

Impact of COVID-19 pandemic on education: Moving towards e-learning paradigm

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ABSTRACT

Besides the economic impact and loss of jobs and revenues, COVID-19 have a great impact on the education sector, with several learning institutions across the world remaining shut down for months. This study evaluated the impact of COVID-19 pandemic on education. The study employed a cross-sectional study design in which data was collected using qualitative methods from various education stakeholders as well as secondary literature. The result showed that learning has severely been affected by the strict protocols adopted by various governments in response to COVID-19 pandemic. The major responses to COVID-19 like closing up schools have left most learners hopeless as they cannot afford the recommended online learning. The major responses to COVID-19 at the few operating schools include: wearing masks, hand sanitization, regular hand washing, constant temperature check for both staff and learners, and lastly change on the sitting arrangements as students are required to maintain a social distance of at least 1.5 meters. Moreover, closure of schools has also had a severe impact on the co-curricular activities that are always undertaken within the academic institutions like athletics, drama and ball games. Measures should be put in place by various governments to ensure that all learners have access to equitable, quality and inclusive forms of education during the present COVID-19 pandemic.

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1. INTRODUCTION

COVID-19 is a coronavirus and a member of the severe acute respiratory syndrome (SARs) family of syndromes that was first reported in Wuhan on December, 2019. The virus damages the body's respiratory system resulting in difficulty in breathing, loss of smell, shortness of breath, and fatigue [1]. According to Bokde *et al.* [2] the impacts of COVID 19 extend beyond the healthcare industry to the general world economy. The contagious disease is mainly spread by droplets whenever an infected individual talks, sneezes, or coughs. Coronavirus pandemic is spreading all over the world and is claiming thousands of lives globally. There are 20% of the corona cases severe and critical. It affects the people with underlying conditions and the older people compared to the younger persons [1], [2]. The pandemic affects the global educational sector, resulting in almost full closures of all the schools in most parts of the world, colleges, and

universities. More than two billion students had been affected by the COVID-19 pandemic as of July, 2020, owing to the closure of their learning institutions [3].

A report by the United Nations Educational, Scientific and Cultural Organization (UNESCO) monitoring team has shown that more than 180 countries across different parts of the world had completely shut down their entire education systems, a factor that affected nearly 95 percent of all learners across the world [4]. For instance, the Cambridge International Examinations (CIE) had to shelve its Cambridge O level education, Cambridge International AS and A level, Cambridge Advanced International Certificate of Education (AICE) Diploma, Cambridge International General Certificate Secondary Education (IGCSE), and Cambridge Pre-U exams for its June series across all the states. The already scheduled international Baccalaureate examinations were equally canceled in June owing to the rapid rise of COVID-19 cases across different parts of the world [2].

It is important to note that the closure of learning institutions affects the learners and the instructors and individual households. Such closure also has extensive economic and societal consequences. The cessation of learning due to coronavirus has brought with it a number of economic consequences together with social issues, including the introduction of Zoom learning [5]. The impact of COVID-19 in as far as education is concerned is that it has had a severe impact on the underprivileged children as well as their individual households, resulting in a kind of disrupted learning, childcare challenges as well as nutritional challenges. In its reaction to the closure of the learning institutions, UNESCO and other governments across the world have suggested the usage of distance learning programs and open educational platforms so that the effect of interrupted education can be minimized [6], [7]. However, this undertaking was severely marred with several challenges pertaining to access to technology, the internet, and the skills required.

While physical learning has stalled, only online learning is still operational, especially for the candidate classes. With reduced operations, many learners have been forced to stay at home as schools begin to resume gradually. Besides, social distancing or maintaining one meter from one another is impacting negatively the way students and teachers used to interact previously; therefore, becoming a major challenge on how the learning process is being carried out [6]. The main argument in this paper is that the COVID-19 has had many negative implications in the educational sector. COVID-19 mitigation strategy limits the number of staff who should work in one office and hence some instructors may not deliver on their work effectively.

While, previous studies [8], [9] strived to explore the overview of COVID 19 to provide a solid ground for the evaluation of the main research topic, the two pieces of literature fail to explain how the pandemic affects the education sector. Moreover, the two sources do not provide a critical evaluation of the magnitude of the illness beyond the biological dimension (human body). This study aimed to evaluate the impact of COVID-19 pandemic on education. In order to achieve this aim, this study has two main questions: i) How has the COVID-19 pandemic impacted education? and ii) How can the effect of the COVID-19 pandemic on education be mitigated?

