Adoption of distance learning at Cheikh Anta Diop University during COVID-19: responses and challenges

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ABSTRACT

Due to the *COVID-19* pandemic, studies at University Cheikh Anta Diop (*UCAD*) were significantly disrupted. Indeed, students set off again to their cities or villages and then lost vital campus services and support. Consequently, rapid response plans based on asynchronous learning mode or live interactive were provided by academic staff. Therefore, we monitored the adoption of online learning by traditional full-time students by taking as case studies three computer networking courses taught at Bachelor and Master Degree programs. The obtained results exhibit a high distribution of access to online contents at the beginning of *COVID-19* response. Nevertheless, several issues like high cost of Internet connectivity, presence of white spot areas as well low broadband capacity, network equipment, housework, barriers of remote teaching and learning, and power outage have mitigated the adoption of distance learning.

Keywords

Distance learning, developing countries, ICT, COVID-19 pandemic.

1. INTRODUCTION

Cheikh Anta Diop University (*UCAD*), located at *Dakar*, *Senegal*, is the largest and most prestigious university in french speaking West Africa. $UCAD$ has more than $70,000$ students, 1412 university lecturers and researchers, 1500 technical staff, 6 faculties, and 10 institutes. Due to the *COVID-19* pandemic, studies at *UCAD* were either ended or significantly disrupted since March 13, 2020. It should be noted that few, if any faculties, regardless or involved students to available programs, had rapid response plans in place in order to provide online courses. Notwithstanding, as of April 1^{st}, 2020 according to programs having less than 100 students, academic authorities decide that online courses can be voluntary provided by using $Moodle$ [1] platform where $BigBlueButton$ [2] is embedded for live interactive meetings.

According to *UCAD* Computer Science department several courses were designed to be studied online, independently. These courses are available on FAD[1] platform with respect to Bachelor and Master Degree. In this paper, we take as case studies three online courses in computer networking field: one taught to sophomore students (second year of the Bachelor degree) and the remainders to undergraduate students (first year of the Master degree).

[1]https://fad.fst.ucad.sn/

In 2010, Senegal had 1 million Internet users that represents 8% of its population. Moreover, it rose to 46% in 2017 according to statistics published by ITU (International Telecommunication Union) [3] out of a population of $15,256,346$ distributed over $196,712$ km^2. For instance, among $10,770,683$ Internet links estimated in 2019, 98.67% of users are connected by using cellular mobile networks ($2G$, $3G$, $4G$) [4]. Indeed, cellular network customers use almost exclusively prepaid plan. Therefore, students that ought to connect into distance learning platforms either for live interactive meetings, or asynchronous learning, or submit work assignments, the high cost of Internet access is a big concern.

At the beginning of COVID-19 responses and during two months, obtained results exhibit a high appropriation of online contents. In fact, in order to achieve good quality of experience in regard to distance learning, a suitable network connectivity as well appropriate accommodation within houses are mandatory. Besides, students set off again to their villages, and thus, they should deal either with low connectivity, or presence of white spot areas, or chores (farming activities, housework), or cramped houses, or power outage.

The contributions of this paper are twofold. Firstly, we illustrate that Internet use is growing across much of big cities located in west coast whereas most counties hosting UCAD students are located within white spot areas. Secondly, we show students behaviour according to their attendance to distance learning activities as well inequities that may arise between them across underserved areas.

The remainder of the paper is structured as follows. Section 2 illustrates the sparse Internet access outside big cities in Senegal. In Section 3, we illustrate the distribution of access to online contents based on three selected courses as case studies. Following that, Section 4 concludes this work and presents some recommendations in order to achieve efficient distance learning in relation to developing countries.

2. INTERNET CONNECTIVITY AND COST ISSUES

Based on ICT Development Index (IDI) provided by ITU [3], Senegal was ranked 142^{nd} out of 175 countries in 2017. It is worth noticing that Senegal is in the middle of the table according to African countries classification. Indeed, IDI is a composite index and gathers a couple of 14 indicators which measure ICT readiness (infrastructure, access), ICT use (intensity), and ICT capability (skills). The low level of Internet use is due to either the presence of huge white spot areas, or a non availability of $3G/LTE$ mobile

