



LEGAL PERCEPTION OF THE QUALITY OF VIRTUAL PHYSICS CLASSES IN STUDENTS OF THE TECHNICAL UNIVERSITY OF MANABÍ -ECUADOR

¹MARÍA JACQUELINE PITA ASAN, GRACIELA JAQUELINE MENDOZA SOLORZANO, CLIDER DE JESÚS GUILLEN, ORLANDO AYALA PULLAS

¹María Jacqueline Pita Asan, Universidad Técnica de Manabí, Facultad de Ciencias Básicas
maria.pita@utm.edu.ec <https://orcid.org/0000-0003-2095-6096>

²Graciela Jaqueline Mendoza Solorzano, Universidad Técnica de Manabí, Facultad de Ciencias Zootécnicas
graciela.mendoza@utm.edu.ec <https://orcid.org/0000-0003-2324-4094>

³Clider de Jesús Guillen, Universidad Técnica de Manabí, Facultad de Ciencias Zootécnicas
clider.guillen@utm.edu.ec
<https://orcid.org/0000-0002-9529-6371>

⁴Orlando Ayala Pullas, Universidad Técnica de Manabí, Facultad de Ciencias Zootécnicas
orlando.ayala@utm.edu.ec <https://orcid.org/0000-0001-7675-7825>

Abstract

The objective of this study was to determine the opinions of students in the Food Engineering, Mechanical Engineering, Industrial Engineering, Electrical Engineering, and Chemical Engineering programs at the Technical University of Manabí on the virtual teaching of Physics that took place during the 2020-2022 period due to the COVID-19 pandemic. To accomplish this, a questionnaire consisting of 14 closed questions and two open questions was completed by 197 students. The results revealed that the majority of students had a negative view of the distance teaching of Physics, particularly regarding problems related to the home environment, connectivity issues, lack of communication between teachers and students, reduced concentration, and a decrease in experimental activities. However, several students also identified positive elements of distance education, particularly related to the teaching of Physics on general topics. These positive elements included increased use of audiovisual material, which contributed to understanding of Physics concepts and processes, and could be adopted more broadly in Physics education, not only in distance learning.

Keywords: virtual education, Physics, student perceptions.

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1. Introduction

The COVID-19 pandemic has affected education at all levels since its first appearance. According to 191 countries have taken measures to universally suspend face-to-face learning in all levels of education, affecting 1.5 billion students.

The suspension of face-to-face education was accompanied by a combination of synchronous and asynchronous distance education. Although distance education has been an effort to ensure the continuity of the learning process, a series of problems emerged, mainly related to the quality of the learning process. Most of the difficulties were related to internet access, lack of the conditions that existed in the family environment of students and teachers, the inherent difficulties of laboratory courses such as science courses, as well as the difficulties that students face in terms of self-discipline



and motivation .

Ecuador is one of the countries with the longest and uninterrupted period of school closure both in basic and university education. Especially in terms of higher education institutions, they were closed from March 19, 2020 until May 20, 2021, although to this day many higher education institutions have started to adopt virtual classes .

In this study, the perceptions of the quality of virtual Physics classes are investigated in students at the Technical University of Manabí. The COVID-19 pandemic posed a rapid transition from face-to-face teaching to the use of technology for online teaching. Both teachers and students faced the challenge of distance education without specific preparation or curriculum adaptation. In this context, the opinions of students are important, as they are the participants and receivers of the whole situation and have not been deeply investigated

2. Literature Review

Distance education is a term that encompasses various educational approaches based on the use of technology and differs from face-to-face education because students and the teacher are not in a physical classroom . Synchronous distance learning refers to the type of education in which individuals involved in the learning process interact at the same time, either in different places, through digital . An important component of synchronous distance learning is the students' commitment to the learning process and interaction between them Student engagement in the learning process is directly dependent on interaction. As a result, there is a strong concern for distance learning, especially in terms of the lack of live interaction between teachers and students. This concern has led many researchers to investigate effective practices for keeping students constantly engaged in the learning process in a distance learning environment .

