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# Telehealth and surgical teaching: creation of an open-access surgical multimedia repository

# Telesalud y enseñanza de la cirugía: creación de un repositorio multimedia quirúrgico de acceso libre

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**Summary:**

Telehealth was the mandatory option in medical education worldwide due to the suspension of face-to-face education, the risk of COVID-19 infection, and the lockdowns imposed by governments to control the pandemic. The purpose of this interventional research study was to understand the experiences of surgery students and faculty with Telehealth (e-Health) as a teaching strategy during the COVID-19 pandemic, as well as the creation of digital learning objects (DLOs) consisting of surgical videos designed according to the precepts of the Multimedia Cognitive Learning Theory (MCTL) and a freely accessible surgical multimedia digital repository to host them: VídeoTec Quirúrgica UNAH 101 (VTQ UNAH 101). A pilot study was conducted, and semi-structured interviews were conducted with the participants (qualitative) after the design and creation of the DLOs based on the learning objectives of the pedagogical space. The inductive analysis of the participants' discourse with axial coding showed wide acceptance among students (96%) and teachers in the use of digital tools and contents of telehealth for blended learning (hybrid, b-learning), as well as the surgical multimedia digital repository VTQ UNAH 101. An increase was evident in the course approval rate (16%), academic performance (3.8%) and student satisfaction and motivation with VTQ UNAH 101 as a teaching resource (Cohen h = 0.38 and a Bayesian analysis of 92% probability of improvement), so it is concluded that VTQ UNAH 101 is a viable and effective alternative to complement academic training in surgery; However, the generalization of its impact requires replication in larger populations and in other faculties of Health Sciences.

**Keywords:** Blended learning, COVID-19 , multimedia teaching, digital learning objects, educational technology.

**Resumen:**

La telesalud fue la opción obligada en educación médica a nivel mundial debido a la suspensión de la educación presencial, el riesgo de infección por COVID-19 y los confinamientos impuestos por los Gobiernos para controlar la pandemia. El propósito del presente estudio de investigación-intervención fue conocer las experiencias de estudiantes y docentes de cirugía con la Telesalud (e-Health ) como estrategia didáctica durante la pandemia de COVID-19 así como la creación de objetos digitales de aprendizaje (ODAs) consistentes en vídeos de cirugías diseñados según los preceptos de la Teoría Cognitiva del Aprendizaje Multimedia (TCAM) y un repositorio digital multimedia quirúrgico de acceso libre para alojarlos: vídeoTec Quirúrgica UNAH 101 (VTQ UNAH 101). Se realizó estudio piloto y aplicaron entrevistas semiestructuradas a los participantes (cualitativo) tras el diseño y creación de los ODAs basados en los objetivos de aprendizaje del espacio pedagógico. El análisis inductivo del discurso de los participantes con codificación axial mostró amplia aceptación entre los estudiantes (96 %) y docentes en la utilización de herramientas y contenidos digitales de la telesalud para aprendizaje semipresencial (híbrido , b-learning), asi como

al repositorio digital multimedia quirúrgico VTQ UNAH 101. Se evidenció un aumento en el índice de aprobación del curso (16 %), el rendimiento académico (3.8 %) y la satisfacción y motivación de los estudiantes con VTQ UNAH 101 como recurso didáctico ( Cohen h=0.38 y un análisis bayesiano de 92% de probabilidad de mejora ) por lo que se concluye que VTQ UNAH 101 es una alternativa viable y efectiva para complementar la formación académica en cirugía; no obstante, la generalización de su impacto requiere replicación en poblaciones mayores y en otras facultades de Ciencias de la Salud.

**Palabras clave:** Aprendizaje semipresencial, COVID-19, enseñanza multimedia, objetos digitales de aprendizaje, tecnología educacional.

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## 1. Introduction

Medical students at the Faculty of Medical Sciences of the National Autonomous University of Honduras (FCM-UNAH), like surgery students worldwide, suffered varying degrees of disruption in their teaching-learning processes due to prolonged quarantines and government-imposed lockdowns to control the transmission of COVID-19. This led to an abrupt cessation of patient contact and the absence of clinical practice in wards and operating rooms due to a lack of personal protective equipment (PPE) and adequate biosafety conditions. Telehealth, in its tele-education component, was the mandatory global strategy to continue the teaching-learning process in medical education at least during the early stages of the pandemic. Hence, it is important to evaluate student and faculty perceptions of Telehealth as a teaching strategy to ensure the quality of medical training.

