

Examining the Capacity of Higher Education Institutions in Ghana for Virtual Learning during COVID-19 Pandemic - Evidence from University of Mines and Technology

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Abstract - Higher Education Institutions across the world have been severely affected following the outbreak of the COVID-19 pandemic. This study was intended to examine the capacity of HEIs in Ghana for virtual learning with evidence from the University of Mines and Technology. The study focused on the infrastructure and connectivity to access the Virtual Learning Environment deployed to sustain teaching and learning in the wake of COVID-19. Using questionnaires to elicit responses from students, the findings suggest that the most pressing challenges were associated with institutional preparedness, network infrastructure and connectivity, cost of data, etc.

Key Words: University of Mines and Technology (UMaT), COVID-19 Pandemic, Teaching and Learning and Virtual Application Environment (VLE).

1. INTRODUCTION

The COVID-19 pandemic, which has led to unprecedented health and socioeconomic crisis and will forever be remembered in our annals of history, has severely impacted the entire education sector around the world. More than 1.58 billion students and youth across the world are or have been affected by school and university closures due to the COVID-19 pandemic [1]. Even though the pandemic has disrupted teaching and learning in most tertiary institutions, findings from relevant previous studies and pre-COVID-19 data can provide vital insights into the pandemic's potential impact[9].

While educators made concerted efforts to ensure learning continuity during the period, some students were forced to rely on their own resources to continue learning remotely via other media such as the Internet, television, or radio. Lecturers have also had to adjust to new pedagogical notions and instructional modalities that they may not have been aware of. Virtual learning quickly replaced face-to-face lectures at the majority of Higher Education Institutions (HEIs). However, these closures had a significant impact on learning and examinations. [2]. Universities will need to rethink their learning environments in order to stay relevant, so that digitalization widens and complements student-teacher and other interactions. Before the coronavirus breakout in Ghana, UMaT had no virtual

learning platform for teaching and learning. The situation became worse and challenging when the Government of Ghana gave a directive to close down all Schools and Universities. At the time, most of the universities had two to three weeks to commence first semester examination. UMaT was confronted with three critical factors and these were the time for lecturers and students to be conversant with the virtual learning environment, availability of online infrastructure, cost of data and other related equipment for teaching and learning via the virtual learning platform. These problems had to be overcome by the University for successful completion of the semester academic work.

The study is limited to the students' perspective on E-learning readiness of the Ghana Tertiary institutions during COVID-19 Pandemic.

1.1 Brief about UMaT

UMaT is located with this on 0° 0' longitude 2 59 45" W and latitude 5 17'42" N cardinal points along the Tarkwa – Esiama road and is 160 m above mean sea level. The University has Faculty of Mineral Resources Technology (FMRT) that consist of six (6) academic departments, Faculty of Engineering (FOE) made up Five (5) academic departments, Faculty of Integrated Management Studies (FIMS) consists of two (2) academic department and satellite campus UMaT School of Railway Infrastructure and Development at Essikado in Sekondi-Takoradi in the Western Region.

2. COVID-19 AND IMPACT ON HIGHER EDUCATION

The impact on higher education has been severe and transformational, with education systems all around the world responding to the pandemic with "emergency Learning" protocols, signaling a quick shift from face-to-face classes to virtual learning platforms [10]. With this unanticipated shift away from the classroom in many regions of the world, many people are questioning if virtual learning acceptance would continue post-pandemic, and how such a shift will affect the global education industry.

The rapid growth and popularity of the internet of things and the pandemic have propelled the growth and adoption of online education across countries. The main purpose of virtual learning is thus to increase the accessibility of

education, cost and productivity. What people learn, how they learn, and where and when they learn have all been transformed by digital technology [2]. COVID-19 has exposed the unpreparedness and the vulnerabilities in our current education systems. These range from access to the internet, reliable environment and infrastructure needed to support online education and the financial and technical muscle to sustain alternative forms of teaching. Prior to the COVID-19 pandemic, education technology had already experienced significant expansion and adoption, with worldwide edtech expenditures reaching US\$18.66 billion in 2019 and the whole industry for online education expected to reach \$350 billion by 2025. Since COVID-19, there has been a considerable increase in utilization of language apps, virtual tutoring, video conferencing tools, and online learning software [11].