Active student participation in the distance learning process is related to peer relationships, student-teacher relationships, and student motivation, such as scores and grades. In addition, during COVID-19, related research revealed and highlighted several challenges in distance education, such as difficulties in internet access, lack of infrastructure, classroom management, teacher and student behavior, and lack of distance education training .

Although there is a lot of literature investigating aspects of distance learning, there is not enough research on students' opinions about distance teaching, particularly in physics classes. If emergency remote instruction during the 2020-2021 academic year is considered worldwide, and in Ecuador, in particular, it is worth exploring students' opinions and the factors that justify these opinions.

1. Material and Methods

In order to give relevance to our research, we have formulated the following research question: What are the perceptions of the quality of virtual Physics classes among students at the Technical University of Manabí? Specifically, the question about students' opinions on the following axes is analyzed:

- a) The quality of interconnection and general conditions in students' home environment,
- b) The content of the subject matter,
- c) Teacher-student and student-student communication and teaching practices, and
- d) Personal commitment and involvement of each student during distance Physics teaching.

Data Collection

The authors created a questionnaire that was used as a research tool, which contained 14 closed-ended questions on a Likert scale of 1-5 or 1-3 and two open-ended questions to highlight the qualitative characteristics of the research. The questions (items) were created and structured into four categories, according to the aforementioned axes, from which the research questions were analyzed:

- a) The quality of the interconnection and general conditions in the students' home environment (three questions),
- b) The content of the subject (three questions),
- c) Teacher-student and student-student communication and teaching practices (five questions), and



d) Personal commitment and participation of each student during distance physics education (five questions).

The questionnaire was created digitally and distributed electronically accompanied by a letter to the students and teachers. The students answered the questions anonymously, outside of class hours. As for the validity of the questionnaire, it is provided by the fact that all questions are related to the students' vision of distance physics education and teaching (content validity) and vice versa, the questionnaire includes all aspects of distance physics education and teaching since they are classified into the four categories mentioned above. In addition, the questionnaire was thoroughly approved by two experts, experienced university physics professors in distance education environments. Both agreed on the content validity of the sixteen items, which means that on a 4-point scale (1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, and 4 = very relevant), they both gave a rating of 3 or 4. As a result, the sixteen elements had a content validity index of 1.00. Regarding the content validity index for the entire scale, which is the proportion of items rated 3 or 4 by the two involved experts, it was calculated as 1.00. Finally, clear instructions were followed, written for university students, explaining in detail how to complete the questionnaire.

Data analysis

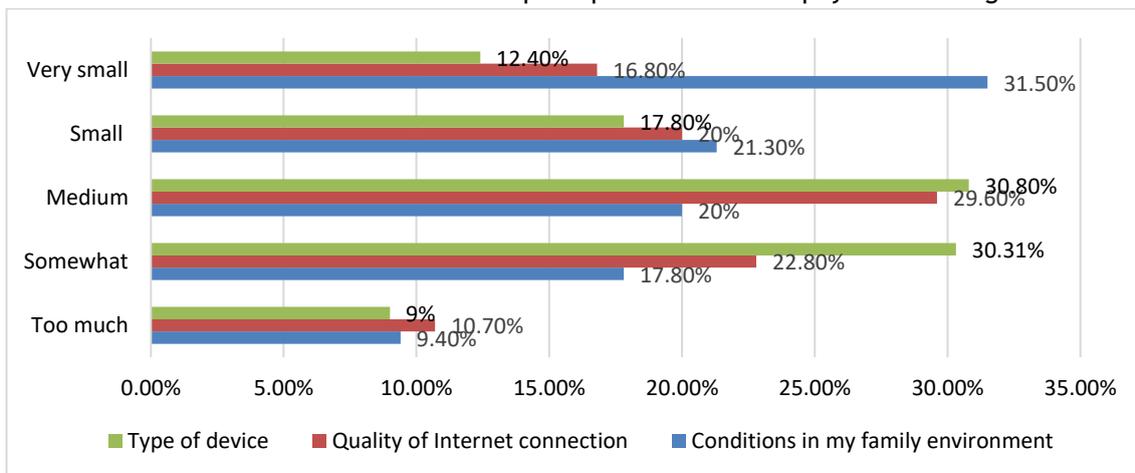
Closed-ended questions were sorted according to predetermined response ratings for each question and recorded in tables. As for open-ended questions, a qualitative content analysis method was used to analyze the data .