The bibliometric analysis in the Scopus database for the years 2020 and 2021 carried out by Boom (1) showed a high frequency of appearance of the key terms COVID-19 , medical education and pandemic, finding the Health area as the second in frequency of scientific publications and evidencing an increase in the relevance of these terms as a result of the health crisis. Additionally, Ahmet *et al* . (2) in their bibliometric review in different electronic databases prior to the pandemic concluded that video-based education has the potential to improve surgical education by improving training time, learning duration, acquisition of surgical skills and student satisfaction; therefore, they recommend the use of videos in addition to standard training techniques to improve learning when students face significant barriers in their learning.

The present research-intervention study aimed to know the experiences of UNAH surgery students and teachers (undergraduate) of the Surgery I pedagogical space (Cl 205) with Telehealth as a teaching strategy during the first years of the pandemic (2021 and 2022), at the same time that digital learning objectives (ODAs) were created following the precepts of the Cognitive Theory of Multimedia Learning ( TCAM) that complemented the academic training of surgery students who did not have the opportunity to attend the operating room due to the lack of freely accessible surgery videos to meet the learning objectives and that could be used by the entire virtual learning community. The videos were created from recordings of surgeries performed on patients at the INCP, following an instructional design aligned with the learning objectives of the Surgery I class (Undergraduate) of the Medicine degree, which were hosted in a digital repository called VTQ UNAH 101 with the purpose of stimulating multimedia learning, defined as "the learning (achieved) of words (spoken or written text) and images (illustrations, photos, maps, graphs, animation or video)" (3). Although there are previous studies that support the effectiveness of teaching surgery through face-to-face sessions with review of surgery videos and their subsequent discussion in institutions with limited resources (insufficient space in the operating room, overcrowding of students) (Shamim, 2018) (4), they have other approaches (quantitative), did not involve Telehealth tools (they preceded the COVID-19 pandemic) nor did they undertake the task of creating the videos following an instructional design or the principles of TCAM when using surgery videos hosted on the internet.

For all the reasons stated above, the study set the following objectives:

1. To characterize the experiences of the actors in the teaching-learning process (teachers and students) with Telehealth (e-Health) as a teaching strategy during the COVID-19 pandemic.
2. Create the surgical multimedia digital repository called VídeoTec Quirúrgica UNAH-101 (VTQ-UNAH 101) with surgical videos for the pedagogical space Cl 205 (Surgery I) of the UNAH Medicine program following the precepts of the TCAM.

## 2. Methods

The study design was qualitative, grounded or substantive theory (5). A pilot study was conducted to determine the feasibility of the study and ensure its credibility, dependability, and transferability. The universe consisted of 92 students who took the subject during the study period (2021 - 2022); the sample was non-probabilistic for convenience (6), made up of 20 students (21.7% of the universe) with an average age of 23 years (half of them female). The criteria for their selection were taking the subject with the researcher during the study period and agreeing to participate voluntarily. Likewise, all teachers (5) who taught the same subject were included within the sample. It is worth mentioning that since this is a qualitative study, a complete vision of the problem and the perceptions and feelings of the participants about the strategy were prioritized. Telehealth teaching. The researcher is a university professor with 19 years of experience teaching surgery and 20 years of experience in public and private clinical practice as a general surgeon. Participants received no incentives. The data collection instruments are described below:

- *Instrument 1.* Observation Guide. Prepared by the researcher, it recorded information on the development of the educational process throughout the study period.
- *Instrument 2.* Developed by the researcher, it contains 33 items designed to obtain information on the tools and resources used in Telehealth by students (11 items), teaching methods (11 items), and the impact of the pandemic on the educational process (5 items), among others. The format is accessible through the following link: https://unahedu-my.sharepoint.com/:w:/g/personal/luis_lozano_unah_edu_hn/EXQxAcVFAzRHg9FcEL7EbEMBj4-Mbfos7yOckxj8y7ICDQ?e=TnNTbO
- *Instrument 3.* Prepared by the researcher, it contains 20 items designed to obtain information on teachers' perceptions of the tools and resources used in Telehealth; accessible through the following link: https://unahedu-my.sharepoint.com/:w:/g/personal/luis_lozano_unah_edu_hn/EYLBGhZVorJDhqXOfxI7TS4BePeQ7HsEFJKkzIA4iR8mJw?e=WfX5R2

The instrument items emerged after identifying variables, identifying categories and subcategories, and then drafting them into open-ended questions that would allow for obtaining broad and in-depth information in accordance with the study objectives. Instruments 2 and 3 were validated by the INCP Ethics Committee to ensure the credibility, reliability, and transferability of the study. The instrument validation process consisted of a complete review of the research protocol, which included a theoretical and contextual review by the Committee to ensure the consistency of the instruments and their correlation with the research assumption and objectives, as well as the coherence, clarity, and relevance of the items through expert judgment. Modifications were made after the pilot test to obtain a final version.

