

# Remote learning of biochemistry during the COVID-19 pandemic: case of undergraduate students in Bogota, Colombia

**Luis Ernesto Contreras-Rodríguez**

Universidad Nacional de Colombia

**Adrian G. Sandoval-Hernández**

Universidad Nacional de Colombia

**Milena Maya-Hoyos**

Universidad Nacional de Colombia

**Carlos Y. Soto** (✉ [cysotoo@unal.edu.co](mailto:cysotoo@unal.edu.co))

Universidad Nacional de Colombia <https://orcid.org/0000-0001-8694-7489>

---

## Case Report

**Keywords:** Virtual learning, Biochemistry, COVID-19 pandemic, Student perception, Remote classes, Universidad Nacional de Colombia

**Posted Date:** September 11th, 2020

**DOI:** <https://doi.org/10.21203/rs.3.rs-72902/v1>

**License:**  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

## Abstract

**Background:** The COVID-19 pandemic forced the implementation of global emergency measures based on social distancing. In Colombia, remote classes in universities have avoided the spread of the disease. However, the implementation of remote classes demands virtual pedagogical strategies that are not traditionally used for teaching basic sciences in the Colombian public education system. This study describes student perception of remote biochemistry classes at Universidad Nacional de Colombia (Bogota).

**Methods:** A virtual survey was applied to undergraduate students of dentistry and biology programs to assess their perception of the quality and academic impact of remote classes during the mandatory lockdown decreed by the Colombian government for semester I of 2020.

**Results:** The students demonstrated an overall acceptance of the remote biochemistry classes, highlighting that the quality of the classes facilitated the understanding of the topics, increased assessment performance, and significantly promoted self-learning (according to 84.6% of the respondents). Although some students reported having experienced reduced attention to the classes throughout the semester, most of them (80.8%) would remotely attend the biochemistry course again.

**Conclusions:** Under confinement, the remote biochemistry classes were well accepted by undergraduate students of dentistry and biology programs of the Colombian public university system. The students acknowledged the quality of the classes, which significantly contributed to understanding basic concepts and motivated the students to develop a deeper comprehension of the reviewed topics. These findings suggest that combining remote learning with traditional lectures could be a suitable choice to enhance the learning process of biochemistry for students of medical and basic sciences. Undoubtedly, virtual learning is a good option for public education in the post-COVID-19 future in developing countries, such as Colombia, which generally have problems related to student desertion and failure due to economic problems.

## Background

The outbreak of SARS-CoV2 (Severe Acute Respiratory Syndrome Coronavirus 2) was declared as a global pandemic by the World Health Organization (WHO) on March 11<sup>th</sup>, 2020. This zoonotic pathogen is the etiological agent of Coronavirus Disease 2019 (COVID-19) that was first reported in December 2019 in Wuhan, Hubei province, China [1, 2]. To date, COVID-19 has spread to 216 countries and caused the death of 0.72 million people worldwide [3].

COVID-19 quickly spread to Europe and, then, to the American continent, which constitutes the current pandemic epicenter. Consequently, the health systems of socio-economically disadvantaged countries in Latin America are being challenged by the increasing COVID-19 pandemic [4]. In Colombia, the first COVID-19 case was detected on March 6<sup>th</sup>, 2020 in a college student who traveled from Milan, Italy [5]. Currently, Colombia is among the top ten countries with confirmed cases of COVID-19, where the disease has a fatality rate of 3.3% [3, 6].

On March 24<sup>th</sup>, the Colombian government declared a mandatory preventive lockdown to reduce the number of infections and prevent patient overflow in the public health system [7]. Consequently, classes were suspended in schools and universities to avoid crowding of students in educational centers [8]. The United Nations Educational, Scientific and Cultural Organization (UNESCO) estimated that 107 countries worldwide implemented school closings, which affected around 862 million children and young people (i.e., half of the global student population) [8, 9]. In Colombia, nearly 12.8 million students from all educational levels have been affected by the mandatory lockdown [10]. Therefore, the implementation of remote classes, as a consequence of the obligatory confinement, was a sudden challenge to the education system in Colombia.

Since 1867, Universidad Nacional de Colombia has been the largest and leading public university in terms of education, research, and development in Colombia [11]. This university comprises 54284 enrolled students, including 45580 undergraduates (84.0%) and 8704 graduates (16.0%) [12]. Particularly, the undergraduate students, including those at the Faculties of Sciences and Health Sciences, come from urban and rural Colombian territories with vulnerable populations, such as indigenous, Afro-Colombian, and victims of the recently ended internal armed conflict [13].

The biochemistry courses at Universidad Nacional de Colombia are offered to students from health and science programs and are instructed by teachers of the Department of Chemistry (Faculty of Sciences). The courses are traditionally taught through theoretical lectures covering structural, functional, and metabolic concepts of carbohydrates, lipids, amino acids, proteins, enzymes, vitamins, and nucleic acids. As a consequence of the COVID-19 pandemic, classroom lectures were adapted to synchronous remote classes using virtual tools, such as Google Meet and Classroom, for students with constant internet access. Lecture videos in MP4 format and other materials used during the remote classes were made specially available for students with internet access problems to avoid low academic performance during the lockdown.

In this work, an analysis of student perception about the quality and academic impact of remote biochemistry classes was conducted with students from dentistry and biology programs at Universidad

Nacional de Colombia. The results show that remote classes were well accepted and enhanced self-learning in a lockdown environment, facilitating the understanding of basic concepts. These findings suggest that virtual learning, together with traditional campus-based lectures, could be a good choice to enhance public education policies in Colombia.