Participants' responses to open-ended questions were the units of content. After indexing the students' responses, the material was worked through and codes were formulated, converting large masses of data related to what university students liked most and least about distance learning and teaching of Physics into smaller and more manageable segments.

Texts for analysis were handed over to a second coder along with analytical rules, such as units, coding agenda, category definition, and level of abstraction for inductive formation. Inductive categories were established by the two coders, with a Cohen's kappa coefficient of 0.8, which is adequate according to . Points of disagreement with the second coder were recorded by a third coder.

Quantitative analysis steps, such as percentages and descriptive statistics, helped quantify findings and provided a clearer picture of perceptions of the quality of virtual Physics classes among students at the Technical University of Manabí.

Graphics 1
Factors that affected students' perception of distance physics teaching.



Source: Own

The reliability of this research study was verified through the implementation of appropriate quality criteria: credibility, transferability, reliability, and confirmability. Peer review was used to enhance the credibility of the data analysis. Specifically, an impartial and qualified colleague reviewed and evaluated

the research methodology, emerging and final categories, and study findings. Transferability is established when researchers provide a complete and detailed description of the context, so that readers can make informed decisions about the applicability of the findings to other situations. As for reliability and confirmability, an external person reviewed and examined the process and data analysis to ensure that the findings are consistent and can be replicated.

Limitations

The data for this research was collected from a limited number of Physics university students from the Technical University of Manabí. The inherent bias of convenience sampling due to the underrepresentation of subgroups in the sample, does not allow for reliable inferences about the intended population.

2. Results

On the Quality of the Interconnection and General Conditions in the Students' Home Environment

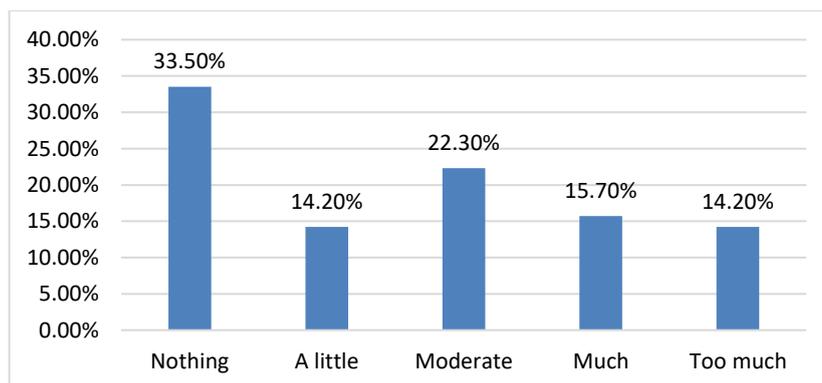
Students were asked whether the prevailing conditions in their home environment, the quality of their internet connection, and the type of device they used to connect had an impact on their perception of virtual Physics classes. Responses are presented in Figure 1. Among the three factors, the conditions of the home environment where the student attempted to connect to the online lesson had the greatest impact (39.3%), followed by connectivity issues (33.5%), and finally the type of device (27.2%).

On the Content of the Material

In Figure 2, students' opinions on how they differentiated the number of experimental activities during virtual learning compared to face-to-face Physics classes are presented. 33.5% of the students responded that the number of experimental activities had not changed at all. However, 14.2% of the students found small differences in the number of experimental activities, and 22.3% found that the number of experimental activities had changed moderately. Finally, almost 30% (15.7% and 14.2%) of the students found many differences in the number of experimental activities between virtual and face-to-face teaching.