Higher Education in Africa has recorded a massive growth in the past decade – though the enrolment rate remains among the lowest in the world – under 10% on average, but 5% for most (**Teferra, 2021**). The pandemic has spared virtually no institution in the world. However, the impact on low-income countries, as in most countries in Africa, where lesser funded institutions are prevalent, has been rather severe. In 2020, Africa had the greatest percentage of HEIs with campuses shuttered as a result of COVID 19. The pandemic has prompted the creation of a comprehensive communication and information infrastructure, as well as the adoption of policies at both the institutional and national levels [12].

Numerous efforts have been underway in Africa to expand access to higher education through distance, online and virtual means, despite long-standing ambivalence attributed to quality, delivery and integrity. On technical aspects, much of this effort has been hampered by poor telecommunications, unreliable power grids and high cost of equipment and data, among others [3].

Following the outbreak of COVID-19 in Ghana, the President ordered the closure of all public and private educational institutions in the country as part of measures to stem the spread of the epidemic. He also gave the Ministry of Education and the Ministry of Communication orders to start offering distant learning programs to students. [13]. Suffice to say, this forced HEIs in Ghana, such as the University of Mines and Technology (UMaT), to adapt to ensure continuity of the academic calendar.

Before 2020, UMaT had no virtual learning platform for teaching and learning as the University's mode of delivery depended solely on face-to-face interaction. The University was therefore confronted with the urgent need to deploy a virtual learning environment to support teaching and learning and ensure the successful completion of the semester activities as a result of the disruption caused by COVID-19. This study, therefore, examines the use of UMaT's Virtual Learning Environment and the ICT infrastructure for its deployment in the wake of the COVID-19 pandemic.

2.1 Virtual Learning Environment

Online delivery of education can no longer be regarded as a fad or the realm of the nerd as we are now on the brink of a major paradigm shift; a key factor being the 'disruptive technology' of eLearning [4]. The concept of a Virtual Learning Environment (VLE) could be considered as a dynamic concept due to the constant evolution of digital technologies, its features and potentialities, and the importance that such environments have within the learning processes. The introduction of VLEs for lecturers and students has increased access to education and it offers schools the opportunity to enroll more students. According to [3,] virtual learning can be more effective in various ways for individuals who have access to the appropriate technology. According to several studies, students who learn online retain 25-60% more content than those who learn in a classroom retain only 8-10%. This is primarily due to students' ability to learn more quickly online; e-learning takes 40-60% less time to learn than traditional classroom learning since students may learn at their own pace, going back and re-reading, skipping, or accelerating through subjects as needed.

The advantages of a virtual learning environment as stated by [14] can be subsumed as:

- (1) **Connectivity:** this means access to information is available on a global scale,
- (2) **Flexibility,** which is learning can take place any time, any place,
- (3) **Interactivity:** that is an assessment of learning can be immediate and autonomous,
- (4) **Collaboration:** the use of discussion tools can support collaborative learning beyond the classroom,
- (5) **Extended opportunities** in terms of e-content which can reinforce and extend classroom-based learning, and
- (6) **Motivation:** where multimedia resources can make learning fun.

According to [5][15], 74 percent of teachers believe VLEs are a very valuable tool for improving teaching, and 71 percent believe VLEs are a very useful tool for improving students' learning. A VLE is used by 99 percent of institutions, 85 percent of teachers, 56 percent of professors use it everyday, 83 percent of students use it, and 56 percent indicate they use it in all or most of their course units.

There is a digital divide between individuals who have never utilized even basic audio-visual equipment, relying on blackboards and flipcharts, and younger teachers who are aware of and skilled in newer technology [4]. As a result, it should be highlighted that this change has provoked debate regarding equity and exclusion, with students and staff in some countries, such as South Africa, expressing opposition to online education [12].

2.2 Internet Coverage In Ghana

One of the first African countries to liberalize its telecoms industry was Ghana [7]. The first mobile network was launched in 1992, and the country was connected to the Internet within two years. The stats on Internet access now reflect the country's tremendous development. The issue of total coverage of mobile network services in the entire country has still not been resolved fully by telecommunication companies. Localities in Ghana do not have the 4G services which is a serious impediment as the coverage in these environments continue to rely on 2G and 3G technology. Ghana has close to 19 million unique mobile subscribers – equivalent to 67 percent of the population, well above the average of 44 percent in Sub-Saharan Africa. Access to the Internet via mobile has increased from 2 percent in 2005 to 45 percent of the population today. Overall, internet penetration in Ghana stood at 50.0% in January 2021 [5].

