of total population	52 percent

Most of the people in our country use mobile phones heavily in their daily activities. As technological kinds of stuff cost more in this country, people are satisfied with their computer alike mobile phones. And it is possible to get a smartphone at a reasonable price as we have many mobile manufacturers here. Here in Table 4. we see the mobile connection types in our country.

Table 3: Internet Speeds in Bangladesh [31]

Description	Number
Average Speed of Broadband Internet Connection	9.06 MBPS
Internet Users as a percent of total population	18.70 MBPS

As a developing country, its literacy rate and per capita income are rising and it is going at a high speed. And one of the best reasons behind its development is

Education. Bangladesh is emphasizing Education highly. We also see in Table 5. the demographic and economic indicators of Bangladesh. There are two types of internet users in Bangladesh and we have seen it from Table 2. But we see a huge difference between mobile and broadband internet users there. Most of the people are suitable with mobile phones. We can analyze it through Table 1.

Table 4: Mobile Connection Types in Bangladesh [31]

Description	Number
Total Number of Mobile Connection	157.2 million
Mobile Connection as a percentage of Mobile Connection	94 percent
Percentage of Prepaid Mobile Connection	97 percent
Percentage of Postpaid Mobile Connection	3 percent
Percentage of Broadband Mobile Connection	43 percent

Previously we have described mobile manufacturers in Bangladesh. Mobile is like a small computer with a lot of advantages. So, with the statistics, we can say that it is feasible to maintain online classroom activities in a developing country named Bangladesh. And it will be able to contribute to building a Digital Bangladesh.

Table 5: Essential Demographics and Key Economic Indicators [31]

Total Population	167.2million
Female Population percentage on whole	49.6 percent
Male Population percentage on whole	50.4 percent
Annual Change in Population Size	+1 percent
Median Age	27.5 years
Urban Population	37 percent
GDP per Capita	3869 dollar
Total Literacy Age(15+)	73 percent
Female Literacy Age(15+)	70 percent
Male Literacy Age(15+)	76 percent

VII. ONLINE CLASSROOM ACTIVITIES IN BANGLADESH

Bangladesh is a developing country. It is emerging day by day with its resources. Though traditional systems are more happening here now a day's new technological system is also preferable with the traditional one. So, online classroom activities have also been started with a limited portion in Bangladesh. TABLE 6: Educational Statistics of Bangladesh in 2018[2]

Bangladesh has a huge education society containing many institutions and its teachers and students. We can observe the quantity from Table 1. Like other people in the world, the people of Bangladesh are also facing a crisis at the time of COVID-19. It is so dangerous that life has been stuck in homes for days long as per the Government's Rule and Safety. All the institutions excluding emergency services and banking are closed in most of the countries. So, all educational institutions are also closed. But they are facing many problems to continue one of the noblest things in the world, and that is Educating. So they are shifting their classes to an online setting. Going through Fig. 8, we can see there are a huge number of students studying at different educational institutions in Bangladesh. They can surely be benefited from the online classroom platforms.

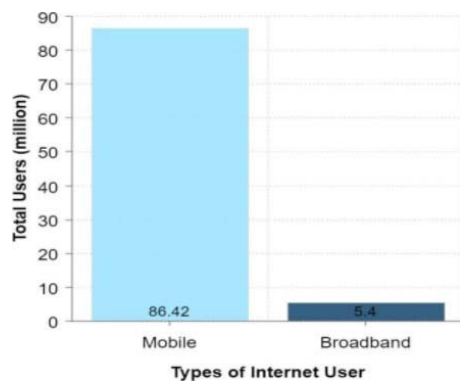


Fig. 1: Comparison of different types of internet user in Bangladesh [31]

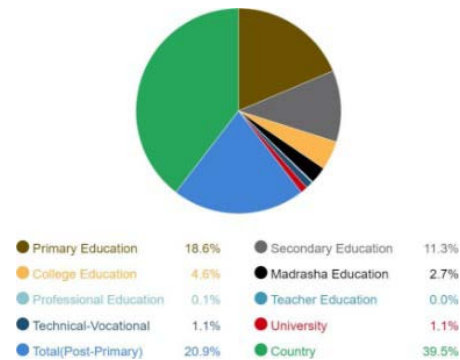


Fig. 2: Different types of education and no. of students in Bangladesh (notitle, n.d.)