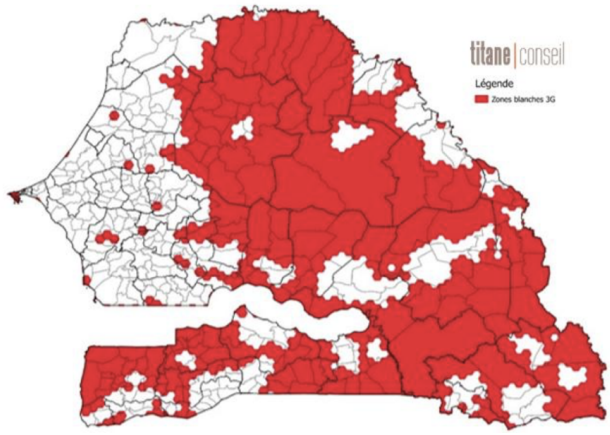


Figure 1: Geographic distribution of 3G white spot areas across Senegal in 2017.

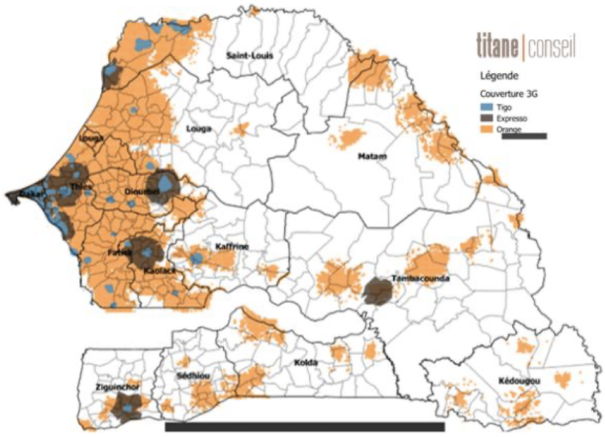


Figure 2: Geographic areas covered by Senegalese 3G mobile network operators in 2017.

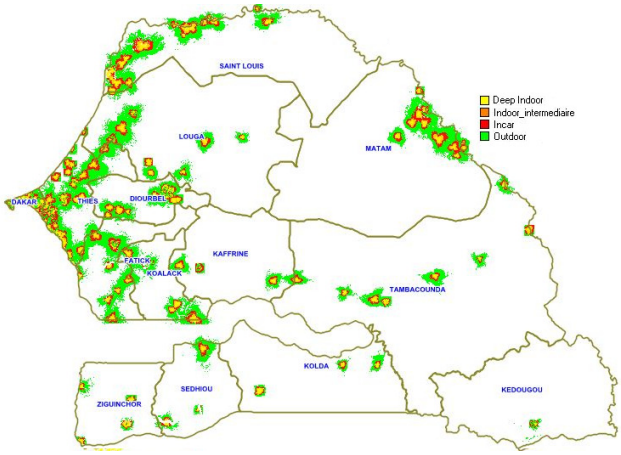


Figure 3: Geographic areas covered by Orange 4G network in December 2018.

network across the country, or Internet connectivity cost. Furthermore, the *Alliance for Affordable Internet* illustrated that consumers in African countries are paying some of the highest rates in the world for internet access as a proportion of income [5].

In contrast to developed countries where most users have Internet access directly to their home through the use of cable modems of $ADSL$, in Senegal 98.67% of users get Internet access by way of the use of cellular mobile networks ($2G$, $3G$, $4G$) [4].

For instance, Figure 1 illustrates white spot areas distribution based on $3G$ by taking into account the three main mobile network operators (MNO) in Senegal which are *Orange*, *Free* (formerly called *Tigo*), and *Expresso*. *Orange* holds the greatest share of the market with 67.97% followed by *Free* 25.42% and *Expresso* 6.59% [4]. Furthermore, Figure 2 shows geographic areas covered by the three Senegalese mobile network operators according to $3G$. In fact, according to *Orange MNO*, its $3G$ (resp. $4G$) cellular network covers 54.39% (resp. 10.93%) of the overall Senegalese territory. As illustrated in Figure 3, $4G$ network is mainly available in west coast that hosts most biggest regions like Dakar, Thies, Diourbel, and Saint-Louis.

Nevertheless, most of $UCAD$ students live in remote rural areas. Figure 4 depicts the geographic distribution of $14,111$ villages across the Senegal. In contrast to $3G$ and $4G$ networks, Senegalese villages are uniformly well distributed around the country. Therefore, students should deal either with a presence of white spot areas as shown in Figure 1, or low broadband capacity as depicted in Figure 2. In fact, a very low connectivity provides a lot of disruption during live interactive meetings. For this reason, learners that do not have suitable network connectivity or appropriate equipment (laptop, smartphone) are stranded.