In accordance with the research purposes, the study was developed through the following phases, which were interactive and recurrent:

1. *Phase 1.* Identification of the study problem, literature review and immersion in the field.
2. *Phase 2.* Design and execution of a pilot study, carried out in April 2022 and accessible through the following link: https://sway.cloud.microsoft/oOCgWKGUwAcNDiIo?

ref=Link . It ensured the technical feasibility and permits to carry out the research study (authorization from the Ethics Committee), and contains videos on the construction of the required equipment as well as the interview format for teachers and students with the questions asked. Design and creation of the ODAs and VTQ UNAH 101, which began in February 2022 and extended until August 2023. The ADDIE instructional design model (analysis, design, development, implementation and evaluation) was used. The techno-pedagogical design of VTQ UNAH 101 can be consulted at the following link: https://unahedu-my.sharepoint.com/:w:/g/personal/luis_lozano_unah_edu_hn/EbtNdBfBJChMnrN4xGbfsSAB7Bhr4z9njFtIul8y2F74eQ?e=itFxIi

1. *Phase 2.1. Analysis:* definition of learning objectives, target population and its characteristics (undergraduate surgery students), and the competencies to be achieved according to the curriculum.
2. *Phase 2.2. Design:* The design phase included a review of the criteria suggested by Kurilovas *et al.* (7) and taken up by Sangrà *et al.* (8) on the characteristics for creating a good learning resource: reliability of information, author identification, appropriateness of language and content validity, reusability and quality of instructional design, among others.
3. *Phase 2.3. Development:* Recording and editing of surgeries. Design of the technical literary script following TCAM principles: coherence (excluding superfluous material), signaling (labeling videos), segmentation (reducing video duration to less than 12 minutes), redundancy, and divided attention (integrating images and words), among others.
4. *Phase 2.4-5. Implementation and Evaluation:* Use of the ODAs created in a hybrid modality (in-person and virtual) and discussion of them based on the review of each of the medical topics (problems) studied according to the teaching plan. No quantitative evaluation (pre- and post-test) was carried out due to restrictions imposed by the institution during this phase of the pandemic, which prioritized formative evaluation over summative evaluation.

3. *Phase 3.* Instrument administration to participants. The interviews were conducted from October 2022 to March 2023 at the facilities of the INCP and the University Teaching Hospital (HEU) in Honduras.
4. *Phase 4.* Analysis of the information obtained and consolidation of results, carried out from January 2023 to August 2023.

The interviews were audio-recorded and transcribed into Microsoft Word for subsequent analysis using Atlas Ti 23® software. An axial inductive analysis was performed using telehealth as the primary category. Initially, 46 codes were identified, which were grouped into themes in the secondary analysis to establish relationships between them. Some of the themes were: academic impact, use and management of technological resources, teaching methods, and the impact of COVID-19 on the economic, emotional, academic, and social spheres. To view the complete list of codes and themes with their respective definitions and associated citations, see the following link: https://unahedu-my.sharepoint.com/:x:/g/personal/luis_lozano_unah_edu_hn/ESUdL7gmId5Cm7Fjai9cR5ABEIBti1B7YOigRLcYIPwmAQ?e=VORc0k .

Similarly, Microsoft Excel was used to tabulate students' academic performance indexes to determine their academic performance and passing rates and compare them across different study periods. Cohen's effect size and Bayesian probability were used for statistical analysis of the collected data.

The study was approved by the Ethics Committee of the INCP of Honduras (letter No. 003 CE-INCP-2022). Informed consent was obtained from the participants, ensuring protection and confidentiality in the handling of information. Its format is accessible through the following link: https://unahedu-my.sharepoint.com/:u:/g/personal/luis_lozano_unah_edu_hn/

EemXhZKkEc9Jog9F5sD8HA8B0qPIPLalGQpPnvQG2nk3uw?e=CV9AwT . Written permission was requested from the patients authorizing their surgeries to be recorded the day before the procedure, explaining the objectives of the study. The ODAs received approval from external peers (national and foreign surgeons) to ensure the validity of their content.