Table 7: Educational Statistics of Bangladesh in 2018 (notitle, n.d.)

Name	Features	Pricing	Source
GoToMeeting	Screen sharing, mobile conferencing, meeting recording and transcription, video and voice conferencing	Professional-pack Costs USD12 per month for 150 participants, Business-pack costs USD16 per month for 250 participants.	[6]
Easymeeting	Free meeting room in the cloud, access to Easy meeting directory, available on Android and iOS.	Single license for USD19 a month, Team license for USD239 a month (includes 10 virtual meeting rooms).	[5]

At this crisis moment like COVID-19, teachers of different educational institutions are instructed to take their classes online. Like other private universities in Bangladesh, Notre Dame University Bangladesh is also taking its classes in online classrooms. Faculties and students are also taking their classes regularly at their routine time. So that they can get enough time to do their other work. And mainly to be at home, which is the main thing to be safe in the COVID-19 situation. All the people are playing their roles in tackling this tough situation.

Quality teaching and ethical formation have been conferring and rendering to youngsters by the Holy Cross Congregation in Bangladesh. Most of them have attained competency in various occupations. They have also stood out as committed citizens to serve Bangladesh with inscription. 'Notre Dame' is a brand that symbolizes excellence in the education sector of Bangladesh. At the crisis moment like COVID-19, they are continuing their educational activities on online platforms. So that the students don't face any kind of study-related problem in their career.

VIII. AN OVERVIEW OF ONLINE CLASSROOM PLATFORMS

Online classroom and learning activities are being incorporated by numerous organizations. They are now working with the advancement of online classroom software and tools. But it is difficult to ensure learner's inclination with both innovating educational stages and advancement in technology. Here we have discussed various online classroom platforms with their features, prices and sources in Table 7 to 10:

ProfiConf	Cutting-edge security to keep data safe, web-based solution without the need to download anything, share screens, ability to record the conference.	Free plan for meetings with up to 2 participants, Pro plan is priced at USD12 per month, and the Premium plan costs USD25 per month.	[7]
ezTalks	HD Video-Audio calling, file screen sharing, instant messaging, interactive whiteboard.	The Standard, Pro and Business plans (for 100, 200 and 300 attendees) cost USD13, USD39, and USD65	[11]
Web Room	Document and File sharing, screen-application sharing, interactive whiteboard.	per month Free	[28]
BlueJeans	Real-time Intelligence, unparalleled interoperability, seamless integration.	Standard license for USD12.49 per month, limited to 50 participants per meeting. Pro license for USD17.49 per month, limited to 75 participants per meeting.	[9]
UberConference	Share screen, voice intelligence, HD video meetings.	Up to 10 participants Uber Conference is free, but requires a PIN for each user. For 11-100 attendees, a subscription costs USD15 per month.	[24]
Mikogo	Screen sharing feature, multi-user whiteboard and annotation tool.	USD14 per month, to be used only for 1:1 meetings. For meetings with up to 25 people, payment is USD16 monthly.	[19]
Vast Conference	Conference Calling, worldwide Coverage, exceptional audio quality.	The Essentials, Standard, and Professional plans (for 10, 100, and 250 attendees) cost USD11.99, USD15.99, and USD31.99 per month.	[26]
join.me	Claim your own personalized URL, customize meeting back- ground, better audio, screen Sharing	join.me's LITE, PRO, and BUSINESS plans are priced at USD10, USD20, and USD30 per month respectively.	[17]

Table 8: Educational Statistics of Bangladesh in 2018 (notitle, n.d.)