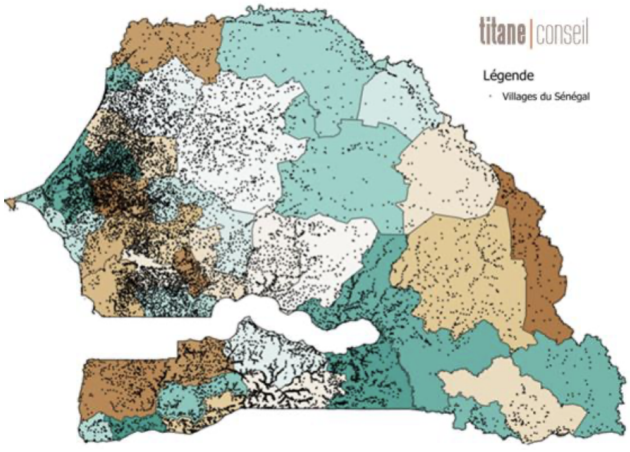
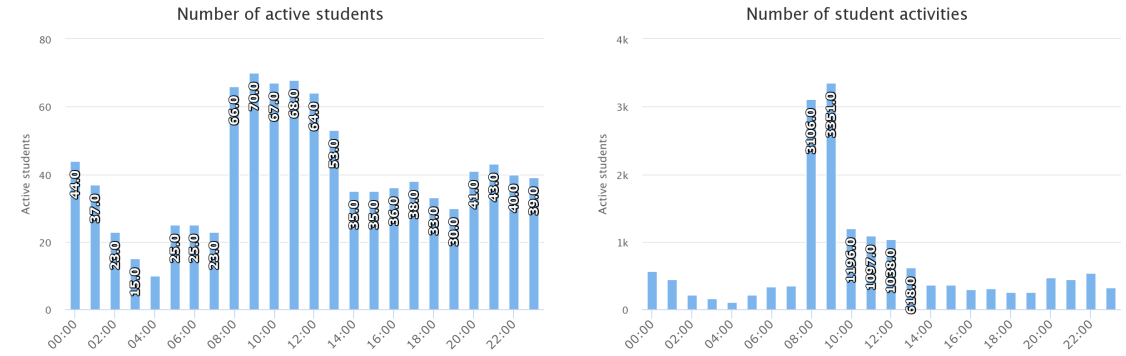


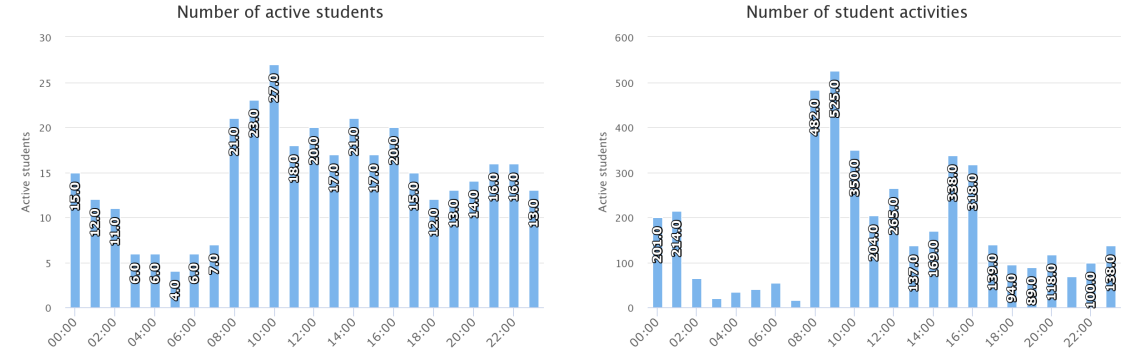
Figure 4: Geographic distribution of Senegalese villages.