2. CONTRIBUTION OF THE STUDY

The present study is of greater significance not only to the members of the public, but also to the education sector as it informs them of the current challenges faced by the sector following the spread of the COVID-19 pandemic and the mitigation measures that should be undertaken to minimize the impact of COVID-19 on the education sector.

Since physical meetings have been highly discouraged, teachers can still interact with their students through online platforms such as zoom meetings. Therefore, the result of this study can be adopted by various governments across the world to inform their decision on how to enhance learning even during the current pandemic. The study has also pointed out the need for various governments to invest in digital technology within their education sector. The present findings might as well be quoted during the academic conference to highlight the impact that COVID-19 has on the education sector and how such impacts can be mitigated. Moreover, the present study has added to the existing scholarly literature in the field of education and how it has been affected by the present COVID-19 pandemic. Other scholars can therefore use the present study as their point of reference for future further study.

3. RESEARCH METHOD

3.1. Scale

A number of questions were developed to help establish the extent to which the pandemic has affected the education system in various parts of the world, and how such impacts may be mitigated. The questions, in this case, had content meant to confirm the educational strategies currently adopted in different parts of the world, challenges faced and the strategies that should be implemented to help overcome the

challenges. More emphasis was placed on the perception of teachers, learners, and parents on how the pandemic has affected the learning process and strategies to which the learning process can be normalized during the present pandemic.

3.2. Study design

The present study employed a cross-sectional study design in which data was collected using qualitative methods. The literature describes a cross-sectional study design as one that involves either studying the whole population or a sample that can be considered representative of the whole population. The study was comprised of data sets collected from parents, teachers, and students regarding the impact of the COVID-19 pandemic on the education sector. Some data collected were surveyed with each of the staff within the learning institutions.

Based on the fact that this was a cross-sectional study design, the overall results only present the situation on the ground at the time the research was being carried out since there was no follow-up involved in the study. The researcher picked on this study design based on the fact that it is relatively cheap and less time-consuming, making it the most appropriate for analyzing the impacts of coronavirus on the learning system.

The general fact that cross-sectional study design is normally less time-consuming and cheap gave it more advantages over the other study designs. While a structured interview was used in collecting primary data, deep reviews of relevant literature were applied during the collection of secondary data [3], [4]. The questions were developed in a manner that allowed the respondents to share their individual perceptions in relation to the impacts of coronavirus on the education system. Because this study focuses on exploring the extent to which coronavirus has impacted the operations of the education sector, applying a naturalistic approach is considered to be very much essential in helping the researcher to provide an accurate answer to the established questions.

3.3. Sample size determination

This will be determined by using Fisher's [5] formula.

$$n = \frac{z^2 pq}{d^2}$$

Where:

z=Standard normal deviate corresponding to 95% confidence level (=1.96)

n=The required minimum sample size (if the population is more than 10,000)

p=Estimated proportion of respondents affected by COVID-19 (taken as 50% since it is not known)

d=Degree of accuracy; set as 0.05

$n = (1.96^2 \times 0.5 \times 0.5) / 0.05^2 = 384$

Cochran's correction formula [6] was used to calculate the sample size since the population is less than 10,000. Whereby n_0 is 384 and N is 336 (the assumed population).

$$\begin{aligned} n &= n_0 / (1 + \{(n_0 - 1) / N\}) \\ &= 384 / (1 + \{(383) / 336\}) \\ &= 45 + 10\% \text{ attrition} = 50 \end{aligned}$$

3.4. Study subjects and sampling process

The study was conducted using an online interview of 50 participants from different parts of the world. The interview schedule that had been developed based on the two research questions was distributed on the researcher's Twitter and Facebook asking people to participate and participants in the study. A total of 50 interview schedules were created through survey monkey and the link was put out on the researcher's social media (Twitter and Facebook). A letter of introduction as well as an invite link was designed and shared with the respective potential participants through Facebook and Twitter accounts. The respective participants were requested to complete the interview questions and return them within one week of admission [7], [8].