Name	Features	Pricing	Source
ReadyTalk	Host audio and video meetings with up to 125 attendees through desktops or mobile devices, customize participant profiles and assign roles for efficient meeting management.	Standard and Premium Subscription cost USD12 and USD24 per month.	[20]
Spread	Share screen, remote control desktop, interactive whiteboard, recording and archiving.	Prices USD199 per year for 20 persons and USD499 per year for 100 persons.	[23]
Vedamo	Online whiteboard, video conference, screen sharing, recording.	Unlimited video sessions for 25 participants are priced at USD25 per month	[27]
GOMEETNOW	Share-view desktop, collaborate in real time, record and playback, generate attendance reports	Basic costs Free for 2-100 participants and the time is only for 40 minutes. But the Pro version costs USD12.95 per month for 2-100 participants with unlimited sessions	[13]

Ring Central Office	Chat, HD video calling, screen sharing	It comprises four packages like Essential, Standard, Premium, Ultimate that cost USD19.99, USD24.99, USD34.99, USD49.99 for 20, 100, 200, 200 participants respectively	[21]
Brain Cert	Scalable, secure, whiteboard editor support, real-time collaboration	It prices three packages like Basic, Pro, Business cost USD39, USD99, USD259 per months for unlimited students and 5, 25, 50 teacher accounts	[10]
Unlimited Conferencing	Unlimited minute, custom greeting, free recording	The Basic, Plus, Pro and Premium plans (for 5, 10, 25 and 100 attendees) cost USD7.95, USD11.95, USD 23.95 and USD39.95 per month	[25]
Adobe Connect	Adding QA-polls games, editing and recording features, inbuilt storage space, VOIP integration	Adobe Connect Meeting costs USD50 per month for hosting meetings with up to 25 participants, Adobe Connect Webinar is priced at USD130 a month	[8]

Table 9: Educational Statistics of Bangladesh in 2018 (notitle, n.d.)

Name	Features	Pricing	Source
Fuze	Ability to save and share meeting files, up to 1GB of cloud storage for all its plans	It offers three plans: Free, Pro and Enterprise. The free allows a maximum of 25 participants while the Pro costs between USD8- USD14 and hosts a maximum of 125 participants. The Enterprise comes with a monthly rate of over USD20 and the maximum number of people can be discussed with the company	[12]
Zoom	Supports HD audio and video calls, content sharing with up to 1000 meeting participants, synced end to end with your calendar via Outlook, iCal, and Gmail	Basic plan is free for holding meetings with up to 100 people but it is limited to 40 minutes. Its pro plan costs USD14.99 per host and has to be paid monthly	[30]
MegaMeeting	Video Audio Conferencing Services, webinar hosting and web conferencing, screen and file sharing, recording	Starter edition costs USD19 per month if pay annually, and USD29 if pay monthly. Pro edition costs USD29 per month if pay annually, and USD39 if pay monthly. Enterprise edition costs USD79 per month if pay annually, and USD99 if pay monthly	[18]
Google Meet	Schedule meetings on the fly, lightweight app version runs smoothly on iOS and Android devices, integrated with Google Calendar and Google Doc, access all of Google's apps from one window	G Suite pricing starts as low as USD6 per user per month for Basic, USD12 per user per month for Business, and USD25 per user per month for Enterprise	[14]
Skype	Audio and HD video calling, smart messaging, screen sharing, live subtitles, call recording, private conversations	Skype for Business is a free tool that can facilitate meetings with up to 250 participants. It is integrated with MS Office apps and accessible via iPhone, Android, and PC/Mac devices	[22]

Table 10: Educational Statistics of Bangladesh in 2018 (notitle, n.d.)

Name	Features	Pricing	Source
Zoho Meeting	No download, screen sharing, audio-video, recording, secure session	Costing for meeting and webinar differs. For meeting is prices USD10 per month for monthly and USD8 per month for yearly payment both for 100 participants. But in webinar it depends on persons. For in- stance it costs USD 19, USD 29, USD 39, USD 79 per month on monthly payment and USD15, USD23, USD31, USD63 per month on annual payment on the basis of participants number 25, 50, 100, 150	[29]
ELECTA LIVE	Rich markup and annotation tools, screen sharing and remote control, power points files and images, text-chat, session notes	It has three packages named Easy, Pro, Professional that cost USD29.90, USD39.90, USD69.90 per month with 1, 1, 3 teacher rooms	[15]
Intermedia Unite	Audio and video conferencing, file and screen sharing, and document management	Contact with the sales team	[16]

Being in a developing country so we have to think about the lowest cost with most facilities. Though it entirely depends on one’s own choice but based on the Tables, we can say that Skype, Google Meet, UberConference, WebRoom, GoToMeeting, BrainCert are much suitable in the perspective of Bangladesh as well as all over the world.