On the other hand, cellular network customers use almost exclusively prepaid plans which are very expensive compared to student revenues. It exists a couple of packages according to data rates and validity period. Most of *MNO* have roughly same prepaid plans. According to *Orange*, in order to have solely Internet access during 1 month, we can purchase either $2.5GB$ at 3.42 USD, or $7GB$ at 8.56 USD, or $15GB$ at 17.12 USD, or $25GB$ at 25.68 USD. It is worth



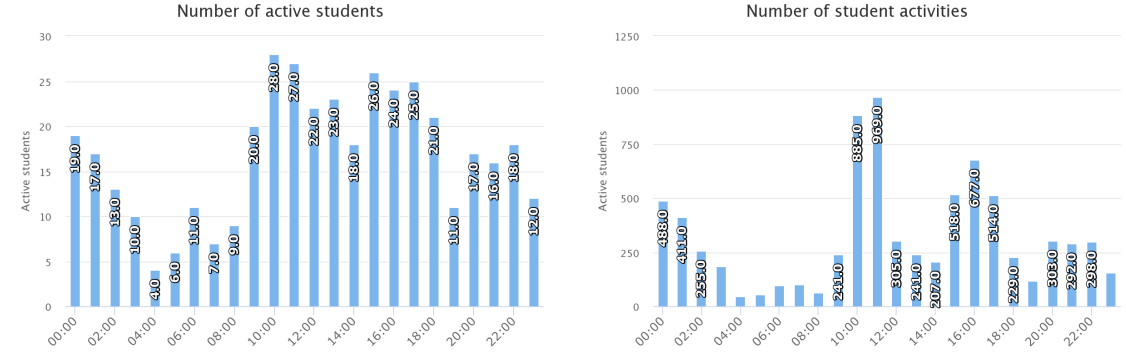
(a) (b)

Figure 5: Total number of daily active users according to "Réseaux Sans Fil" online course.



(a) (b)

Figure 6: Total number of daily active users according to "Systèmes Répartis" online course.



(a) (b)

Figure 7: Total number of daily active users according to "Routage IP et Services IPv6" online course.

noticing that during the COVID-19 pandemic, *Orange* offers $1GB$ more between $12am$ to $8am$.

Moreover students located in big cities have unlimited access to Internet since they use *ADSL* connections which are estimated to 1.33% among Internet links [4]. Without cheap prepaid plan dedicated for education as well as an enhanced coverage rate, several barriers exist for an efficient, sustainable, and fair distance learning.

3. LEARNED LESSONS

3.1 Collected data-sets

Responding to the COVID-19 pandemic, *UCAD* computer science department has seen the necessity to pivot as much as possible into distance learning. An online platform based on *Moodle* [1] was already available but under used by academic staff. Therefore, from April 6, 2020 several courses were available for distance learning. Indeed, used data-sets were collected from April 9, to June 30, 2020 among on-line

computer networking courses. In fact, 88 students are enrolled in the "*Réseaux Sans Fil*" (*i.e.*, "Wireless Networks") online course given at the second year of Bachelor degree, whereas 31 students are enrolled for "*Routage IP et Services IPv6*" (*i.e.*, "*IP Routing and IPv6 Services*") and "*Systèmes Répartis*" (*i.e.*, Distributed Systems) courses which concern the first year of Master Degree program. As summary, the behaviour of 119 students enrolled to 3 online courses were monitored roughly during 3 months.

We note that during online courses most of instructors are broadcasting through sharing their desktops. In fact, screen sharing takes the most bandwidth [2]. As a consequence, if instructor's screen is updating frequently, the *BigBlueButton* server could transmit 1 Mbits/sec. Moreover, if the instructor's screen is largely idle, the desktop sharing application will transmit about 0.2 Mbits/sec [2]. In addition, a VoIP connection to the *BigBlueButton* server takes approximately 0.04 Mbits/sec for receiving (respectively transmitting) to each user. In order to have a good quality of experience, it is mandatory that students have at least 500 Kbits/sec upstream and 1 Mbits/sec download bandwidth.

Daily access to live interactive meetings by using *BigBlueButton* [2], or to online resources available asynchronously such as assignments, forum, quiz, files, folders, pages, and URLs are monitored by using the "Analytics graphs" plugin [6] embedded in *Moodle* platform. This plugin provides several graphs that facilitate the identification of students profiles. It is worth noticing that due to bandwidth constraints within *UCAD* network, our *BigBlueButton* web conferencing tool is hosted by *Amazon AWS* and live videos are still available in streaming for download. Moreover, faculties *Moodle* servers are anchored in *UCAD* network.