A sample size of 50 participants was considered as enough as it was large enough to enable the researcher to unfold richly and new texture in the general understanding of how COVID-19 has impacted the education system. The research employed a simple random sampling technique in which every participant has been accorded an equal chance to participate in this researcher. Moreover, it is important to mention that the research did account for personal biases which had the potential of influencing the findings [9].

3.5. Data collection

An interview schedule was chosen as a data collection instrument. An interview guide is a self-report form intended to provide data and information that can be obtained through the written responses of the subjects by the respondents. The interview questions were distributed to all the intended respondents after seeking permission. The data and information obtained through a questionnaire are always the same as that obtained through the interview, but questionnaires tend to have less in-depth and that is why the interview was chosen for the purpose of this study. Each participant had their informed consent sought before administering the questions to them.

The participants were contacted through social media (Twitter and Facebook) regarding their role during the data collection. The interview questions were then administered through an online survey due to the adverse effects caused by COVID-19 across different parts of the world. In this case, the questions were administered within 10 days before being analyzed. A total of 50 people had the interview administered to them.

Additionally, some data were collected through desktop data collection models. According to previous studies [10], [11], a vast amount of information has been archived over the months, and it is therefore practical to utilize existing data and information to carry out secondary research. Previous researchers [3], [12] argued that secondary data analysis involves analysis and interpretation of data collected by another researcher for another purpose. This is a viable research method that is less costly and saves the time spent going to the field for data collection [11], [13]. Appropriate secondary sources for review included publications, journal articles, books, periodicals, databases, and health sectors report as well as government policy documents and reports. Secondary data consist of information that already exists having been collected for another research study or purpose. This data formed the literature review and the analysis and discussion of the study findings.

Before using the data, the quality of literature used should be evaluated to ensure that it is current, free of errors, dependable, and relates to the objectives of the current study [13], [14]. This requires a comparison of data from different sources, understanding why and for what the information was collected, and the level of expertise of the researcher [15], [16]. The study used search engines like NELSON to locate relevant articles for analysis. Some articles also provided further reference listing which was identified and explored. International journals databases and organizational and professional databases were also searched for relevant literature for this study.

3.6. Ethical considerations

The researcher strictly adhered to the ethical considerations of researching while engaging with the respondents. Firstly, potential respondents were given the content and purpose of the survey to make individualized decisions on whether to participate or not to participate in the study. The researcher then made full disclosure of the research's intention and how the respondents would benefit from the research. Most importantly, the participants were informed of their freedom of choice to withdraw from the study at any given point in time. Consistent with previous study [13] concerns over informed consent, confidentiality, and anonymity arose during the study since it involved human subjects. Several ethical considerations were taken to address these issues. Informed consent was sought by issuing participants with a consent form detailing the purpose, procedures, and potential benefits and risks the investigation poses. It specified that participation was voluntary to ensure that participation was free from any form of coercion. Response anonymity and data confidentiality were ensured by removing any detail that could potentially identify participants and keeping all the gathered information in a password-secured computer and locking them in a cabinet. Moreover, all the secondary information used in this study were collected with at most good faith, making proper in-text citations and listing all the literature used in the list of references [17]. Other people's work has adequately been acknowledged in order to avoid the problem of plagiarism.

3.7. Data analysis

Following the confirmation of response by the participants, the analysis of data did commence. Data from multiple-choice questions were entered into a computer program, statistical package for the social sciences (SPSS), for further analysis. Data were analyzed using descriptive statistics. The SPSS software is useful for classifying the collected data and information in thematic areas that would prove useful for the development of the analytical process. In the end, clustering and undertaking of the collected data would surface. These were then used to create inferences that informed the research outcome. Independent variables with various factors were identified and measured using a five-point scale. The relationship between these two variables (dependent and independent) was described by descriptive statistics that were presented in form of tables, charts, and frequencies. On the other hand, qualitative data were organized into themes and used to support quantitative data.

3.8. Reliability and validity

Reliability and validity refer to the measures taken by a researcher in ensuring that the findings of the research represent an accurate and precise picture of the actual situation concerning the study or research. Reliability explains the extent to which the findings are dependable and the actions taken to ensure that they can be depended on. The validity on the other hand is the accuracy of the findings of the research. In this research, the validity of the research instrument was determined by seeking the opinions of experts in the field of study. This facilitated the necessary revision of the research instrument [13]. The reliability of the research instrument was enhanced through a pilot study that was carried out before the actual study.