IX. CONCLUSION

In the activities of the online classroom, we can be benefited in many ways. It has broadened many fields of technology in online classrooms. It will save both our time and money. And the remaining can be invested in other mediums. It can also prepare us for the upcoming era of digitalization. It can help us to be familiar with technologies. Online classroom trends are forming like never before. These advanced classrooms are going to stay for a long time. It may happen that the traditional classrooms will be replaced by online ones. Technology is giving us so many things that cannot be counted. For instance, we are getting a new interactive education world for it as it is passing the physical and traditional boundaries. We should never stop learning. There is no limit to that also. Also, it is opening the new education door to the working people who work in the daytime. They can learn new things and enrich their knowledge through online classes. So we should be more familiar in Bangladesh to continue our education regularly whatever crisis like COVID-19 we face at any time. Through this paper, anyone can select their online learning platform as per their requirement. We have tried our best to put all the main features and costing details in a short format.

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Optimal Asymmetric Data Encryption Algorithm

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Abstract- Today, public-key cryptosystems are particularly vulnerable to fetching cipher text and adaptively matched plaintext attacks. To prevent such attacks, in practice, optimal asymmetric algorithms are used, for example, RSA-OAEP and etc. In this article, using the method of encoding messages by points of an elliptic curve, an optimal asymmetric algorithm is proposed for data encryption which is based on elliptic curves.

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GJCST-H Classification: *E.3*



Strictly as per the compliance and regulations of:



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Keywords: asymmetric algorithms, elliptical curves, encoding and decoding.

I. INTRODUCTION

To date, the durability of modern asymmetric algorithms (data encryption and digital signature) is characterized by their properties to withstand all kinds of attacks and the laboriousness of the best known hacking algorithm [1-9].

The standards of asymmetric data encryption algorithms used in practice are based on the problems of factorizing a composite number and discrete logarithm in a finite group of large prime order.

The main problems in this class of cryptographic transformations are the low speed of such transformations, a significant increase in the size of the cryptogram compared to the size of the original message, and also the decreasing strength due to the development of mathematical methods and cryptanalysis tools.

In recent years, elliptic cryptography has been intensively developed, discovered independently by N. Koblitz and V. Miller in 1985, in which the role of a one-sided function is played by scalar multiplication of a point by a constant, implemented on the basis of operations of addition and doubling of points of elliptic curves (EC) in finite fields of various characteristics [14-15].

In [11], a status of the directional encryption was considered, possibilities of implementing directional encryption in groups of points on the EC were substantiated, in [12], a method of commutative encryption was proposed using computations on the EC, which ensures the exponential strength of the commutative encryption algorithm and its performance increase compared to other algorithms [13].

For cryptosystems (symmetric and asymmetric), there exist Chosen-plaintext attack (CPA), Chosen-cipher text attack (CCA), and adaptive chosen plaintext attack (CCA-2). The CPA and CCA attacks were originally intended for active cryptanalysis of secret key cryptosystems.

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The purpose of this cryptanalysis is to break the cryptosystem using open and encrypted messages received during the attack [18-20]. They were then adapted for cryptanalysis of public key cryptosystems.

Analysis shows that public key cryptosystems are especially vulnerable to CCA and CCA-2 [17]. Therefore, to prevent such attacks, in practice, optimal asymmetric algorithms are used, for example RSA-OAEP [16] and etc.

The purpose of this work is to propose an optimal asymmetric data encryption algorithm for EC using the method of encoding messages with EC points.

In the EC encryption algorithm considered below, - bit data block of the message m is encoded by the EC point M , which is then transformed with a secret key. As a result, the cryptogram represents some point C .