## 3. Results

### *3.1. Results of the Research Study*

Slightly more than half (52%) of the participants considered Telehealth solely from its educational component (tele-education), while the remaining 48% did so from its remote healthcare provision component (telemedicine). The blended or hybrid (b-learning) modality used to teach the class (approval rate for the hybrid modality, obtained by dividing the number of positive opinions by the total number of participant opinions multiplied by 100) was widely accepted among students (95%) and teachers (80%), noting the following advantages: optimization of study time, savings in financial resources, less physical fatigue, better self-management and organization of time, greater availability of digital learning resources, less stress due to not having PPE to evaluate patients during the pandemic, and greater flexibility of this modality in the face of abrupt interruptions of the educational process due to emerging situations (strikes, public demonstrations). The analysis of co-occurrences using Telehealth as an axial category reflected that the most used digital tools in decreasing order of frequency were applications (Apps), videoconferences, the UNAH Virtual Campus Moodle platform, social networks, forums and email (Table 1 and Figure 1).

**Table 1.** Co-occurrences of the Telehealth category with the most used tools and resources (content) **.**

| Tools and resources | Co-occurrences |
|---|---|
| Apps | 78 |
| Videoconference | 50 |
| UNAH Virtual Campus | 40 |
| Social networks | 23 |
| Forums | 17 |
| Surgery Videos (internet) | 34 |
| VTQ UNAH 101 | 33 |
| Clinical cases | 27 |
| Projects | 21 |
| Shared documents | 20 |

*Source* : prepared by the author based on information from Atlas ti 23.

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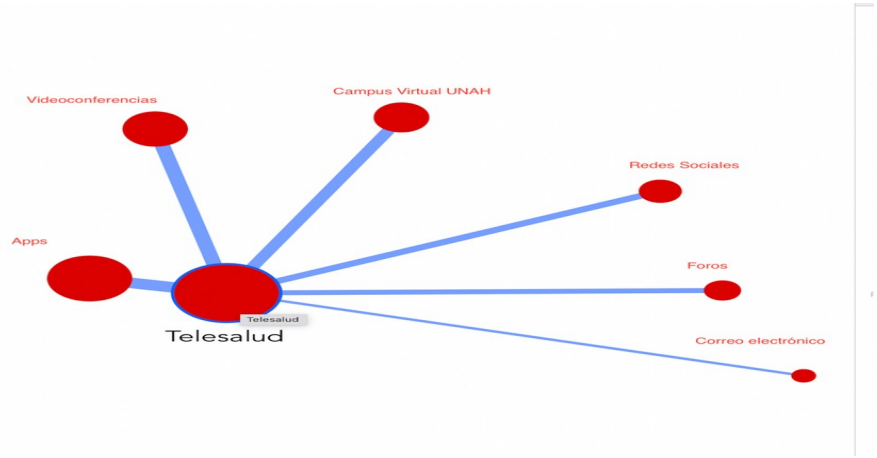



**Figure 1.** Telehealth tools most used by participants .

*Note* : Each node represents a tool; the volume of the sphere corresponds to the number of times it appears in the discourse; the thickness of the link refers to the number of co-occurrences in relation to Telehealth. Source: Prepared by the authors using Atlas ti 23.

The social networks most used by students were Tik Tok and Twitter (currently X), with an average daily connection time of 2.2 hours. The digital resources (content) most used by students are shown in Table 1 and Figure 2.

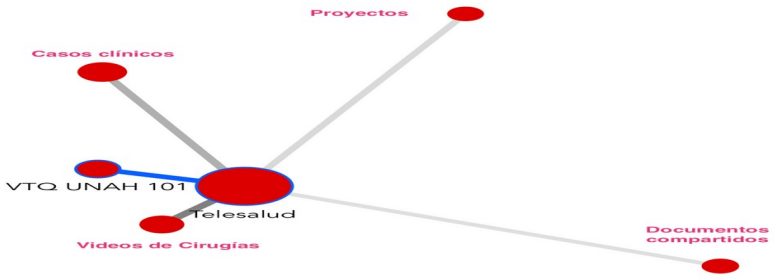



**Figure 2.** Co-occurrences of the Telehealth category with the most used teaching resources (contents) in Cl 205.

*Note* : Each node represents a digital resource; the volume of the sphere corresponds to the number of times it appears in the discourse; the thickness of the link refers to the number of co-occurrences in relation to Telehealth. Source: Prepared by the authors using Atlas Ti 23.