Graphs 2

Evolution of the number of experimental activities during virtual Physics teaching.



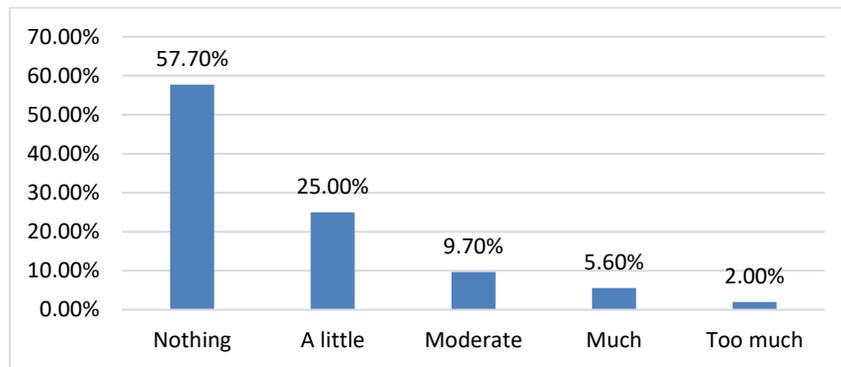
Source: Own

In graph 3, the opinions of university students are provided regarding how virtual teaching helped them participate in scientific practices such as formulating hypotheses and conducting experiments. The majority of respondents indicated that they agreed that virtual Physics teaching does not foster the development of their scientific practice skills ($\bar{X}=1$).



Graph 3

To what extent did virtual Physics teaching help you formulate and experimentally control your own hypotheses compared to in-person teaching?



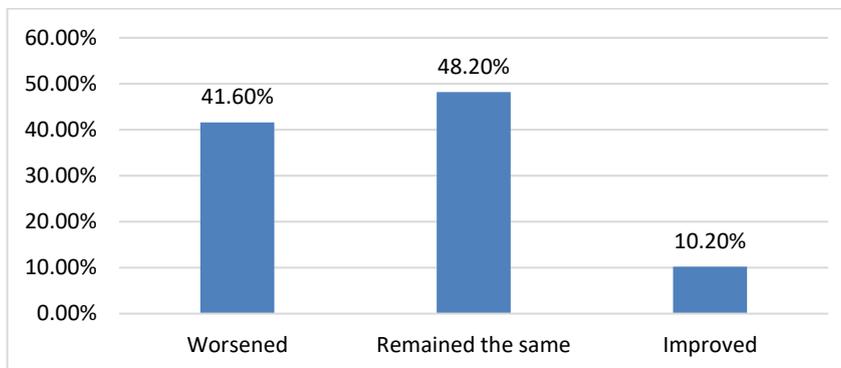
Source: Own

Regarding teacher-student and student-student communication and teaching practices

The graph includes responses from university students regarding teacher-student communication in virtual teaching compared to in-person teaching. The majority of students agree that communication remained the same ($\bar{X}=2$), while a significant portion of them consider that communication worsened.

Graph 4

Professor-student communication in the context of virtual physics teaching.



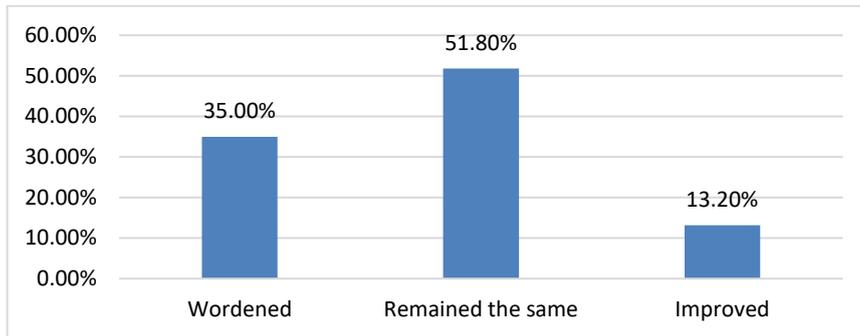
Source: Own

Graph 5 includes the opinions of students about communication with their classmates on topics related to the lesson. The results are similar to the previous question, revealing the agreement of the majority of students with the idea that communication remained the same ($\bar{X}=2$) while a significant part of them thinks that it worsened.