The decryption procedure involves performing inverse transformations over point C , after which point M is restored and decryption is performed, leading to the receipt of message m .

II. MAINPART

Let a prime number be given $p > 3$. Then an elliptic curve E defined over a finite prime field F_p is the set of pairs of numbers (x, y) , $x, y \in F_p$, satisfying the identity

$$y^2 \equiv x^3 + ax + b \pmod{p}, \quad (1)$$

where $a, b \in F_p$ and $4a^3 + 27b^2$ is not comparable to zero mod p .

An invariant of an elliptic curve is a magnitude $J(E)$ that satisfies the identity

$$J(E) = 1728 \frac{4a^3}{4a^3 + 27b^2} \pmod{p}, \quad (2)$$

The coefficients a, b of the elliptic curve E , according to the known invariant $J(E)$ are determined as follows

$$\begin{cases} a \equiv 3k \pmod{p} \\ b \equiv 2k \pmod{p}, \end{cases} \quad (3)$$

where, $k = \frac{J(E)}{1728 - J(E)} \pmod{p}$, $J(E) \neq 0$ or 1728 .

Pairs (x, y) that satisfy identity (1) are called points of the elliptic curve E ; x and y are the x - and y -coordinates of the point, respectively.

The points of the elliptic curve will be denoted by $G(x, y)$ or G . Two points of an elliptic curve are equal if their corresponding x - and y -coordinates are equal.

On the set of all points of the elliptic curve E we introduce the addition operation, which we will denote by the "+" sign. For two arbitrary points $G_1(x_1, y_1)$ and $G_2(x_2, y_2)$ of the elliptic curve E , we consider several options.

Let the coordinates of the points $G_1(x_1, y_1)$ and $G_2(x_2, y_2)$ satisfy the condition $x_1 \neq x_2$. In this case, their sum will be called the point $G_3(x_3, y_3)$, the coordinates of which are determined by the following formula

$$\begin{cases} x_3 \equiv \lambda^2 - x_1 - x_2 \pmod{p}, \\ y_3 \equiv \lambda(x_1 - x_3) - y_1 \pmod{p}, \end{cases} \quad (4)$$

$$\lambda \equiv \frac{y_2 - y_1}{x_2 - x_1} \pmod{p}.$$

where,

If the equalities hold $x_1 = x_2$ and $y_1 = y_2 \neq 0$, then we define the coordinates of the point G_3 , as follows

$$\begin{cases} x_3 \equiv \lambda^2 - 2x_1 \pmod{p}, \\ y_3 \equiv \lambda(x_1 - x_3) - y_1 \pmod{p}, \end{cases} \quad (5)$$

$$\lambda \equiv \frac{3x_1^2 + a}{2y_1} \pmod{p}.$$

Where,

In the case when the condition $x_1 = x_2$ and $y_1 = -y_2 \pmod{p}$ is satisfied sum of the points G_1 and G_2 will be called the zero point O , without determining its x - and y -coordinates. In this case, the point G_2 is called the negation of the point G_1 . For the zero point O , the equalities holds.

$$G + "O = O" + "G = G, \quad (6)$$

Where G is an arbitrary point of the elliptic curve E .

On the set of all points of the elliptic curve E , we introduce the subtraction operation which we denote by the sign "-". By the properties of points on elliptic curves, for an arbitrary point $G(x, y)$ of an elliptic curve, the following equality holds:

$$-G(x, y) = G(x, -y), \quad (7)$$

In accordance with equality (7), for two arbitrary points $G_1(x_1, y_1)$ and $G_2(x_2, y_2)$ of the elliptic curve E , the subtraction operation is defined as follows:

$$G_1(x_1, y_1) - G_2(x_2, y_2) = G_1(x_1, y_1) + G_2(x_2, -y_2), \quad (8)$$

i.e. a subtraction operation can be converted to an addition operation.