Fifty-two percent of participants reported not finding enough surgery videos on YouTube or other platforms, citing as limitations the lack of expertise in evaluating the quality of the video content, the lack of relevance to the medical problems addressed, the fact that the videos were narrated in a foreign language (which made them difficult to understand), and the fact that they were not intended for academic but rather for commercial purposes. The most frequent problems identified by participants with Telehealth as a teaching-learning strategy are shown in Figure 3, citing the lack of training in virtual education (92%) and internet connectivity issues (56%) as the two most common.

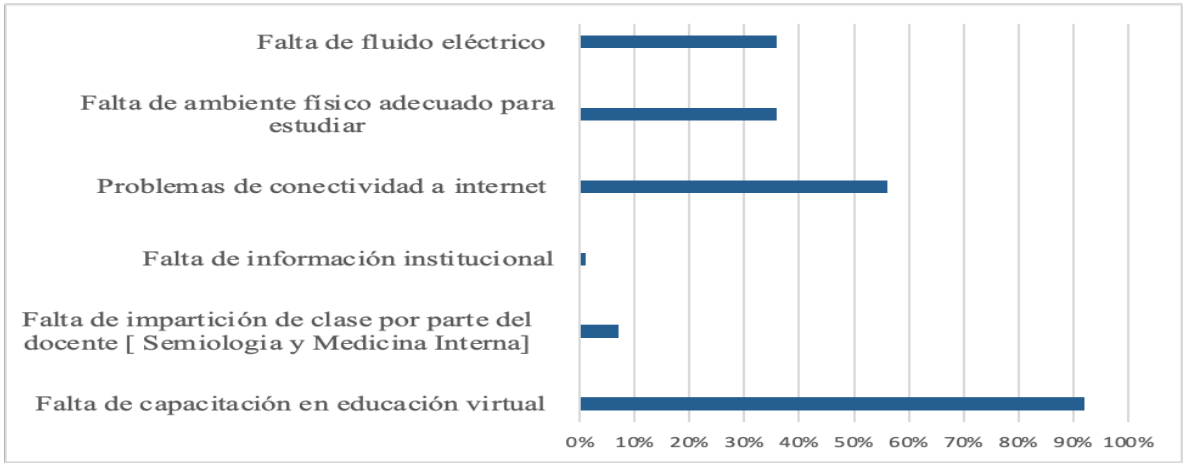



**Figure 3.** Problems in the development of Telehealth as a teaching strategy in Cl 205 **.**

*3.2 Results of the Intervention Project*

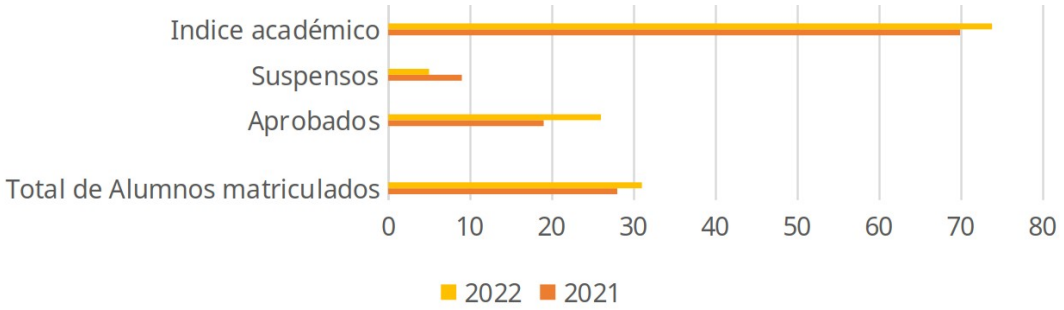
VídeoTec Quirúrgica UNAH-101 (VTQ-UNAH 101) was created in the first months of 2022 for the entire university community (Figure 4). It currently has 20 ODAs whose techno-pedagogical design complies with the TCAM recommendations, they have the approval of the INCP Ethics Committee and have been validated by expert surgeons from other Universities. It is freely accessible with a visual link, it can be linked to Moodle, it is multiplatform (it can be displayed on Android and iOS devices), multi-device (it automatically adapts to the digital devices on which it is displayed) and it was widely accepted by the participants (97%) who classified it as " *useful, eye-catching, interesting, of a good level* " as well as all the teachers " *excellent* [videos] , *easy to understand* ".