Graph 5

Student-to-student communication in the context of virtual Physics teaching.

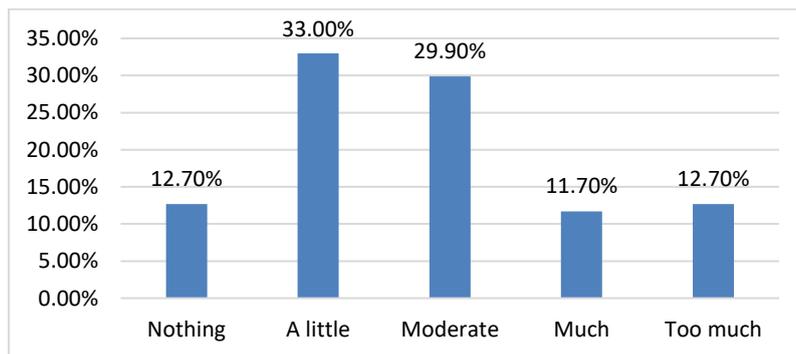


Source: Own

In Graph 6, the opinions of the students are presented on how different the teacher's teaching style was compared to face-to-face teaching. According to the students' responses, approximately 85% of the teachers differentiated their practices during virtual Physics teaching.

Graph 6

To what extent did teachers change their teaching practices during virtual physics teaching?

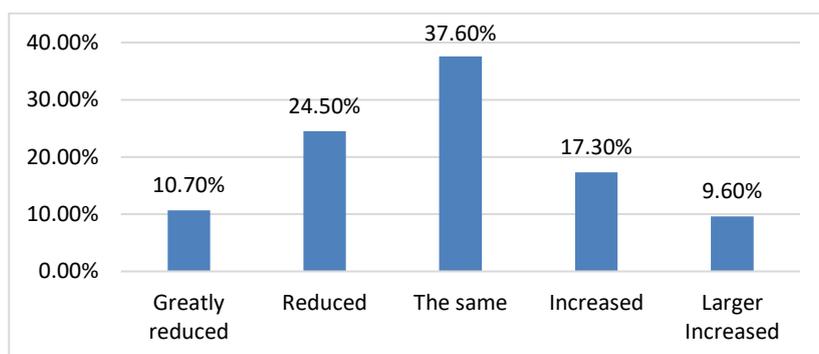


Source: Own

Graph 7: The amount of homework during virtual physics teaching compared to in-person teaching is shown in Graph 7. The majority of students believed that homework demands remained the same (37.6%) or decreased (35.6%).

Graph 7

Tasks in the context of virtual physics teaching.



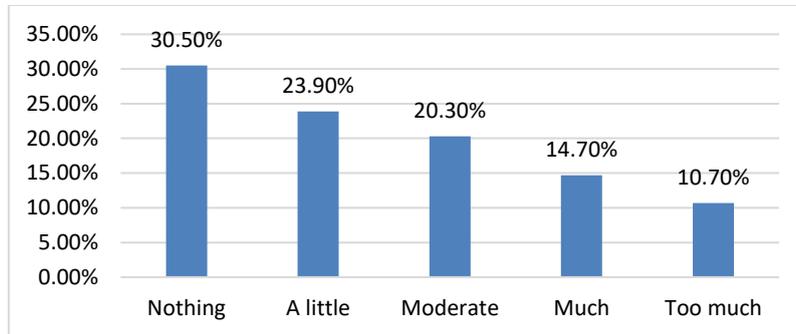
Source: Own

Graph 8 shows differences in the way teachers provide feedback to students during virtual classes

compared to in-person teaching. The majority of students seem to agree that the way teachers provide feedback remained the same or changed slightly ($\bar{X} = 2$).