4. RESULTS

4.1. Demographic information

Most of the respondents were male (60%, n=120) while females comprised 40%. Most of these participants were aged between 25-40 years with the least number of participants aged below 25 years. Important to note is the fact that participants were either enrolled or had various academic qualifications which included basic and tertiary education.

4.2. Widened physical contact between the teacher and the learner

Asked about how COVID-19 has impacted school operations, most of the respondents stated that it has had a severe impact while only a few claimed that COVID-19 has not had a major impact on the learning process. Besides, the study established that governments find it difficult to deliver educational services to their citizens as the world is faced with lock-downs, a ban on gathering, and restrictions on movement. Senior government officials reported that limited movement and practice of social distancing inhibit learners from going to school since most schools and classrooms are overcrowded. According to the interviewed persons, the most pronounced challenge affecting the education sector across the world is an inability to keep social distance in the learning environment.

As supported by scholarly articles, most learners have not received any form of education across different parts of the world. As one of the respondents explained, "*My child is no longer learning at all as she is only waiting for the schools to re-open so that she can resume her studies*". Most parents indicated that it does not make them happy that children are not going to school at all. As one respondent explains, many children have never received any feedback, instruction or even interaction with their teachers. One of the respondents posted, "*Children are facing the hardest time in human history.*"

As has been demonstrated, one of the main impacts of COVID-19 on the educational sector is the absence of physical contact between the teacher and learners. This has consequently occasioned the over-staying at home by the individual learners without receiving the required form of education. The problem has specifically been caused by the World Health Organization's (WHO) regulations of maintaining social distancing to avoid the spread of the virus. The learning environment is mostly overcrowded and therefore had to be closed to comply with the social distancing protocols. Moreover, children were categorized as among the most vulnerable to COVID-19. Therefore, they had to be kept away from the virus by shutting down the schools.

Interestingly, as noted by one of the study participants, physical learning was substituted with digital learning across different parts of the world. However, most learners are not in a position to access technology and internet, especially those found in the rural regions and in underprivileged families and this has always barred them from taking part in digital learning. As explained by one of the study participants, the paucity of access to technology or rather sound internet connectivity has been a great hurdle to continued learning, more also for learners who come from poor families. In response to closure to institutions as instigated by COVID-19, UNESCO did recommend the application of distance learning platforms. UNESCO also suggested open education applications plus any other additional platforms that instructors and institutions can make good use of so as to get in touch with their respective students and subsequently minimize the interruption of the learning process.

As explained by Nicola *et al.* [18], school tends to play a significant part in protecting the individual learners, more also girls who originate from poor, marginalized, and vulnerable communities. With almost all schools closed in different parts of the world, refugees are not confined within their camps which they commonly refer to as home. The risk that the schools tend to protect them from is now glaring at them. Such learners are in dire need of home-based learning within what they commonly refer to as home but some of them are lack of facilities [19]. On the same note, teachers who would help such learners achieve the required education are at home and are not supported by the required technology so as to enhance online learning.

4.3. Interruption of library services for members of the public

In order to support the efforts, put in place by the health experts in their attempts to reduce the spread of COVID-19, most public and private libraries across the world have been closed. For instance, the widely publicized public libraries in San Francisco, Seattle, New York, and Los Angeles have remained closed since March, 2020. The same case has been experienced in different parts of the world when the governments ordered for the closure of all schools as well as places of public gathering like academic centers and libraries. One of the respondents indicated that without educational learning resource centers and libraries as well as the internet, students have been struggling to cope with distance learning.

4.4. Unequal access to online learning by students

It is well understood that unequal access to the relevant educational resources among learners has posed a serious challenge to students coming from underprivileged families. While most governments usually have a disaster management policy for the educational sector but unfortunately, this has never been the case with COVID-19 as it hit almost all sectors of the world [20], [21]. As reported by one of the respondents, however, various governments have recommended the usage of information and communication technologies (ICTs) so as to upsurge access to basic quality education especially for the marginalized and vulnerable group of learners. The governments have also established policies that ensure that funds are properly allocated so as to help deliver proper ICT infrastructure so as to help address access, equity and quality challenges in education among the marginalized and vulnerable learners.