## Methods

### Course description

Two theoretical courses of biochemistry (Principles of Biochemistry-2023214 and Basic Biochemistry-1000042) were offered by the Department of Chemistry, Faculty of Sciences, Universidad Nacional de Colombia (Bogotá). The courses comprised two classes per week (two-hour classes) for 16 weeks. The courses 2023214 and 1000042 were taught to 26 and 52 students from biology and dentistry programs, respectively.

The objective of the courses was to study the structure and function of carbohydrates, lipids, peptides, proteins, and nucleic acids, along with their metabolic pathways. For the first two weeks (from March 5<sup>th</sup> to 16<sup>th</sup>), the classes were given through traditional campus-based lectures, while for the remaining 14 weeks (from March 16<sup>th</sup> to June 26<sup>th</sup>), during the mandatory lockdown, the topics were taught by remote synchronous lectures through Google Meet software using PowerPoint presentations and applied exercises on a virtual whiteboard. With prior consent of the students, all classes were recorded in MP4 format and shared through the Google Drive platform. Non-cumulative grading of the topics was performed using Moodle software by applying different types of questions, including multiple-choice, true/false, matching, and numerical questions.

### Virtual survey description

One week after the final exam, a virtual survey was sent to all of the students through Google Forms. The students were previously informed that the main objective of the survey was to evaluate their perception of the quality and academic impact of the remote classes during the mandatory lockdown. The survey was anonymously answered by most students, who willingly participated. Only one entry was allowed per respondent. The details of the virtual survey, which was based on previous reports [14, 15], are provided in the Supplementary Material. Survey data analysis was performed using GraphPad Prism (version 8.0).

## Results

### Remote classes were highly attended and motivated self-learning

The majority of students extensively attended the remote classes or used the lecture videos during the academic semester (69.3% of respondents), indicating active participation. Less than half of the students moderately (26.9%) or minimally (3.8%) attended the classes (Fig. 1a). Moreover, 96.2% of students used the lecture videos during the academic semester as pedagogical support to solve assignments or review theoretical concepts (Fig. 1b). According to the students, the videos were an important resource to prepare for exams and obtain satisfactory grades. Regarding the use of additional educational resources, 84.6% of the students consulted books or websites to complement the topics discussed during the course (Fig. 2a). Additionally, the students expressed that remote classes considerably (51.9%), moderately (40.4%), or limitedly (7.7%) promoted self-learning (Fig. 2b), evidencing that the virtual learning environment improved self-motivation.

### **Remote classes offered different aspects of quality**

The students rated different aspects of the remote classes, including clarity of concepts, use of concise and simple language, development of calculations, management of virtual platforms (e.g., Google Meet, Classroom and Moodle), and quality of audio, video and PowerPoint presentations. In general, all aspects were rated on average from 3.8 to 4.4 (Fig. 3a). Furthermore, the students considered the quality of the remote classes as excellent (26.9%), good (46.2%), or satisfactory (17.3%) (Fig. 3b). The perception of quality was a key factor for students to obtain good results in exams and encouraged them to frequently view the recorded lectures to review theoretical concepts. Less than 10.0% of the students considered that the classes had regular or low quality (Fig. 3b).

### **Remote classes facilitated learning basic concepts and improved test-solving**

According to student perception, the shift to remote learning improved the understanding of the topics and the ability to solve assignments, quizzes, and exams (the most valued). Furthermore, the remote classes promoted motivation towards the course and an interest in biochemistry (Fig. 4). However, the students also considered that their attention to the classes had reduced over time, suggesting that novel strategies should be used in virtual classes to capture the students' attention throughout the course.

Additionally, most students considered that the remote classes contributed considerably (61.6%) or moderately (28.8%) to their learning process, while 9.6% indicated that the remote classes had a low impact on learning biochemistry (Fig. 5a). Moreover, repeater students, who previously attended the same course through traditional campus-based lectures, highlighted that the remote classes contributed considerably (51.9%) or moderately to their learning (40.7%) (Fig. 5b). These findings indicate that virtual tools, including video lectures, facilitated the learning process for more than 90.0% of the students.

## **Remote classes could be an alternative to avoid student desertion**

Regarding virtual learning as an alternative during the mandatory lockdown, 73.1% of the students considered that the remote classes were a suitable option to traditional learning (Fig. 6a). Most of the students (90.4%) manifested the importance of continuing to implement remote classes during the COVID-19 pandemic, or any other reason for lockdown, at any time (Fig. 6b), and 80.8% of the students would like to repeat the course through remote classes (Fig. 6c). However, traditional lectures continue to be the preferred modality (61.5%) for learning biochemistry (Fig. 6c).

### **Positive and negative aspects of the remote classes**

The virtual survey also included open questions designed to inquire about the positive and negative aspects of the remote classes through free opinions from the students. Among the positive aspects, the students expressed: "Flexibility to access to the topics", "Facilitates learning", "Allows repeating classes to review the topics", "The class recordings allow you to not get lost", "It is easier to review with the recordings", "Time is better used because there is no need to travel to the campus", "Recorded lectures require less effort to take notes", "The classes help to have self-discipline", "The classes were didactic", "It always provides a front row seat to the academic content", among others. On the other hand, regarding the negative aspects of the remote classes, the students mentioned: "Poor internet connection", "It is hard to be fully concentrated", "Little interaction with peers", "External stimuli affects concentration to the class", "Sometimes, the audio failed", "Difficulty to understand math calculations", "The remote classes are exhausting at some point", "More distractions occur", among others.