The cost of mobile network data to an average African is too expensive as compared to other Asia nations and elsewhere. According to [16], Equatorial Guinea has the most costly mobile data in the world, with an average cost of \$49.67 per GB, roughly a thousand times the cost of mobile data in Israel. With 1GB costing \$0.15 on average, Kyrgyzstan came in second, followed by Fiji (\$0.19) in third. Six of the top ten most expensive countries in the world are from Sub-Saharan Africa, with Equatorial Guinea (\$49.67) topping the list, followed by Saint Helena (\$39.87), So Tomé and Príncipe (\$30.97), Malawi (\$25.46), and Chad (\$23.33).

The prices of mobile data differ in Ghana from one service provider to another. The two service providers that have served the population for the longest period are MTN and Vodafone Ghana. They have special packages for customers at night apart from the regular charges of data during the day. The prices of Mobile Data from Glo and AirtelTigo are quite competitive however due to challenges associated with data coverage, they are less patronised. Over the given period from 2015 to 2020, MTN held a majority of the market share of mobile subscriptions (55%) while Vodafone has persisted at around 22% [17]. Table 1 and showd the prices of MTN and Vodafone mobile data packages in 2021.

Table 1 MTN Basic Data Package

MTN	
Volume	Price
23Mb	\$0.08
46Mb	\$0.17
461Mb	\$0.52
943Mb	\$1.75
12GB	\$21.05
205GB	\$70.00

Source: [17]

Table 2 Vodafone Basic Data Package

Vodafone

Volume	Price	Validity Period
2.07GB	\$0.37	hourly
1.04GB	\$0.94	daily
569MB	\$0.57	Daily
4.1GB	\$3.77	Weekly
25GB	\$17.54	Monthly

Source: [17]

2.4 Data Connectivity for HEIs In Ghana

Before the formation of the Ghana Academic and Research Network (GARNET), most of the HEIs in Ghana subscribed to telecommunication companies such as MTN, Vodafone, MainOne, etc. Universities were however constrained to go for large data bandwidth because of the high cost of the packages. GARNET, which is owned by tertiary institutions in Ghana, is a high performance national network connecting academic and research institutions. As of April 2019, GARNET has 10-Gbps Connection to Ghana Internet Exchange (GIX), 10-Gbps Connection to Google Cache, 10-Gbps Connection to MainOne (WACREN, GEANT, Internet2) and leased circuits from Vodafone to GARNET member institutions.

Table 3 shows the estimated student population of some public HEIs in Ghana and the total internet bandwidth available for academic work. Evidence from table 1 suggests students that these HEIs are fraught with challenges to get stable internet connectivity for their students.

Table 3 Internet Bandwidth of Some Public HEIs

Institution	Regular Student	Distance Learning Students	Total Internet Bandwidth	GARNET Bandwidth
UG	45,000	5,000	3000 Mbps	1000 Mbps
KNUST	45000	10,000	4000 Mbps	1000 Mbps
UCC	20000	40,000	3000 Mbps	1000 Mbps
UEW	24,000	35,000	2000 Mbps	310 Mbps
GIMPA	5,000		310 Mbps	155 Mbps
UDS	30,000		2000 Mbps	1000 Mbps
UHAS	3,500		310 Mbps	155 Mbps
UPSA	14,000		465 Mbps	155 Mbps
UMaT	3500		310 Mbps	155 Mbps
UENR	5,000		310 Mbps	155 Mbps

Source: GARNET, 2019

In 2020, the Government of Ghana commissioned the Free Wifi Project for tertiary institutions to enhance teaching, learning and research activities. The project being executed at a cost of over US\$ 11 million, was facilitated and implemented by the Electricity of Ghana (ECG) leveraging on 650 kilometres of its Fibre Optic Network, in collaboration with the National Information Technology Agency (NITA), Ghana Grid Company Limited (GRIDCo). The beneficiary tertiary institutions include; the University of Ghana, University of Professional Studies, University of Cape Coast, Kwame Nkrumah University of Science and Technology and Ghana Institute of Journalism. Others are the Ghana Institute of Management and Public Administration, University of Education, University of Health and Allied Sciences, University of Mines and Technology, Regional Maritime

University, Ghana Institute of Languages, National Film and Television Institute and Ghana Technology University College (Arthur-Mensah, 2020). It is estimated the completion of this project would significantly boost academic work in the beneficiary institutions and accelerate national development.