As reported by one of the respondents, however, most of these policies have gone without being implemented as they only gutter dust in the shelves. As schools did close abruptly sometime back in March, most learners, especially in poor countries were forced to close their books as they do not have access to the internet. Literature has shown that millions of learners live in remote areas and as such do not afford the online learning [7]. One of the respondents argued that only a small percentage of learners, especially those found in the urban centers, are able to access digital tools for online learning. The situation, in this case, is even worse for the special learners who require extra attention.

5. DISCUSSION

The study explored the impact of COVID-19 pandemic on educations. The result showed that the education sector as a whole has majorly been affected by the strict social distancing and restriction of public gather protocols that have been implemented in response to COVID-19 pandemic. As it is established by both the respondents and the existing secondary literature, COVID-19 pandemic has dealt a major blow to the educational sectors across different parts of the world. While physical learning has been completely stalled in most parts of the world, online learning is still operational, especially for the candidate classes across the global [18], [21]. However, most students still remain unattended to as they cannot access the technological requirements for online learning. Specifically, the learning institutions across the world are greatly challenged to adapt the appropriate program structures, teaching, curricula, as well as general methods of learning so as to account for a new important range of aptitudes. Such aptitudes actually comprise of communication, flexibility, and lastly, motivation [22], [23].

Within the last few months, the continuous spread of COVID-19 has also changed the manner in which people work and live. The internet has become a tool for learning in different classrooms. This offers a very meaningful learning experience for all learners. Teachers currently have numerous chances to apply technology more increasingly so as to enhance the overall learning of the students [24]–[26]. The application of the internet and computers has become an important integral part of the daily lives of student and teacher.

Even with the great advantages associated with applying technology to attend to students who have been forced to stay at home due to COVID-19, technology can at times be very much addictive. At times the students might end up using technology, not for the intended learning outcome but to do their own things. This makes the lesson process become least productive instead of improving it [19], [27].

It has also been demonstrated by the teachers that most schools do not find it feasible to keep up with online learning. Online learning has been reported to be costly in terms of the acquisition, maintenance, and power or internet usage. Some schools find it totally impossible to acquire technologies for teachings due to the heavy cost that are likely to be involved. As such, most students have remained untaught throughout the period of the COVID-19 pandemic [28], [29].

Previous researchers [30], [31] carried out several studies to support the argument that remote learning may help reduce the physical strain associated with learning from the classrooms. Taking their classical study, as an illustration, the researchers in this case established that remote or rather, online learning causes high incidences of loneliness and might equally be stressful as it limits the interactions that learners might have among themselves and with the teachers. Franchi [32] pointed out further that with restrictions on

movement and WHO directives for people to remain indoors and keep their distance, few alternative ways of interacting have since been established, leaving most students lonely as they remain kept at home.

As it is common in all studies, the present study had its own limitations. For instance, the researcher developed a cross-sectional study design in which case the qualitative data was mainly collected from the primary respondents who had limited knowledge of how COVID-19 has impacted the education sector. This may lower the validity and reliability of the study findings. Therefore, a future further study is recommended on the same topic but which involves only education professionals. Such future study needs to investigate the possible long-term interventions that various governments need to undertake to ensure the continuity of education even during a crisis like in the present COVID-19 pandemic.

6. CONCLUSION

The result from both the respondents and the literature review shows that learning has severely been affected by the strict protocols adopted by various governments in response to COVID-19 pandemic. COVID-19 pandemic has dealt a major blow to the education sector across the world. Issues of lockdown and restriction on movement have left most schools not operating, except for candidate classes in some cases. The major responses to COVID-19 at schools include: putting masks, hand sanitization, regular hand washing, constant temperature check for both staff and learners, and lastly change on the sitting arrangements as students are required to maintain a social distance of at least 1.5 meters. Additionally, the management at various learning institutions has invested in modern technology that helps in offering online learning. For instance, schools are exploring relevant solutions like using zoom to conduct lessons but unfortunately, not all learners are capable to afford this.

Conclusively, the COVID-19 pandemic has exposed the numerous inadequacies as well as inequalities within the education systems across different parts of the world; right from access to computers and broadband required for online learning and the subsequent supportive nature of environments required focusing on the learning process, up to the level of misalignment between needs and available resources. The response to COVID-19 by initiating lockdowns has interrupted the normal school process with nationwide closure of schools in most parts of the world. Even though the educational community has made great efforts towards maintaining a continuation of learning during this period of the pandemic, students and pupils have had to depend more on their own resources to continue learning through the use of the internet, radio and televisions. Teachers have also suffered in their adoption of pedagogical concepts as they have to initiate their own innovation to train learners through the relevant online platforms. More particularly, learners from the marginalized groups, who have no access to the required digital learning tools or lack engagement and resilience to learn on their own, have been left behind.