## **Discussion**

The mandatory lockdown due to the COVID-19 pandemic forced Colombian universities to suddenly shift to virtual learning without having broad experience in this modality [16, 17]. This study describes student perception of remote classes in order to gain insight into the academic impact of virtual learning on a biochemistry course and identify conceptual elements to redefine pedagogical actions in pandemic and post-pandemic times. This study was conducted considering the suggestions of UNESCO, which mention the importance of implementing pedagogical strategies focused on people to maintain the teacher-student relationship during the COVID-19 pandemic [18]. Therefore, assessing student perception of remote classes will be valuable to enhance teaching quality in post-pandemic times.

The students highlighted the quality of the content and materials used in the remote classes, which promoted the understanding of the topics, motivation, and self-learning. Furthermore, the students manifested an interest in gaining a deeper understanding of the theoretical concepts, which improved their ability to solve assignments, quizzes, and prepare for exams. These findings indicate that the quality

of remote classes significantly reduces the time dedicated to students by teachers. On the other hand, it has been observed that the teaching quality of biochemistry in undergraduate courses influences students to conduct biochemical research during graduate studies in Colombia. There is an increasing interest of graduate students in developing biochemical and biomedical research, which requires solid basic concepts of biochemistry. From another perspective, the mutual construction of basic concepts between teachers and students through remote classes (i.e., an elaboration that implies an effective transmission of information) is benefited by a clear communication through the virtual environment. Therefore, remote classes should include visual, phonetic, and language clarity, which is markedly influenced by selecting versatile video platforms and proper internet connectivity. Nowadays, college students rely significantly on their visual abilities for the learning process [19, 20].

Recording and sharing videos of remote classes facilitate permanent contact with concepts and encourages students to review the topics at any time; therefore, favoring the learning process, as previously described for other virtual education tools [14, 15]. Recording classes could also provide benefits when teaching courses to students from diverse career programs. In this case, students likely have different backgrounds on the basic concepts, which can be partially overcome by reviewing the recorded classes.

Universidad Nacional de Colombia admits top students from different ethnic and minority groups (e.g., mestizos, Afro-Colombian, indigenous, among others) and territories, including regions involved in the recently ended Colombian armed conflict [13]. Students from these areas usually have adverse economic conditions that can potentially affect their academic performance and capacity to attend traditional classes. For this reason, the possibility of attending asynchronous pre-recorded classes, such as those implemented in this study, will positively impact the academic performance of this group of students and contribute to reducing desertion, a situation that has markedly increased in Colombia for years [21].

The analysis of student perception described in this work demonstrates that the virtual learning process of theoretical courses, such as biochemistry, could be an adequate alternative for Colombian public universities to adopt in the post-COVID-19 future. Particularly, low-income populations could be provided with the opportunity to undertake professional training through virtual learning. In addition, remote classes can also significantly benefit the extramural programs offered by Universidad Nacional de Colombia, preventing teachers from traveling to remote areas away from the main university campus.

The COVID-19 pandemic has changed traditional pedagogical strategies, whereby virtual approaches and online resources are complementary and enhance the conventional campus-based lectures. This

situation provides an ideal opportunity to reconfigure the classical educational platforms and public education policies related to basic sciences, such as biochemistry, in Colombia. The observations from this work can be extrapolated to the university education system of other developing countries or public universities in Latin America, where SARS-CoV2 transmission was thought to reduce, but, on the contrary, outbreaks are also attributed to asymptomatic young people, including university students [22, 23].

### **Limitations and considerations for further research**

This study has several limitations that should be indicated. First, the study was restricted to students from dentistry and biology programs. Although student perception in this academic population was obtained and analyzed, the biochemistry course at Universidad Nacional de Colombia is also offered to students from agronomic engineering, veterinary medicine, and nursing programs, whose perceptions would enrich the findings of this study. In addition, although the sample size is statistically valid, it could be increased to strengthen and confirm the conclusions of this report. A larger sample size would corroborate our suggestion to combine remote classes with traditional campus-based lectures in the post-COVID-19 future to enhance the learning process of biochemistry in the public education system of Colombia.

While recording and sharing videos of remote biochemistry classes appear to have increased the assessment performance of the study participants. Comparative analyses of grades from different experimental groups with and without access to the recorded classes can allow corroborating this positive aspect emphasized by the students.

Another limitation is related to the fact that some students reported experiencing reduced attention to the remote classes throughout the semester. This observation requires teachers to implement novel pedagogical strategies to avoid student distractions throughout the remote academic semester. In this regard, when the students were asked about what additional educational resources they would like to see implemented during the remote biochemistry classes, some of the responses were: "forums", "gamification", "debates", "virtual laboratories", "interactive workshops", and "active breaks", among others. These responses could be considered to enhance the pedagogical effectiveness of the remote biochemistry classes at Universidad Nacional de Colombia. Consequently, the implementation of novel pedagogical strategies remains to be explored and implemented in future remote classes to ease the learning of biochemistry for undergraduate students in a lockdown environment.

## **Conclusion**

This study shows that remote classes during the COVID-19 pandemic have had a positive impact on various aspects of the learning process of biochemistry in undergraduate students. The survey analysis

suggests that high-quality remote classes enhance self-learning and facilitate the understanding of concepts. Additionally, the pedagogical strategy of recording remote classes constitutes a permanent communication modality throughout the academic semester, which likely contributes to reducing student failure and desertion. Therefore, combining remote learning approaches with the traditional campus-based lectures is suggested here to enhance public education strategies in developing countries, such as Colombia, in the post-COVID19 future.