3. RESOURCES AND METHODS USED

The study adopted the use of the descriptive survey to elicit responses from UMaT students. The choice of this research design was considered appropriate because of its advantages of collating and identifying opinions and expectations of students from the larger population. Primary and secondary sources of data were used to derive the aims of this paper. The primary sources consisted of responses to questionnaires administered to undergraduate students via the Google survey platform. Responses to the questionnaire were collated during the period November 2020 to January 2021 and focused mainly on connectivity and use of the VLE. Additionally, a technical audit of ICT equipment available to host and deploy the VLE at UMaT was undertaken.

UMaT deployed the VLE to support teaching and learning based on the Modular Object-Oriented Dynamic Learning Environment (MOODLE) after the onset of the COVID-19 pandemic. MOODLE is an open-source Learning Management System distributed under the General Public License¹ and is one of the most widely used and accepted LMS in academia and the corporate world alike. The MOODLE Project is led and coordinated by MOODLE HQ, an Australian company of 50 developers which is financially supported by a network of eighty-four (84) MOODLE partner service companies worldwide. MOODLE's development is also being assisted by the work of open-source programmers [8]. Besides providing online features, UMaT's VLE can support offline learning and includes features for tracking, recording and assessing offline events along with online ones. It has several flexible testing and assessment features, for example, automatic and manual marking, storage of learner's complete assessment portfolio and others. Fig 1 and 2 shows the graphical user interface available to the lecturer and students respectively.

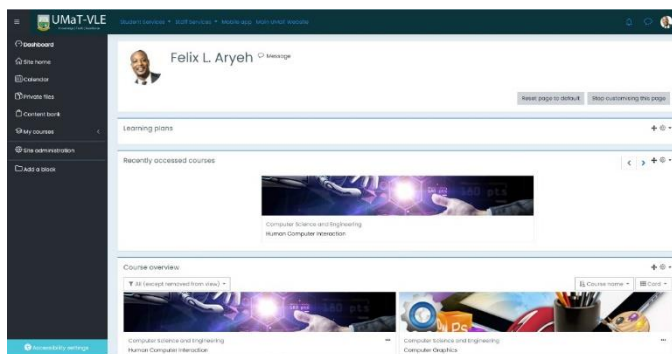


Fig 1: UMaT's VLE Lecturer Interface

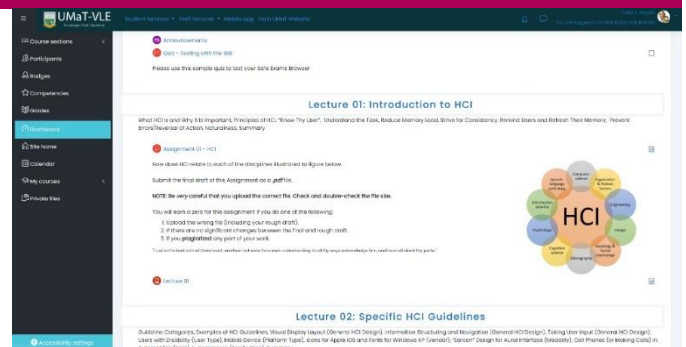


Fig 2: UMaT's VLE Student Interface

4. RESULTS AND DISCUSSIONS

4.1 Demographic Data of Respondents

The results showed that the number of undergraduate students who responded to the questionnaire administered via Google Forms stood at 520 from 14 Departments in the University. Out of this, 510 students indicated their gender comprising 372 (73%) males and 138 (27%) females. The highest number of 66 from the Mining Engineering Department represented 13.4% of the total number of respondents followed by Mechanical Engineering students who represent 12.8% of the respondents. The results also revealed that students who responded to the questionnaire were from all regions across the country.

Chart 1 shows the level of the students that responded to the questionnaire. Out of 511 students who responded to the questionnaire, 180 (35.2%) were in the 2nd year, 172 (33.7%) 3rd Year, 145 (28.4) in 1st year and 14 (2.7%) in the 4th year.