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REFERENCES

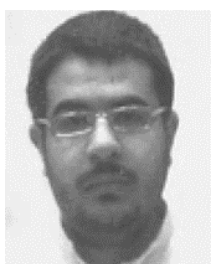
- [1] F. He, Y. Deng, and W. Li, "Coronavirus disease 2019: What we know?" *Journal of Medical Virology*, vol. 92, no. 7, pp. 719–725, Jul. 2020, doi: 10.1002/jmv.25766.
- [2] V. Bokde, H. Kharbikar, M. Roy, P. Joshi, and A. Ga, "Possible impacts of COVID-19 pandemic and lockdown on education sector in India," *Food and Scientific Reports*, vol. 1, pp. 30–33, 2020.
- [3] O. D. Apuke, "Quantitative research methods: A synopsis approach," *Kuwait Chapter of Arabian Journal of Business and Management Review*, vol. 6, no. 11, pp. 40–47, Sep. 2017, doi: 10.12816/0040336.
- [4] M. P. Johnston, "Secondary data analysis: A method of which the time has come," *Qualitative and quantitative methods in libraries*, vol. 3, no. 3, pp. 619–626, 2017.
- [5] W. Lehmacher and G. Wassmer, "Adaptive sample size calculations in group sequential trials," *Biometrics*, vol. 55, no. 4, pp. 1286–1290, 1999, doi: 10.1111/j.0006-341x.1999.01286.x.
- [6] H. Ahmad and H. Halim, "Determining sample size for research activities: The Case of Organizational Research," *Selangor Business Review*, vol. 2, no. 1, pp. 20–34, 2017.
- [7] W. M. Elmannai, A. Odeh, and C. Bach, "Academic use of online social networks," *International Journal of Innovation and Applied Studies*, vol. 3, no. 2, pp. 337–345, 2013.
- [8] A. Santos, E. Pinheiro, R. Mateus, A. Odeh, and E. A. Fattah, "Analysis of video streaming using LTE technology," in *2015 Long Island Systems, Applications and Technology*, May 2015, pp. 1–5, doi: 10.1109/LISAT.2015.7160213.
- [9] M. N. Ferrel and J. J. Ryan, "The impact of COVID-19 on medical education," *Cureus*, vol. 12, no. 3, p. 5, Mar. 2020, doi: 10.7759/cureus.7492.
- [10] D.-N. Zhang, Q.-Q. Shanguan, C.-J. Xie, and F. Liu, "A modified Johnson–Cook model of dynamic tensile behaviors for 7075-T6 aluminum alloy," *Journal of Alloys and Compounds*, vol. 619, pp. 186–194, 2015.