With respect to the introduced operation of addition, the set of all points of the elliptic curve E , together with the zero point form a finite abelian

(commutative) group of order w , for which the inequality [2] holds.

$$p + 1 - 2\sqrt{p} \leq w \leq p + 1 + 2\sqrt{p}, \quad (9)$$

A point T is called a point of multiplicity k , or simply a multiple point of an elliptic curve E , if for some point N the equality

$$T = \underbrace{N + \dots + N}_k = [k]N, \quad (10)$$

III. ASYMMETRIC ENCRYPTION ALGORITHM PARAMETERS

The parameters of the asymmetric data encryption algorithm are:

1. Prime number p is the modulus of an elliptic curve satisfying the inequality $p > 2^{255}$. The upper bound of this number should be determined with a specific implementation of the asymmetric algorithm;
2. Elliptic curve E defined by its invariant $J(E)$ or coefficients $a, b \in F_p$;
3. Integer w is the order of group points of the elliptic curve E
4. Prime number n is the order of the cyclic subgroup of group points of the elliptic curve E , for which the following conditions are satisfied:

$$\begin{cases} w = l * n, l \in \mathbb{Z}, l \geq 1 \\ 2^{254} < n < 2^{256} \end{cases}$$

5. point $G \neq O$ of the elliptic curve E , with coordinates (x_0, y_0) , satisfying the equality $[n]G = O$.

The above parameters of the asymmetric encryption algorithm are subject to the following requirements:

1. The condition $p^j \neq 1 \pmod{n}$ must be fulfilled, for all integers $j = 1, 2, \dots, B$, where B satisfies the inequality $B \geq 31$;
2. The inequality must be satisfied $w \neq p$.

Each user of the asymmetric encryption algorithm must have private keys:

1. The private key of the asymmetric algorithm d is an integer satisfying the inequality $0 < d < n$;
2. The public key of the asymmetric algorithm Q is a point of an elliptic curve with coordinates (x, y) satisfying the equality $[d]G = Q$.

An asymmetric encryption algorithm based on elliptic curves includes the following processes: expressing a message with elliptic curve points, encrypting a message, decrypting a message, expressing elliptic curve points as a message.

To implement these processes, each user must know the parameters of the asymmetric encryption

algorithm. Also, each user must have d private and $Q(x, y)$ public keys of the encryption algorithm.

Below processes of expressing a message with elliptic curve points, encrypting, decrypting and expressing elliptic curve points as a message are given.

a) *Algorithm for expressing a message by points of an elliptic curve [12]*

Specified S - the message for the next sequence is represented by an elliptic curve point.

1. Assign value of the counter $i = 0$, calculate the value $p' = p \text{ div } 2^{16}$ and compare p' and S as μ - bit binary numbers (div- operation of taking quotient). If $p' \leq S$, then go to step 6.

2. If $i < 2^{16}$, then form a 16-bit string r , the binary value of which is i . Otherwise, display the message "The point of the elliptic curve does not exist".

3. Assign $S || r$ to the variable x , where the sign " $||$ " denotes a concatenation operation and calculate the value $w = (x^3 + ax + b) \bmod p$

4. Calculate the Legendre symbol $\lambda = \left(\frac{w}{p}\right)$. If $\lambda = -1$, then increase the counter ($i = i + 1$) and go to step 2.

5. Calculate two root values $y_{1,2} = \pm\sqrt{w} \pmod{p}$ where $y_{1,2} \in \{1, 2, \dots, p-1\}$, assign the larger value of $y_{1,2}$ to y and go to step 10.

6. If $i < 2^{15}$, then form a 15-bit string r , the binary value of which is equal to i . Otherwise, display the message "No elliptic curve point exists".

7. Assign the value $S || r$ to the variable x and calculate the value $w = (x^3 + ax + b) \bmod p$

8. Calculate the Legendre symbol $\lambda = \left(\frac{w}{p}\right)$. If $\lambda = -1$, then increase the counter ($i = i + 1$) and go to step 6.

9. Calculate two root values $y_{1,2} = \pm\sqrt{w} \pmod{p}$ where $y_{1,2} \in \{1, 2, \dots, p-1\}$, assign the larger value of $y_{1,2}$ to y .