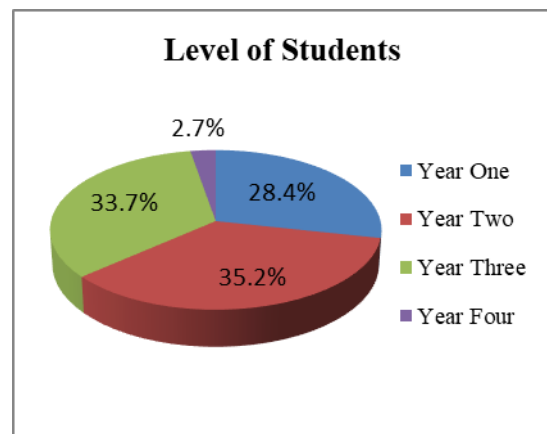


Chart 1: Level of Students

4.2 Mobile Network Service Provider

Chart 2 shows the mobile network service used by the students to access the University's Virtual Learning Environment platform (VLE). From the findings, 402 students (78.7%) out of the 511 responses used MTN to access the VLE. 81 students representing 15.9% used Vodafone whiles 28 students represent 5.5% used Airtel-

Tigo. There was no student in the survey that used the Glo mobile network service to access the university virtual learning application. From this finding, it is assumed that a large number of students in UMaT use MTN services than other mobile network service providers in the country. This has confirmed the research indicating MTN's majority share in Ghana's mobile subscriptions.

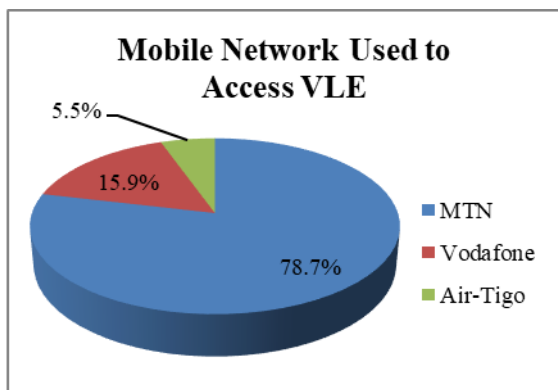


Chart 2: Mobile Network Used to Access VLE

The results showed that 122 (23.7%) out of 513 students strongly disagreed that the network strength at the various locations across the country was always strong to access the VLE. 158 (30.8%) of the students had fluctuations in network connectivity while 84 (16.4%) of the students indicated that the network service was always strong in their area to access the VLE without any downtime. This confirms the 2020 Afrobarometer findings on Ghana's e-learning program which indicates that rural and urban areas continue to experience challenges with internet connectivity.

4.3 Devices Used to Access VLE

In all, 513 students responded to the question on the type of devices used to access the UMaT's VLE application. Fig 5 showed that 362 students (70.6%) used their mobile phones. 139 (27.1%) students used laptops while 8 students used tablets. 3 students (0.6%) used desktop computers. 402 students (78.4%) of 513 indicated that their mobile devices were compatible with the VLE. This result showed that most of the mobile devices available for students at UMaT have the capacity of storage, speed and memory to handle the requirements of virtual learning.

4.4 Ease of Access of the VLE

As mentioned before, UMaT had never deployed the VLE prior to the COVID-19 pandemic as the mode of delivery was strictly face-to-face. It was therefore obvious that most of the students had not experienced this form of virtual learning before. Since the University was closed in conformity to the Government's directive, students accessed the VLE from outside campus. As a result of this, there were varying challenges concerning accessing the VLE platform.

Also, the findings suggest that most of the students were not conversant with the VLE following its deployment. This

could also be attributed to the fact that this was their first time using such a platform as a total of 318 (62.1%) out of 513 had reservations about the use of the VLE and indicated that UMaT was not ready and could not deploy the system. The reasons given included:

1. Difficulty in navigating through the platform;
2. Cost of data;
3. Poor preparation to deploy the system;
4. Slow speed in accessing the portal;
5. The system could not properly help students understand some practical courses;
6. Some lecturers did not know how to use the system.
7. Some students didn't have proper devices to use the platform.