## Abbreviations

COVID-19: Coronavirus Disease 2019; WHO: World Health Organization; SARS-CoV2: Severe Acute Respiratory Syndrome Coronavirus 2; UNESCO: United Nations Educational, Scientific and Cultural Organization

## Declarations

### Acknowledgments

We thank our 2020-I undergraduate students for having attended the remote classes, participated in the virtual survey conducted in this study, and contributed with observations and comments to our teaching work.

### Authors' contributions

LC, AS, MM and CS conceived and designed the study, collected, analyzed and interpreted the data, and wrote the manuscript. LC and MM performed the statistical analysis of the results. All authors have approved the final manuscript and take full responsibility for the data presented.

### Authors' information

LC is a Biochemistry Assistant Professor at Universidad Nacional de Colombia.

AS is a Biochemistry Assistant Professor at Universidad Nacional de Colombia.

MM is a Biochemistry PhD student at Universidad Nacional de Colombia.

CS is a Biochemistry Full Professor at Universidad Nacional de Colombia.

### Funding

There was no funding received for the publication of this manuscript.

## **Availability of data and materials**

The datasets used and/or analyzed during the study are available from the corresponding author upon reasonable request.

## **Ethics approval and consent to participate**

This study did not include experiments on animal or human subjects.

## **Consent for publication**

The students involved in this study, who willingly participated, were informed about the potential use of the information collected through the virtual survey of this study.

## **Competing interests**

The authors declare there is no conflict of interests.