- [11] M. Alshowkan, E. A. Fattah, and A. Odeh, "Performance evaluation of DYMO, AODV and DSR routing protocols in MANET," *International Journal of Computer Applications*, vol. 49, no. 11, pp.29-33, 2012.
- [12] P. Iyer, K. Aziz, and D. M. Ojcius, "Impact of COVID-19 on dental education in the United States," *Journal of Dental Education*, vol. 84, no. 6, pp. 718–722, Jun. 2020, doi: 10.1002/jdd.12163.
- [13] N. Malhotra, J. Hall, M. Shaw, and P. Oppenheim, *Marketing research: An applied orientation*. Frenchs Forest, N.S.W: Pearson Education Australia, 2006.
- [14] S. Pokhrel and R. Chhetri, "A literature review on impact of COVID-19 pandemic on teaching and learning," *Higher Education for the Future*, vol. 8, no. 1, pp. 133–141, Jan. 2021, doi: 10.1177/2347631120983481.
- [15] A. Cropley, *Introduction to qualitative research methods*. Hamburg, Germany, 2015.
- [16] A. Schleicher, "The impact of COVID-19 on education: Insights from education at a glance 2020," OECD, Paris, 2020. [Online]. Available: <https://www.oecd.org/education/the-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf>.
- [17] D. Silverman, *Interpreting Qualitative Data*. SAGE Publication, 2015.
- [18] M. Nicola *et al.*, "The socio-economic implications of the coronavirus pandemic (COVID-19): A review," *International Journal of Surgery*, vol. 78, pp. 185–193, Jun. 2020, doi: 10.1016/j.ijssu.2020.04.018.
- [19] O. N. Jacob, I. Abigeal, and A. Lydia, "Impact of COVID-19 on the higher institutions development in Nigeria," *Electronic Research Journal of Social Sciences and Humanities*, vol. 2, no. 2, pp. 126–135, 2020.
- [20] J.-L. N. Upoalkpajor and C. B. Upoalkpajor, "The impact of COVID-19 on education in Ghana," *Asian Journal of Education and Social Studies*, vol. 9, no. 1, pp. 23–33, 2020, doi: 10.9734/ajess/2020/v9i130238.
- [21] International Association of Universities, *IAU Global Survey on the Impact of COVID-19 on Higher Education around the World*. UNESCO, International Association of Universities, 2020.
- [22] D. Mhlanga and T. Moloi, "COVID-19 and the digital transformation of education: What are we learning on 4IR in South Africa?" *Education Sciences*, vol. 10, no. 7, p. 180, Jul. 2020, doi: 10.3390/educsci10070180.
- [23] S. Tadesse and W. Muluye, "The impact of COVID-19 pandemic on education system in developing countries: a review," *Open Journal of Social Sciences*, vol. 08, no. 10, pp. 159–170, 2020, doi: 10.4236/jss.2020.810011.
- [24] M. Assunção Flores and M. Gago, "Teacher education in times of COVID-19 pandemic in Portugal: national, institutional and pedagogical responses," *Journal of Education for Teaching*, vol. 46, no. 4, pp. 507–516, Aug. 2020, doi: 10.1080/02607476.2020.1799709.
- [25] X.-Y. Ge *et al.*, "Isolation and characterization of a bat SARS-like coronavirus that uses the ACE2 receptor," *Nature*, vol. 503, no. 7477, pp. 535–538, Nov. 2013, doi: 10.1038/nature12711.
- [26] A. Odeh, "Taxonomy of Cluster-Based Target Tracking System in Wireless Sensor Networks," *International Journal of Sensors Wireless Communications and Control*, vol. 10, no. 5, pp. 649-658, 2020, doi: 10.2174/2210327910999200606230150.
- [27] Y. Chen, Q. Liu, and D. Guo, "Emerging coronaviruses: Genome structure, replication, and pathogenesis," *Journal of Medical Virology*, vol. 92, no. 4, pp. 418–423, Apr. 2020, doi: 10.1002/jmv.25681.
- [28] A. Odeh, I. Keshta, and E. Abdelfattah, "Machine learning techniques for detection of website phishing: a review for promises and challenges," in *2021 IEEE 11th Annual Computing and Communication Workshop and Conference (CCWC)*, Jan. 2021, pp. 0813–0818, doi: 10.1109/CCWC51732.2021.9375997.
- [29] S. Rashid and S. S. Yadav, "Impact of Covid-19 pandemic on higher education and research," *Indian Journal of Human Development*, vol. 14, no. 2, pp. 340–343, Aug. 2020, doi: 10.1177/0973703020946700.
- [30] A. Aristovnik, D. Keržič, D. Ravšelj, N. Tomaževič, and L. Umek, "A global student survey 'Impacts of the covid-19 pandemic on life of higher education students' Methodological framework," 2020. [Online]. Available: <http://www.covidsoclab.org/wp-content/uploads/2020/07/Covid19-Methodological-Framework-09072020.pdf>.
- [31] L. Espino-Díaz, G. Fernandez-Caminero, C.-M. Hernandez-Lloret, H. Gonzalez-Gonzalez, and J.-L. Alvarez-Castillo, "Analyzing the impact of COVID-19 on education professionals. toward a paradigm shift: ICT and neuroeducation as a binomial of action," *Sustainability*, vol. 12, no. 14, p. 5646, Jul. 2020, doi: 10.3390/su12145646.
- [32] T. Franchi, "The impact of the Covid-19 pandemic on current anatomy education and future careers: A student's perspective," *Anatomical Sciences Education*, vol. 13, no. 3, pp. 312–315, May 2020, doi: 10.1002/ase.1966.

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