Graph 8

Was the way of receiving feedback in virtual Physics lessons different from in-person lessons?



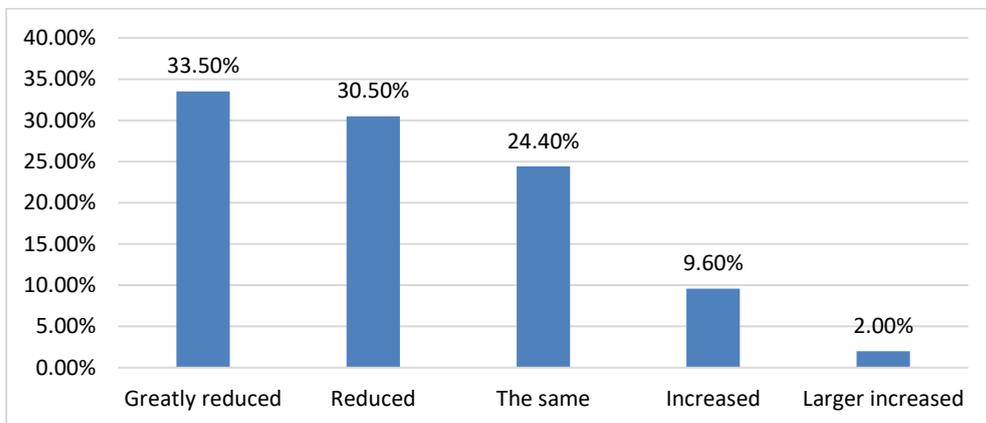
Source: Own

On the personal commitment of students during virtual Physics teaching.

In the fourth category of questions, students were asked about parameters of virtual Physics teaching, such as their concentration during the lesson (Graph 9) and understanding of new concepts (Graph 10). Most students reported that they could not concentrate during virtual teaching compared to in-person teaching ($\bar{X}=2$) and had low cognitive performance ($\bar{X}=2$). Finally, students were asked for an overall evaluation of virtual Physics teaching compared to in-person teaching (Graph 11). Students' responses reveal that the majority of them did not enjoy virtual Physics teaching ($\bar{X}=1$).

Graph 9

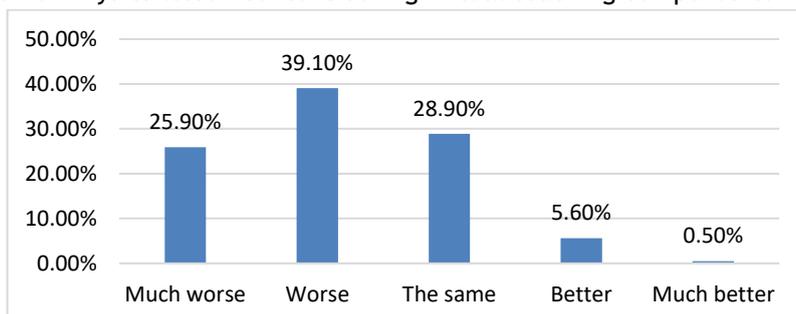
Student concentration during virtual teaching compared to in-person teaching.



Source: Own

Graph 10

Conceptualization of Physics lesson content during virtual teaching compared to in-person teaching

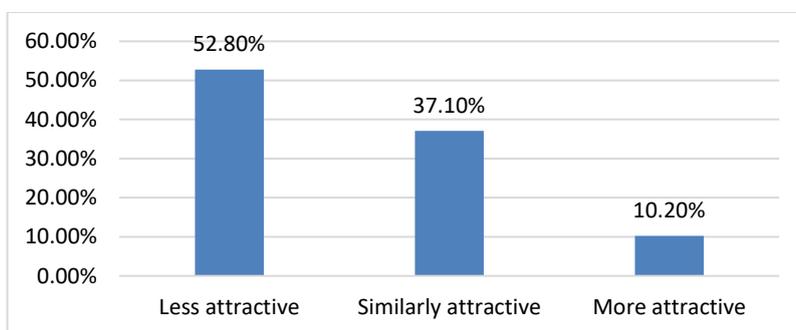




Source: Own

Graph 11

Global evaluation of virtual Physics teaching compared to face-to-face teaching.