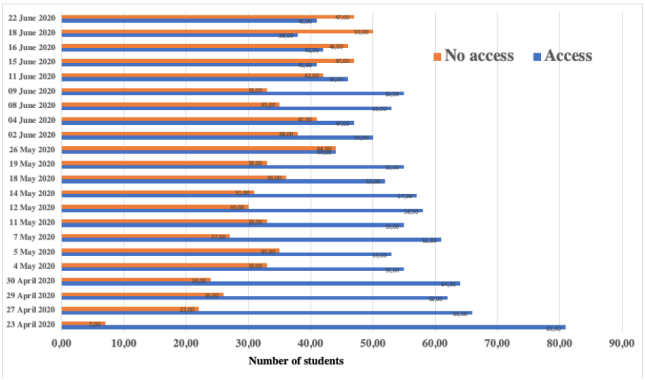


Figure 8: Number of active students following live interactive "Réseaux Sans Fil" online course.

3.2 Enabling online learning

In this section, according to selected online courses, we monitor students profiles following provided activities. Figures 5, 6, and 7 illustrate the total number of daily active users according to respectively "Réseaux Sans Fil", "Systèmes Répartis", and "Routage IP et Services IPv6" online courses.

Figures 5(a) and 5(b) exhibit that students are more active in the morning. According to "Réseaux Sans Fil" online course, interactive live is planned between 9*am* to 10*am* three times per week. Between 8*am* to 12*pm*, roughly 67 students are active among 88 enrolled to this program. Nevertheless, peak activities (Figure 5(b)) are noted during 8*am* to 10*am* interval which means that students are more active on the platform when live interactive is planned. On the other hand, we note an intensive students attendance at midnight. In fact, network operators offer 1*GB* more between 12*am* to 8*am*. Therefore, in order to overcome Internet access cost, several asynchronous learning activities are done during this interval.

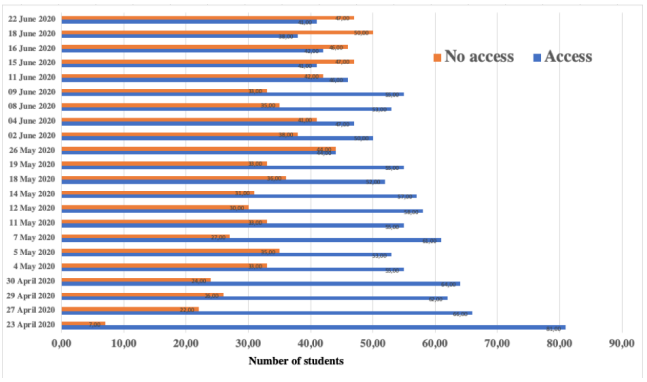


Figure 9: Number of active students following live interactive "Systèmes Répartis" online course.

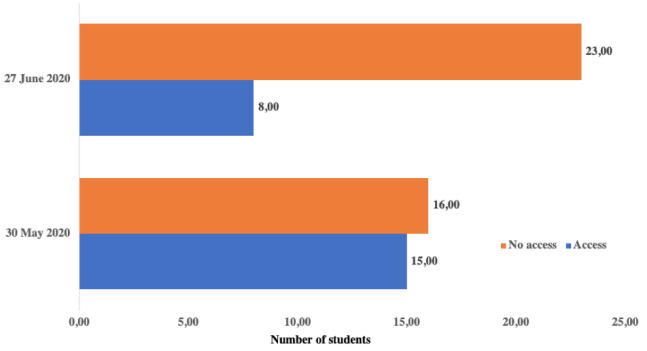


Figure 10: Number of active students following live interactive "Routage IP et Services IPv6" online course.

The same trends are noted according to Figures 6 and 7. In relation to both online courses, live interactive meeting is planned once each week between 10*am* to 12*pm* and most activities are done during this period.

Additionally, Figures 8, 9, and 10 highlight the number of students that accessed to live interactive or streaming with respect to our three one-line courses. In contrast to "Réseaux Sans Fil" and "Systèmes Répartis" courses, we note just two videos according to "Routage IP et Services IPv6". Indeed, course's instructor is more focus to asynchronous learning. For instance, live interactive is just planned in order to give insights to students.

We can observe more attendance with respect to live streaming during the first two months of pandemic responses (bottom part of figures). Following that, the number of students that do not access to videos is higher than those who viewed (upper corner of Figures 8, 9, and 10). The main explication is due to Internet connectivity cost, and thus, students are trying to save up purchased prepaid plans.