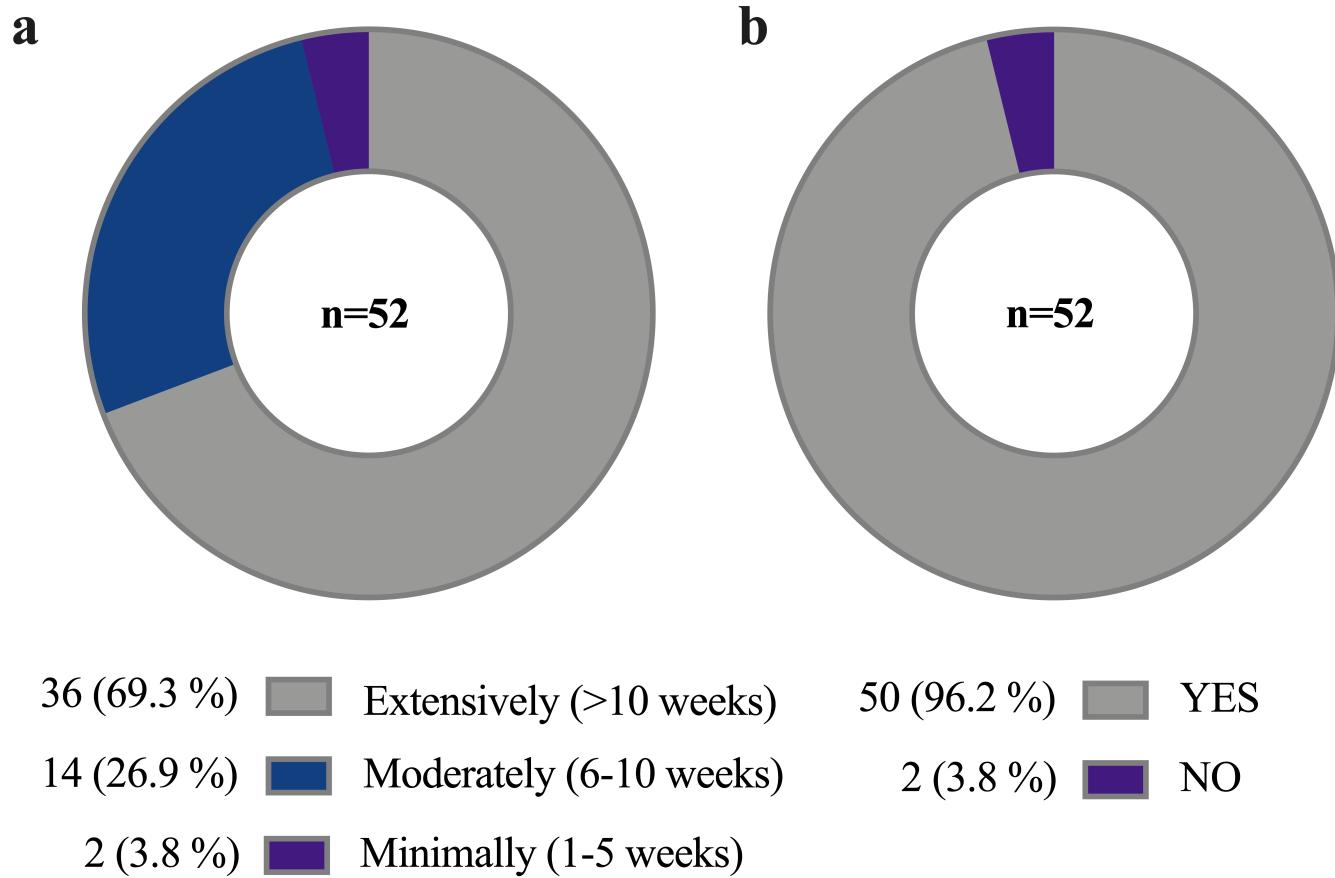
## **References**

1. Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. *Acta Biomedica*. 2020; doi:10.23750/abm.v91i1.9397.
2. He X, Lau EHY, Wu P, Deng X, Wang J, Hao X, et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. *Nat Med*. 2020; doi.org/10.1038/s41591-020-0869-5
3. World Health Organization (WHO). Coronavirus disease (COVID-19). 2020. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>. Accessed 8 Aug 2020.
4. Almeida F. Exploring the Impact of COVID-19 on the Sustainability of Health Critical Care Systems in South America. *Int J Heal policy Manag*. 2020; doi:10.34172/ijhpm.2020.116.
5. Amariles P, Granados J, Ceballos M, Montoya CJ. COVID-19 in Colombia endpoints. Are we different, like Europe? *Res Soc Adm Pharm*. 2020; doi:10.1016/j.sapharm.2020.03.013.
6. Instituto Nacional de Salud (INS). COVID-19 Colombia. 2020. <https://www.ins.gov.co/Noticias/Paginas/Coronavirus.aspx>. Accessed 8 Aug 2020.
7. Ministerio del Interior de Colombia. Decreto 457 de 2020: Por el cual se imparten instrucciones en virtud de la emergencia sanitaria generada por la pandemia del Coronavirus COVID-19 y el

- mantenimiento del orden público. 2020. <https://www.mincit.gov.co/prensa/noticias/general/decreto-457-mediante-el-cual-se-imparten-instrucciones>. Accessed 8 Aug 2020.
8. Nicola M, Alsafi Z, Sohrabi C, Kerwan A, Al-Jabir A, Iosifidis C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. International Journal of Surgery. 2020; doi:10.1016/j.ijsu.2020.04.018.
  9. Viner RM, Russell SJ, Croker H, Packer J, Ward J, Stansfield C, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. The Lancet Child and Adolescent Health. 2020; doi.org/10.1016/S2352-4642(20)30095-X.
  10. United Nations Educational Scientific and Cultural Organization (UNESCO). Education: From disruption to recovery. 2020. <https://en.unesco.org/covid19/educationresponse>. Accessed 8 Aug 2020.
  11. SCImago. SCImago Institutions Rankings. 2020. <https://www.scimagojr.com/institution.php?idp=1953>. Accessed 8 Aug 2020.
  12. Universidad Nacional de Colombia. UNAL en un vistazo. 2020. <http://estadisticas.unal.edu.co/home/>. Accessed 8 Aug 2020.
  13. Universidad Nacional de Colombia. Programas de Admisión Especial. 2020. <http://www.bienestar.unal.edu.co/sistema-de-bienestar/educacion-inclusiva/programas-de-admision-especial/>. Accessed 8 Aug 2020.
  14. Varghese J, Faith M, Jacob M. Impact of e-resources on learning in biochemistry: First-year medical students perceptions. BMC Med Educ. 2012; doi:10.1186/1472-6920-12-21.
  15. Prakash SS, Muthuraman N, Anand R. Short-duration podcasts as a supplementary learning tool: Perceptions of medical students and impact on assessment performance. BMC Med Educ. 2017; doi:10.1186/s12909-017-1001-5.
  16. Estévez Ceballos J, Castro Martínez J, Rodriguez Granobles H. La educación virtual en Colombia: exposición de modelos de deserción. Apert Rev Innovación Educ. 2015; ISSN 2007-1094.
  17. Rodríguez Albor G, Gómez Lorduy V, Ariza Dau M. Calidad de la educación superior a distancia y virtual: un análisis de desempeño académico en Colombia. Investig Y Desarro. 2014; ISSN 2011-7574.
  18. United Nations Educational, Scientific and Cultural Organization (UNESCO). Apoyar a los docentes y al personal educativo en tiempos de crisis. 2020. [https://unesdoc.unesco.org/ark:/48223/pf0000373338\\_spa?posInSet=1&queryId=6039d913-4495-4f39-a427-45e0c3c15b8f](https://unesdoc.unesco.org/ark:/48223/pf0000373338_spa?posInSet=1&queryId=6039d913-4495-4f39-a427-45e0c3c15b8f). Accessed 8 Aug 2020.
  19. Bobek E, Tversky B. Creating visual explanations improves learning. Cogn Res Princ Implic. 2016; doi:10.1186/s41235-016-0031-6.
  20. Milner RE. Learner differences and learning outcomes in an introductory biochemistry class: Attitude toward images, visual cognitive skills, and learning approach. Biochem Mol Biol Educ. 2014; doi:10.1002/bmb.20658.