10. Output a pair of values (x, y) as coordinates of the point $M(x, y)$ of the elliptic curve for the given message S .

b) *An algorithm for expressing the points of an elliptic curve in the form of a message [12]*

Let, $M(x, y)$ be a point of an elliptic curve. Then the sequence of transition of a given point to S - the message goes as follows.

1. Calculate the value $w = (x^3 + ax + b) \bmod p$.

2. Calculate two root values $y_{1,2} = \pm\sqrt{w} \pmod{p}$, where $y_{1,2} \in \{1, 2, \dots, p-1\}$

3. If $y = y_1$ then, $S = x \text{ div } 2^{15}$. Otherwise, calculate $S = x \text{ div } 2^{16}$ and S - announced by the corresponding message of the point $M(x, y)$.

c) *Encryption process*

Given M message by conditions $\mu = \pi - k_0 - k_1 - 16$ divided into blocks $M = \{m_1, m_2, \dots, m_v\}$,

length $|m_i| = \mu$ bits, where k_0, k_1 - natural numbers, π - a character that determines the length of a given prime number p , each m_i - blocks, separately encrypted according to the sequence below.

1. Generate a random integer k satisfying the inequality $0 < k < n$, calculate $C_1 = [k]G$ and $R = [k]Q$ elliptic curve points.

2. Randomly generate l - message of length k_1 bits.

3. Calculate $S_1 = (m_i || 0^{k_0}) \oplus \text{Hesh1}(l)$, where Hesh1 - hash function [10] of length $\mu + k_0$ bits.

4. Calculate $S_2 = l \oplus \text{Hesh2}(S_1)$, where Hesh2 - hash function [10] of length k_1 bits.

5. Perform the operation $S = S_1 || S_2$

6. It is checked whether the message S is an elliptic curve point. If the message is not an elliptic curve point, then go to step 12.

7. Using the x - coordinate of the point $M(x, y)$, calculate the value $w = (x^3 + ax + b) \bmod p$

8. Calculate $y_{1,2} = \pm\sqrt{w} \pmod{p}$

9. If $y = \min(y_1, y_2)$ then, go to step 12.

10. Assign 3 to the variable q and calculate $C_2(x, y) = M(x, y) + R(x, y)$, $t = x_{C_2} || q$, and go to step 12 (where $|q| = 2$ bits).

11. Assign 1 to the variable q and calculate $C_2(x, y) = M(x, y) + R(x, y)$, $t = x_{C_2} || q$, and go to step 13.

12. Assign 0 to the variable q and calculate $C_2(x, y) = M(x, y) + R(x, y)$, $t = x_{C_2} || q$.

13. $E_i = \{C_1(x, y), t\}$ - declare as blocks of ciphertext.

d) *Decryption of cipher texts blocks*

The sequence of decrypting the ciphertext E_i ($E_i = \{C_1(x, y), t\}$) into the plaintext is as follows.

1. Calculate $U(x_u, y_u) = [d]C_1$

2. If $q = 0$, then calculate $S = x_{C_2} \oplus x_U$ and go to step 10.

3. Calculate $w = (x_{C_2}^3 + ax_{C_2} + b) \bmod p$
4. Calculate $y_{1,2} = \pm \sqrt{w} \pmod p$
5. If $q=3$, then go to step 7.
6. Calculate $y = \min(y_1, y_2)$ and go to step 7.
7. Calculate $y = \max(y_1, y_2)$.
8. Calculate $M(x, y) = (x_{C_2}, y) - U(x_U, y_U)$.
9. $M(x, y)$ is expressed as message S.
10. Set the initial $\mu + k_0$ bit of message S to S_1 , the last k_1 bit to S_2 . i.e. $S_1 || S_2 = S$.
11. Calculate $l = S_2 \oplus \text{Hesh2}(S_1)$.
12. Calculate $Sm = S_1 \oplus \text{Hesh1}(l)$.
13. If the last k_0 bit of the Sm message ends with zero values, then the message is genuine and the start μ bit is declared as a plaintext block m_i . Otherwise, the message is not genuine.