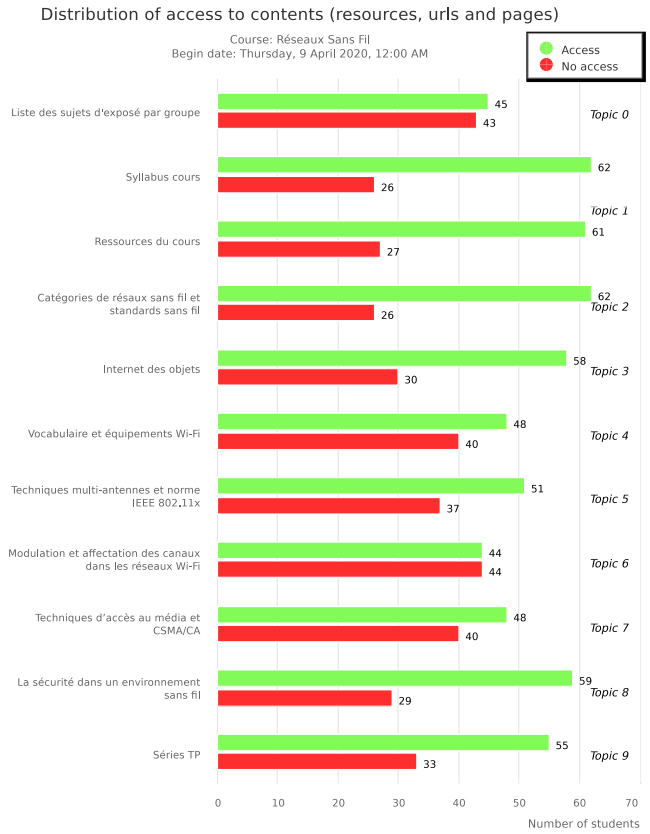


Figure 11: Adoption of asynchronous learning according to "Réseaux Sans Fil" course.

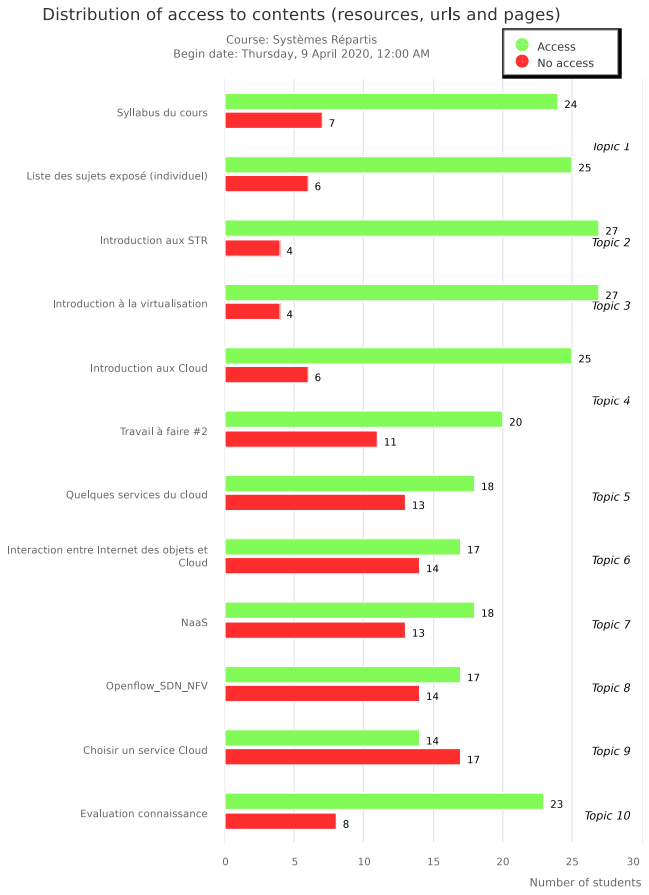


Figure 12: Adoption of asynchronous learning according to "Systèmes Répartis" course.

Finally, Figures 11, 12, and 13 depict the distribution of access to contents (resources, urls, and pages) in asynchronous learning mode according to our three selected online courses. These figures show the number of students that have accessed or not to study materials and online learning resources. Therefore, they monitor the adoption of distance learning by students. In fact, online contents are split in several topics are illustrated in Figures 11, 12, and 13. As example, topics related to courses can be homework, Cisco Packet Tracer Labs, lessons, attendance to forum, etc. In a general manner, we see that several online resources were never viewed by several students enrolled to corresponding programs.