4.5 Data Provided to Students

Apart from the whitelisted sites provided by MTN and Vodafone Ghana, the Management of UMaT also purchased 10 GB worth of mobile data at \$8.75 for each student especially for learning and examinations during the second semester of the 2019/2020 academic year. Out of the 506, 153 students representing 30.2% disagreed that the data provided was adequate for the purpose intended. 28.5% of students were neutral on the adequacy of the data provided while 16.7% of the students agreed that the data given to them was enough to complete the semester. It could be suggested that with the proliferation of streaming services such as Netflix and social media platforms, most of the students used the data provided to access those platforms.

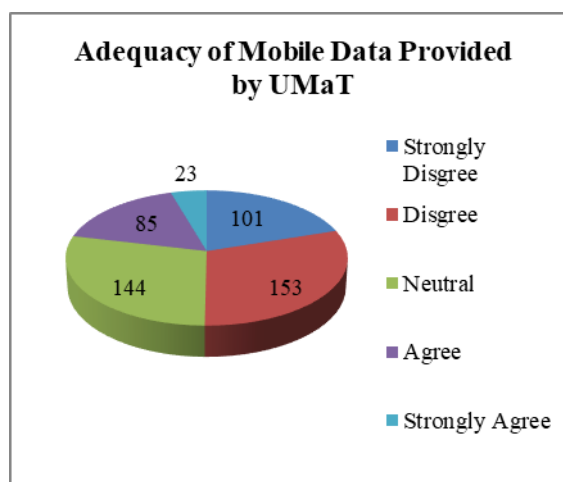


Chart 3: Adequacy of Mobile Data Provided by UMaT

4.6 The Cost of Additional Data Purchased

The whitelisted sites were capped to 500Mb and whenever a lecture session goes beyond one and half hours, students have no option but to use their own data to continue participating in the class. Upon the provision of the whitelisted sites and the University's support of data to the students, 23.2% of the students representing 119 out of 513 students strongly disagreed that there was no significant additional cost of data incurred by using the VLE. However, 20.3% (104

students) agreed that there was no significant additional cost incurred while 5.3% of students strongly agreed that they did not incur any significant additional cost.

4.7 Overview of UMaT's ICT Infrastructure

The University's major internet connectivity is provided via two Synchronous Transport Module level-1 (STM-1) fibre optic networks to support teaching, research and administrative activities. In terms of network infrastructure, the University has core switches and routers that can manage layer 3 applications. The Datacenter has four servers that manage the domain, student portal, examination and admission applications. These applications ran on default processors and memories with a maximum of two 600 GB hard drives storage capacity. The University's website is hosted on the cloud. The University has fifteen Nodes/distribution centres that transmit data traffic via fiber technology across the University community. Most of the fixed-configuration switches at the nodes are managed switches with few Power over Ethernet (PoE) technology. Facilities in UMaT have at least two Wi-Fi Access points.

5. CONCLUSIONS

UMaT has taken the advantage of COVID-19 Pandemic to implement a VLE to complement its traditional method of teaching and learning. The implementation of VLE has directly reduced the number of papers used to write examinations and assignments. This has a positive correlation to the cost of the A4 sheets the university purchased.

The VLE has provided a convenient and relaxing atmosphere for lectures and students to access education at any time at any place. It has removed the fear of missing lectures for students which was a limitation to the traditional method of teaching and learning.

Lectures and students have acquired new technology for accessing education with ease. However, UMaT incurred a huge cost of implementing VLE for teaching and learning. The other related issues confronting the operation of VLE to teaching and learning are:

- a. the additional cost of data incurred by the student to access the online education.
- b. The poor mobile network services at the locality of these students to access the VLE remotely.
- c. The frequent power fluctuations during online classes prevented the continuity of the lectures and therefore make lectures boring and unattractive.
- d. Some lecturers and students still struggling with the use of the VLE.

In all, the positive impact of the COVID-19 pandemic on the Teaching and Learning at UMaT outweigh the negative and challenges it faces and this is no different from other Tertiary Education in Ghana.

6. RECOMMENDATIONS

This paper recommends the following.

- a. The University should consider the option of hosting the Virtual Learning Environment in the cloud as the population increases.
- b. Government should invest and purchase a large volume of bandwidth capacity and share to institutions at a moderate price.
- c. Telecommunication companies operating in Africa should expand and spread their service coverage of their mobile network
- d. Universities should invest in ICT to promote the quality of research.

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