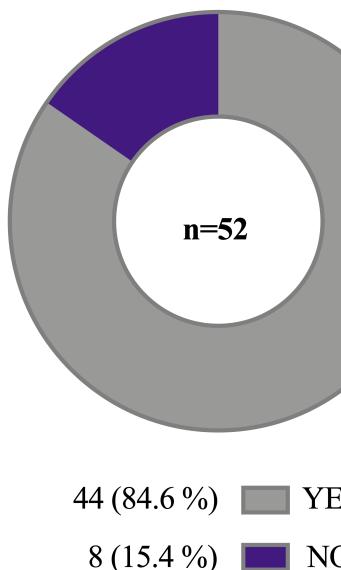
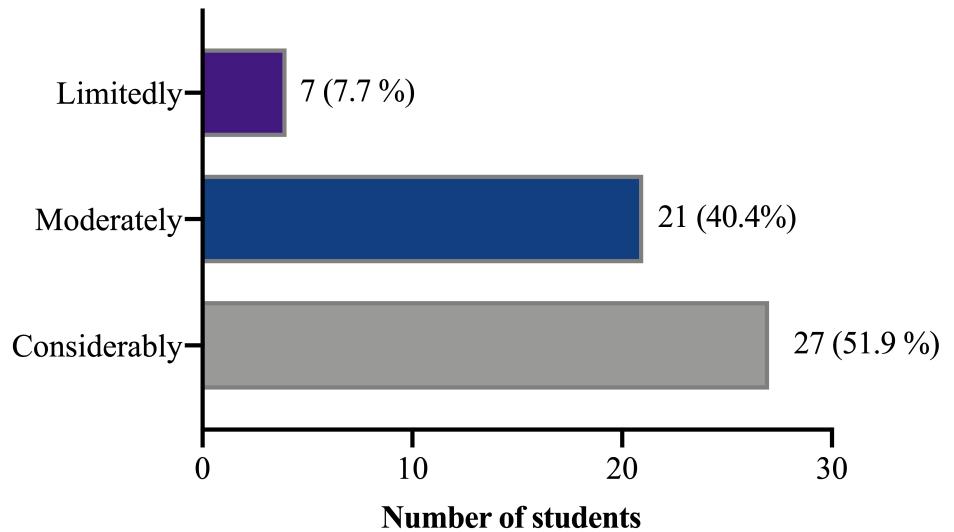
21. Rueda Ramírez SM, Urrego Velásquez D, Páez Zapata E, Velásquez C, Hernández Ramírez EM. Perfiles de riesgo de deserción en estudiantes de las sedes de una universidad colombiana. Rev Psicol. 2020; doi.org/10.18800/psico.202001.011.
22. Gao Z, Xu Y, Sun C, Wang X, Guo Y, Qiu S, et al. A systematic review of asymptomatic infections with COVID-19. Journal of Microbiology, Immunology and Infection. 2020; doi:10.1016/j.jmii.2020.05.001.
23. Kronbichler A, Kresse D, Yoon S, Lee KH, Effenberger M, Shin J II. Asymptomatic patients as a source of COVID-19 infections: A systematic review and meta-analysis. Int J Infect Dis. 2020; doi:10.1016/j.ijid.2020.06.052.

## Figures

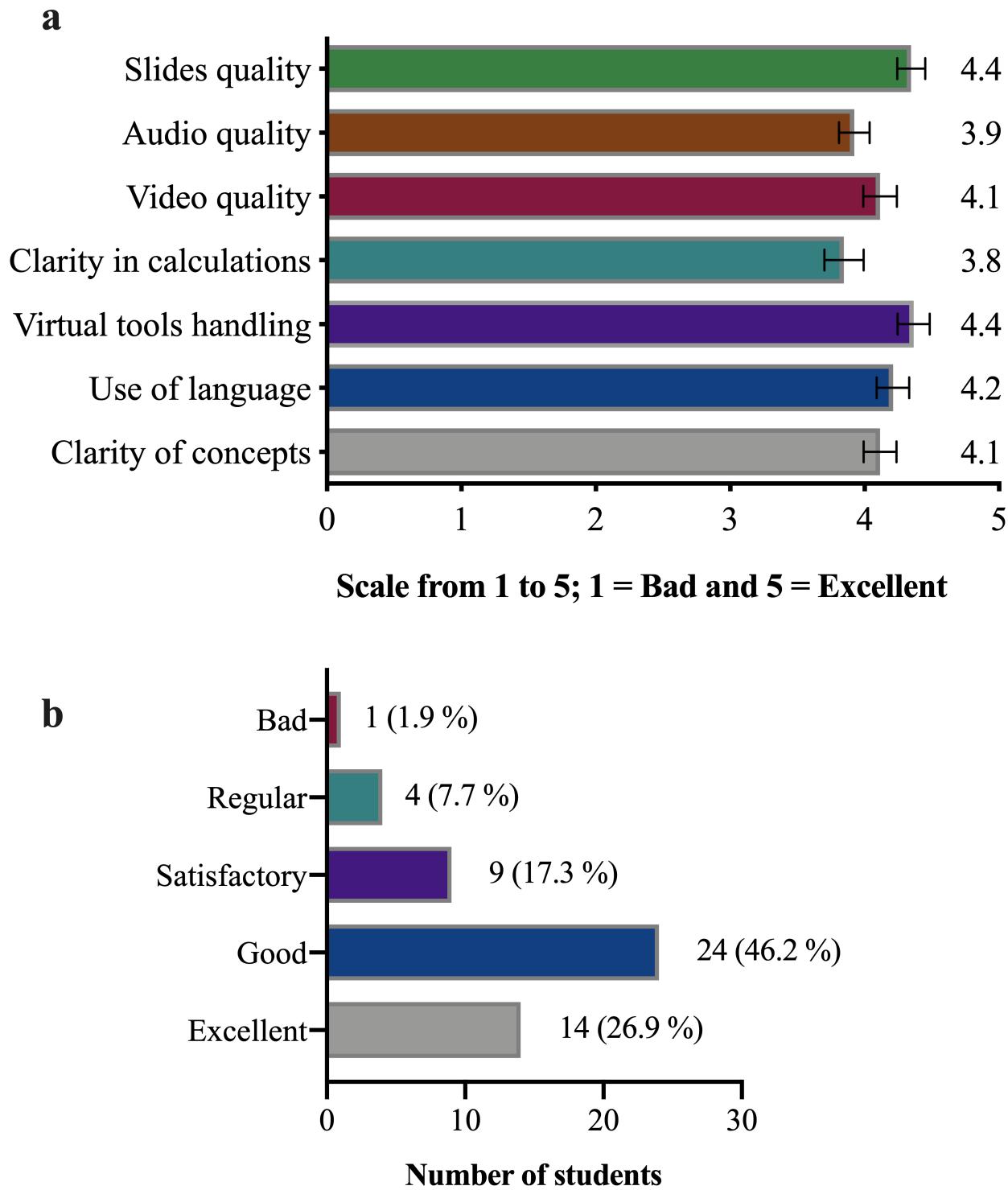


**Figure 1**

Attendance to remote classes and/or use of videos throughout the academic semester. Results obtained for the survey questions: a To what extent did you attend or use the videos of the remote classes during the semester? b In addition to attending the remote classes, did you use their videos again at any time during the semester to solve workshops, assignments, and/or review concepts?