Source: Own

Table 1

What did you like during virtual physics teaching?

Responses	Percentage
Audiovisual material (video, PowerPoint, etc.)	36.2%
Nothing	8.5%
Various facilities (shorter class time, no need for mask, comfort of home, no school commute)	13.0%
Communication via email with teachers	2.5%
Other	1.5%

Source: Own

Table 1 presents the students' responses to the question "what did you like the most during virtual Physics teaching," after indexing and categorizing. A percentage of 36.2% responded that they did not like anything during virtual Physics teaching, indicative of adolescent indignation towards the quarantine. A percentage of 38.2% of students reported that they liked the increased use of audiovisual material, such as video experiments, educational software, videos, presentations, images, etc. A percentage of 8% of students appreciated the teachers' efforts to cope with the difficult conditions posed by the COVID-19 pandemic and recognized that teachers were much more lenient. A percentage of 13% pointed out several advantages of virtual teaching, such as not needing to waste time traveling to the university. Finally, only 2.5% of students found it very interesting that they could ask questions after the lesson, through communication via email with the teachers.

Table 2

What did you not like during virtual physics teaching?

Responses	Percentage
Technical problems	23.1%
Weak communication between classmates and teachers	18.1%
Did not like anything	16.6%
Ineffective teaching just to cover the material	12.6.5%
Weak concentration	10%
Various issues (exam format, constant noise from some classmates, too much homework, etc.)	9%
Lack of experiments	8.5%
Liked everything	4.6%
No response	0.5%

Source: Own



Table 2 presents the students' responses to the question "what did you not like during virtual physics teaching?" as formatted after indexing and categorization. A percentage of 13.6% of students responded that they did not like anything, while 4.6% of students stated that they "liked everything." A significant percentage of students (23.1%) reported experiencing technical problems with their Internet connection, while 18.1% considered the lack of communication with teachers and classmates and the lack of classroom atmosphere to be a major disadvantage.

A percentage of 12.6% referred to ineffective teaching practices, with the main symptom being the acceleration of pace solely to cover the curriculum rather than prioritizing learning and familiarization with natural phenomena under consideration. Ten percent (10%) reported having difficulty concentrating, either due to personal weakness or because "the lesson is boring," while 9% noted several aspects of virtual education that they did not like, such as exam format, amount of homework, and continuous disruptions during class by different students. Only 8.5% expressed dissatisfaction with the lack of experiments and educational visits.

3. Discussion

The study demonstrated the perceptions of the quality of virtual Physics classes among students at the Technical University of Manabí, organized into four categories. With respect to the first category, which relates to technical difficulties and conditions in the students' home environment, the students expressed their concerns accordingly in the context of open-ended questions, where technical issues appeared to be one of the main disadvantages of virtual education. According to one student's response, "It was really bad not being able to hear or be heard due to a weak connection." Some of them also attributed the lack of student-student and student-teacher communication to connection problems: "Communication with classmates was limited, mainly due to poor connection." These findings are in line with research on teachers' opinions on virtual education in the context of the COVID-19 pandemic .

Regarding the second category, the subject matter content, the students found that the number of experimental activities had not changed at all or had changed moderately, implying that they may not do experiments in face-to-face Physics classes either. Students were not encouraged to participate in scientific practices such as hypothesis formation and experiment implementation. Analysis of open-ended questions revealed students' dissatisfaction with the weak existence of scientific practices and experimentation in class. On the other hand, students noted the increased use of audiovisual material as a positive aspect of virtual education, which is consistent with similar research on virtual science education in higher education .