e) *Correctness of the proposed algorithm*

$$m_i || 0^{k_0} = Sm = S_1 \oplus \text{Hesh1}(l) = (m_i || 0^{k_0}) \oplus \text{Hesh1}(l) \oplus \text{Hesh1}(l) = m_i || 0^{k_0}$$

1st case, ($q=0$):

$$\begin{aligned} M &= x_{C_2} \oplus x_u = M \oplus x_R \oplus x_{[d]C_1} = \\ &= M \oplus x_{[k]Q} \oplus x_{[d][k]G} = \\ &= M \oplus x_{[k][d]G} \oplus x_{[d][k]G} = M \end{aligned}$$

2nd case, ($q=1$ or $q=3$):

$$\begin{aligned} M(x, y) &= (x_{C_2}, y) - U(x_U, y_U) = \\ &= M(x, y) + R(x_r, y_r) - U(x_U, y_U) = \\ &= M(x, y) + [k]Q - [d]C_1 = \\ &= M(x, y) + [k][d]G - [d][k]G = M(x, y) \end{aligned}$$

Below a comparison of the software results of the proposed optimal encryption algorithm (EA), elliptic curve (EC) encryption algorithm (EA) is given, RSA and RSA-OAEP (Table 1 and 2)

Table 1: Comparison of the time spent on the encryption, decryption process and the volume of cipher texts for non-optimal algorithms based on EC and RSA

Encryption algorithm (EA)	Encryption algorithm (EA) based on elliptic curve (EC)*		Algorithm RSA	
Open message length (bytes)	151928	1 671 208	151928	1 671 208
Change in ciphertext volume (%)	21,65 %	21,65 %	3,21 %	3,21 %
Time spent on encryption process (seconds)	16,91	184,876	29,936	332,297
Time spent on decryption process (seconds)	16,926	182,49	56,41	621,086

* this algorithm differs from the proposed one by the absence of a complement scheme[21]

Table 2: Comparison of the time spent on the encryption, decryption process and the volume of cipher texts for optimal algorithms based on EC and RSA-OAEP

Encryption algorithm (EA)	Optimal EA based on EC		RSA-OAE Palgorithm	
Open message length (bytes)	151928	1 671 208	151928	1 671 208
Change in ciphertext volume (%)	199 %	199 %	154 %	154 %
Time spent on encryption process (seconds)	41,06	451,433	76,814	848,243
Time spent on decryption process (seconds)	41,356	451,83	140,135	1558,147

IV. CONCLUSIONS

Analysis of the software results shows the following:

1. EA on EC increases the size of the cryptogram by 18.44% more than the RSA algorithm, and 2.2 times faster in speed.
2. The optimal EA on the EC increases the volume of the cryptogram by 45% more than the RSA-OAEP algorithm, and 2.4 times faster in speed.
3. These results were obtained using a computer with the following configuration: 64-bit Intel (R) Core (TM) 2 Quad CPU Q8400 2.67 GHz, 4 GB RAM.

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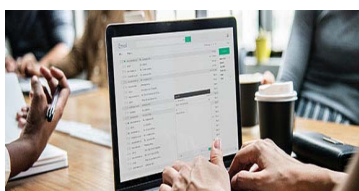
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Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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PREPARING YOUR MANUSCRIPT

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.



Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

- a) A title which should be relevant to the theme of the paper.
- b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
- c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
- d) An introduction, giving fundamental background objectives.
- e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
- f) Results which should be presented concisely by well-designed tables and figures.
- g) Suitable statistical data should also be given.
- h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

- i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
- j) There should be brief acknowledgments.
- k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

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Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

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A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

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Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.



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TIPS FOR WRITING A GOOD QUALITY COMPUTER SCIENCE RESEARCH PAPER

Techniques for writing a good quality computer science research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of computer science then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

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7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

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10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.



20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium through which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



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- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.



The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
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- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
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As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

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This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

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Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

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- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

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Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."



Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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Topics	Grades		
	A-B	C-D	E-F
<i>Abstract</i>	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
<i>Introduction</i>	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
<i>Methods and Procedures</i>	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
<i>Result</i>	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
<i>Discussion</i>	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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