Moreover, Figure 13 illustrates that students do not attend in active manner to forum with respect to different chapters in progress. For instance, the attendance to forum, tagged "Forum de discussion" in Figure 13, is very poor according to the six available channels. In spite of Internet connectivity issues, we need to figure out whether students have enough pedagogic capacity to continuously follow distance learning in long term.

4. CONCLUSION

Responding to the COVID-19 pandemic, several online courses were started by UCAD computer science department based on *Moodle* platform for asynchronous learning and *BigBlueButton* web conferencing for live interactive. In developing countries like Senegal, distance learning was adopted, though issues of pedagogic capacity, Internet connectivity, infrastructure, houseworks, and equity immediately emerged as challenges in remote delivery. Nevertheless, students that do no have network connectivity or appropriate equipment (laptop, smartphone, etc) are stranded.

Furthermore, student's feedbacks point out the Internet cost connection, a lack of suitable low-noise and calm working environment, and family obligations are main concerns towards an efficient distance learning. Nevertheless, obtained results according to students behaviour exhibit a lack of pedagogic capacity in order to continuously follow distance learning during a long period.

To overcome previous pitfalls, academic authorities are seeking to make servers dedicated to education freely accessible across the country. Furthermore, when campus will be opened in September 2020 as expected, we suggest that skills in relation to online study should be provided to students and academic staff. Assets gathered from distance learning during the COVID-19 pandemic should be consolidated by providing a hybrid learning approach.

Indeed, available physical infrastructures as well as academic staff are not in correlation with students growth number across Senegalese universities. In spite of Internet connectivity issues that can be solved by political authorities,

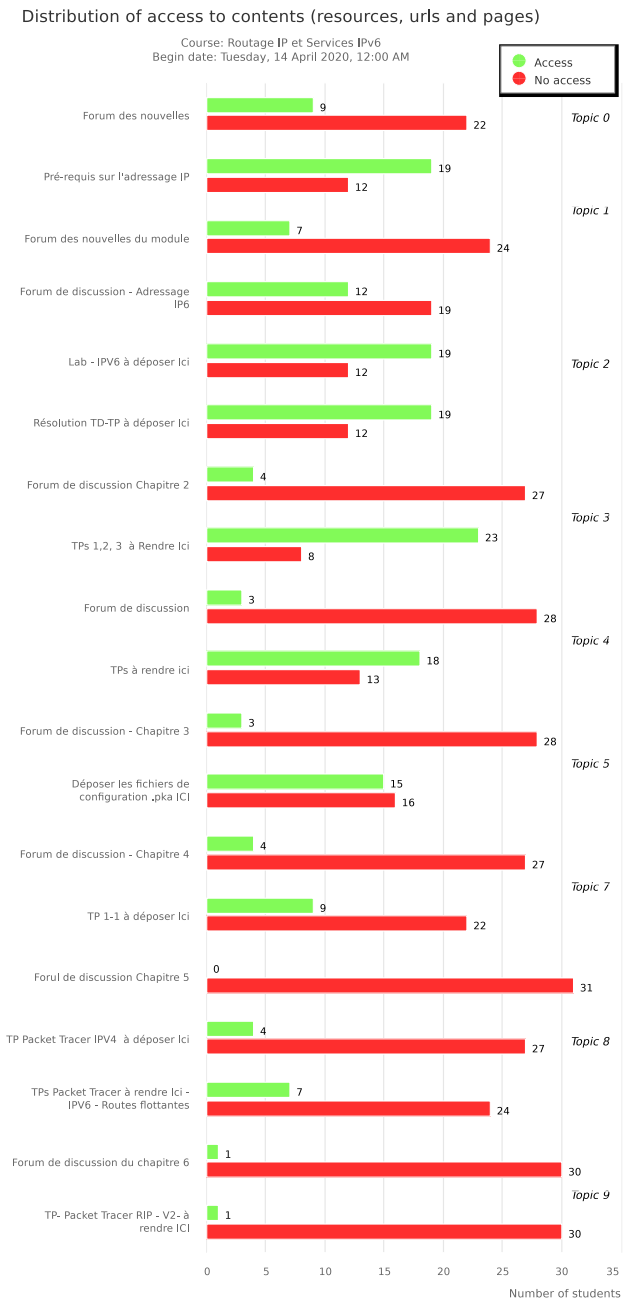


Figure 13: Adoption of asynchronous learning according to "Routage IP et Services IPv6" course.

for a sustainable higher education it is mandatory to promote distance learning.

5. REFERENCES

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