The fact that experimental activities are reduced while the use of audiovisual material is increased suggests that audiovisual material may have been used in a rather passive manner and not in active participation in electronic class consultations to improve experimental procedures. Regarding communication, it appears that virtual teaching deprives students of exchanging views, asking questions, and giving clarifications, i.e., all the elements that provide immediacy in the classroom. These findings are in line with students' responses in open-ended questions (Table 2), where the lack of communication stands out as the second most popular negative aspect of virtual Physics teaching.

Analysis of open-ended questions shows that students recognized their teachers' efforts to cope with the difficult situation of the COVID-19 pandemic but at the same time perceived that communication and concentration were weak at all levels. Overall, it seems that virtual teaching did not foster communication between teachers and students or among students.

Furthermore, students' responses reveal teachers' persistence in traditional practices regarding feedback provision, which is related to the fact that teachers lack sufficient knowledge and experience in virtual education to adapt to new conditions. These findings are consistent with relevant research on teachers' opinions and their need for training in virtual education .

Regarding students' personal commitment during virtual Physics teaching, there was a clear trend in all responses, showing that most students had much lower concentration in remote class as they did not consider it to be an appropriate educational environment to concentrate in. Findings in the conceptualization of Physics are similar to concentration, as it seems that the achievement of cognitive objectives of the Physics lesson failed largely.

This failure can be attributed to the problems posed in the previous questions. Such problems include



lack of concentration due to inappropriate home environment, weak communication between teacher and students, as well as technical problems. The finding is confirmed through students' responses to an open question about "what they did not like": "The lesson is like the goal is to cover the material. Usually, I don't understand what it's about." What students expressed in their own words is a need for curricular adaptation for the didactic material to make sense.

These findings deserve the attention of the scientific community, as some of them, such as the inadequacy of students' family environment to participate in remote classes and infrastructure-related issues, go far beyond educational research and lead to broader social inequalities. This finding is consistent with other research related to tertiary education, which shows that the shift to online education reinforced social inequalities .

Additionally, negative attitudes of students towards virtual education could be attributed to factors related to the COVID-19 pandemic rather than education itself, such as prolonged confinement at home and social isolation, expressed in statements such as "it was very boring" or "I was constantly tired on the computer." Such statements indicate the emotional and psychological.

4. Conclusions

The aim of this study was to determine the perceptions of the quality of virtual Physics classes among students at the Technical University of Manabí. The findings revealed that students had a mainly negative view of remote Physics class. Their viewpoint seemed to be influenced by the prevailing conditions in their home environment and technical problems that occurred in internet connectivity, lack of communication among peers and the teacher, and reduced experimental activities. However, several students found and pointed out some positive elements of the long period of virtual education that referred either to Physics teaching or to other general subjects. Such positive elements are the increased use of audiovisual material, which helped in the understanding of Physics concepts and processes, and which could be adopted in Physics teaching more widely, and not just in virtual education.

The study indicated that the challenges of virtual Physics teaching for university students are similar to the challenges of virtual education in general. Therefore, it cannot be considered in isolation from the context of virtual education in Ecuador due to the COVID-19 pandemic. Although it was expected that students would primarily refer to the lack of experimentation and teacher-centered teaching practices as the main problems, the main problems of students with virtual Physics teaching were more general, such as conditions in their home environment, poor connectivity issues, and lack of communication among teachers and students, as well as among students themselves. These problems reinforce social inequalities and demand the adoption of policies that optimize the inclusive use of online education.

Although the sample was limited and convenient, the findings call for further research on the opinions of science teachers on virtual teaching, how they faced corresponding challenges, and what kind of virtual education training they found important. Additionally, the findings call for further research on the opinions of students from different socio-cultural backgrounds, as it seems that the great dissatisfaction of students arose from issues that were not so much related to the teacher and the process but to student infrastructure. Finally, student opinions call for further research on the adaptation of science curricula to virtual modalities so that virtual teaching leads to learning effects of fully remote learning.

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