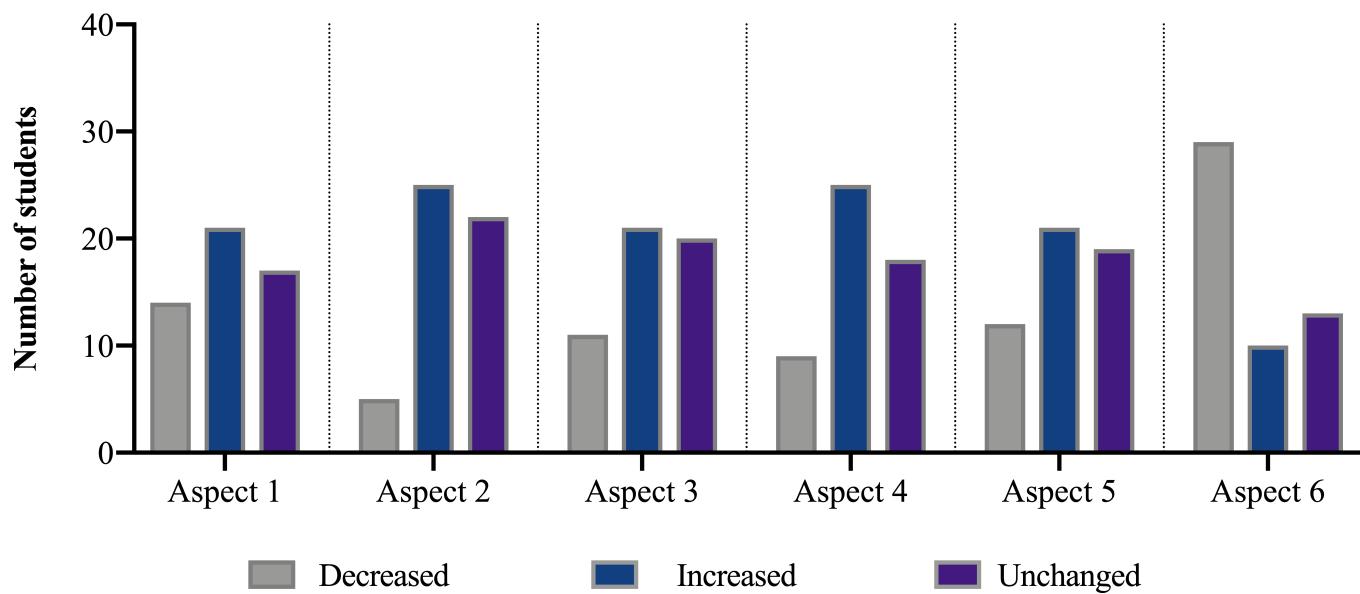
**a****b****Figure 2**

Simultaneous implementation of other educational resources during remote classes and their relationship with self-learning. Results obtained for the survey questions: a. During the development of the remote classes, did you simultaneously implement any other educational resource such as books or websites in order to complement the class topics? b. To what extent did the remote classes promote self-learning?



**Figure 3**

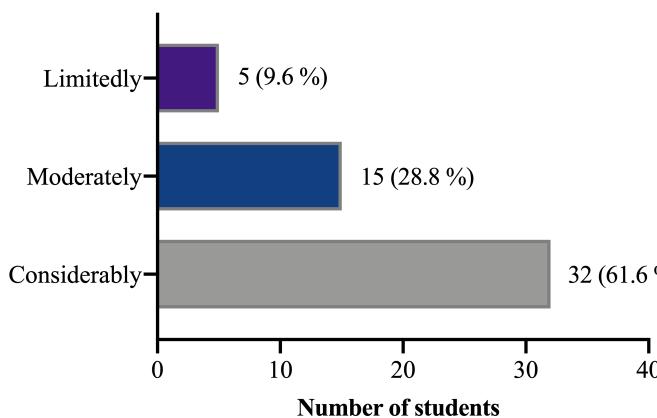
The quality of the remote classes was outstanding. Results obtained for the survey questions: a. On a scale of 1 to 5, where 1= Bad and 5= Excellent, how would you rate the following aspects of the remote classes and / or their videos? Data is reported as the average  $\pm$  SEM of two independent surveys. b. How would you rate the quality of the remote classes and/or their videos?



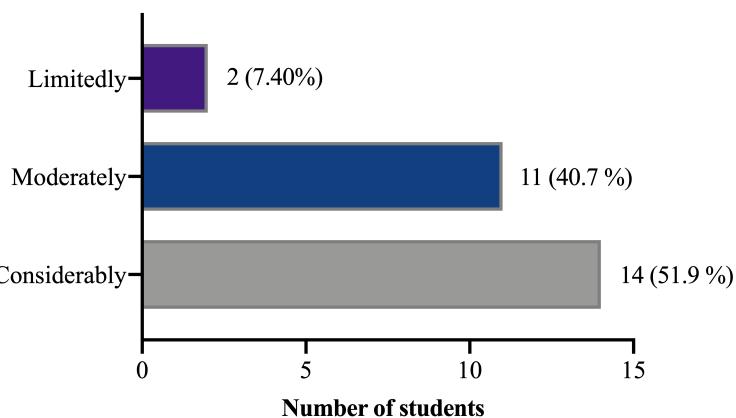
**Figure 4**

The remote classes impacted on different learning aspects. Results obtained for the survey question: Indicate how the remote classes and / or their videos impacted the following aspects as a student of the theoretical biochemistry course: Aspect 1: Your motivation regarding the course; Aspect 2: Your interest in biochemistry; Aspect 3: Your understanding of the topics developed during the semester; Aspect 4: Your ability to solve workshops, assignments, quizzes, and/or partial exams; Aspect 5: Your ability to follow the development and completion of the course remotely; Aspect 6: Your level of concentration or attention during the course.

a



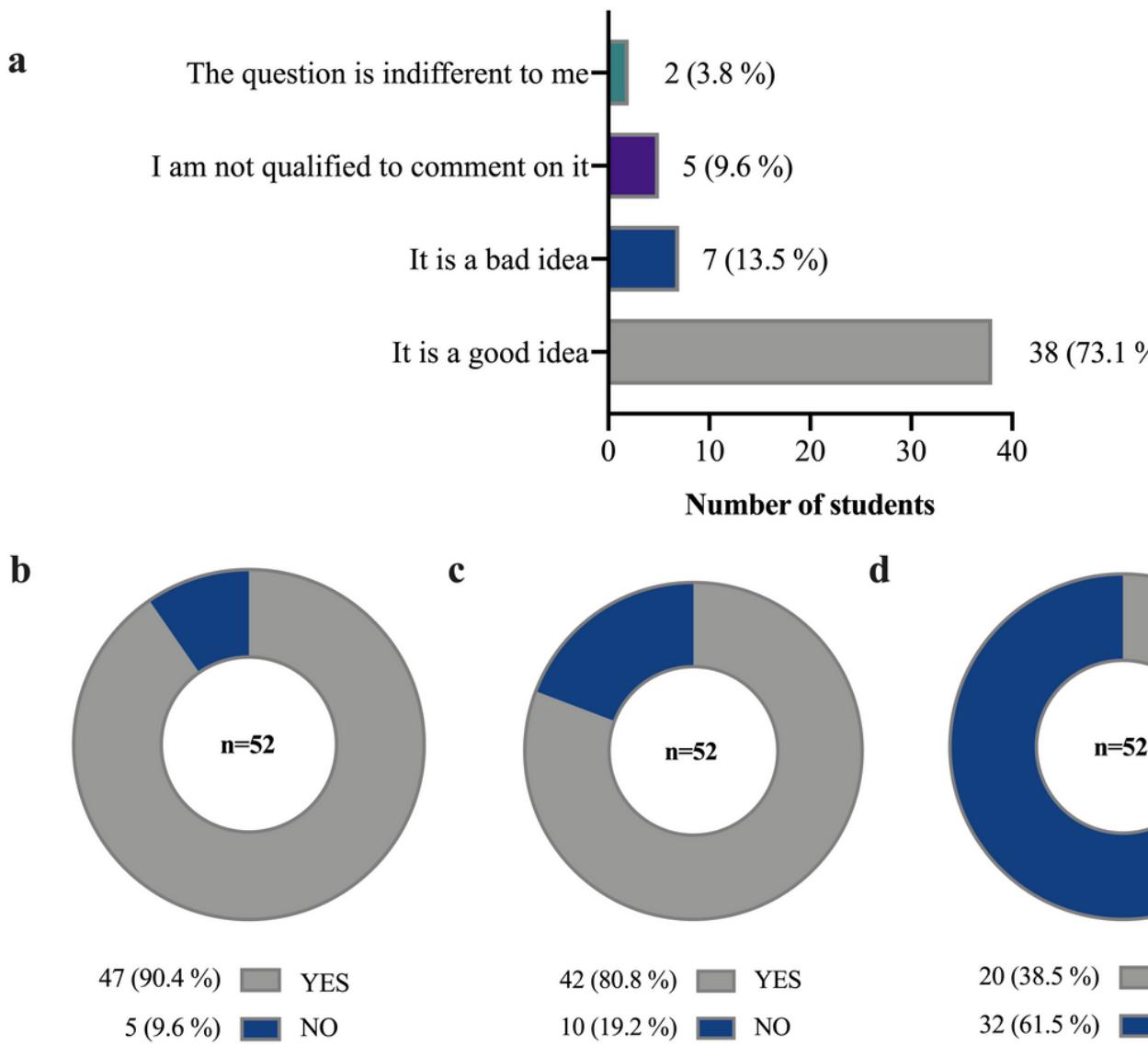
b



**Figure 5**

The remote classes contributed to the learning process of the course topics. Results obtained for the survey questions: a. To what extent do you consider that the remote classes of the theoretical course in biochemistry contributed to learning the topics? (n=52). b. If you are a repeater student of the

biochemistry course and in comparison to the non-virtual modality you have previously attended, to what extent do you consider that you benefited from the remote classes and / or their videos? (n=27).



**Figure 6**

The remote classes are a satisfying learning tool. Results obtained for the survey questions: a. At the end of the biochemistry course, what is your opinion on the implementation of remote classes? Choose the option that best suits your current thinking. b. Should the remote classes of the theoretical course in biochemistry continue to be held in the state of pandemic by COVID-19 or any other reason for confinement? c. Would you repeat the theoretical biochemistry course through the virtual learning modality? d. Would you prefer to study the biochemistry course remotely instead of through non-virtual classes?

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Additionalfile1.docx](#)