**Figure 4.** Visual link to VTQ UNAH 101 generated by Ms Sway, also accessible through alphanumeric link: https://sway.cloud.microsoft/NfT8lJZf9amPH3En?ref=Link&loc=play

With the intention of evaluating the impact of using VTQ UNAH 101, a comparison was established between students of the second Academic Period (PAC) of 2021 who did not use VTQ UNAH 101 and students of the second PAC of 2022 who used the created ODAs, with the rest of

the conditions similar (same teacher, same Telehealth tools and contents, except VTQ UNAH 101). The results showed a 3.8% improvement in average academic performance and a 16% improvement in the comparative class passing rate (84% passed in 2022 versus 68% in 2021) (Figure 5 and Table 2), which decreased the incidence of course repetition and increased student satisfaction with the rotation. Based on the effect size, the absolute effect (+16 percentage points) and Cohen's h = 0.38 suggest a pedagogically relevant improvement. Likewise, the Bayesian analysis confirms the directionality (92% probability of improvement). Although the sample size is small due to its qualitative approach, making it difficult to apply conventional statistical tests, the above results present a positive path for future studies in this field, expanding the sample size. Although we cannot rule out concurrent factors such as participants' adaptation to the COVID-19 pandemic, gender equity and students' progress in the curriculum remain the same.

**Figure 5.** Comparison between students PAC Cl 205 students from 2021 and 2022.




Note: Average improvement of 3.8% in academic index, 16% increase in passing rate.

**Table 2.** Comparison between students PAC Cl 205 students from 2021 and 2022.

| Year | Enrolled students | Approved | Fails | Academic index |
|---|---|---|---|---|
| 2021 | 28 | 19 | 9 | 69.9 |
| 2022 | 31 | 26 | 5 | 73.8 |
| Total | 59 | 45 | 14 | 3.9 |

Finally, the emotional, academic, and economic impact of the COVID-19 pandemic during the study period was investigated. Regarding the emotional impact, the majority (95% of students and 80% of teachers) reported negative feelings as a result of the pandemic: the most frequently used terms were anxiety, depression, sadness, stress, insomnia, fear, and isolation, although no validated psychological assessment tool was used (values obtained by dividing the number of participants reporting negative feelings by the total sample, multiplied by 100).

The academic impact of the pandemic was reflected in the interruption of their studies, a decline in their academic performance, the loss of physical spaces for their internships in hospitals, and a lack of empathy from teachers in previous classes. Teachers, in turn, expressed frustration, a lack of training in virtual education, and a lack of empathy with students due to the loss of daily physical contact.

The economic impact of the pandemic was evident in the increase in the cost of living of the participants for different reasons: increase in the basic food basket and the Increase in the cost of internet service (from $35 to $160 per month, which represents 26% of the monthly minimum wage for our country in 2025).

## 4. Discussion

Telehealth has been a strategy used in healthcare and education for years, but it has never been used as intensively and consistently as during the COVID-19 pandemic. This study established the impressions of those involved in the teaching-learning process during the lockdown imposed by the COVID-19 pandemic using Telehealth as a teaching strategy. Its effectiveness depends on a holistic understanding of the term, digital literacy skills, and the training received by those involved in the educational process. These aspects were found to be lacking in this study. Despite this, they considered it an effective and well-accepted strategy using the digital tools and content described for blended learning (hybrid, b-learning).

On the other hand, it is necessary for universities to establish, promote and maintain psychological support programs for the teaching and student population, as suggested by Saravia *et al.* (9) who, through a cross-sectional descriptive study carried out on first-year medical students at a Peruvian university during the first 5 months of the pandemic, were able to determine, through the application of the Generalized Anxiety Disorder 7 (GAD-7) measurement scale, that 75% of said students suffered some degree of anxiety during the pandemic (16% of them with severe anxiety), manifesting as the most frequent symptoms pathological worry and the inability to relax, also finding a statistically significant association between the female gender and anxiety.

In contrast, the present study revealed a higher level of emotional disorders among participants. who expressed it as " *anxiety, depression, sadness, stress, insomnia, fear and isolation* " without distinction of gender, most of them without having attended an evaluation or obtained professional psychological support and only 12% of them with a diagnosis of depression receiving pharmacological treatment. This impact was magnified by the confinement imposed by the Government, which the participants consider the main responsible for the negative social impact of the pandemic, favoring social isolation and fear of infection by COVID-19 .

COVID-19 pandemic merited similar considerations , having a negative economic impact on the entire academic community, increasing the cost of living, the cost of internet connection, the increase in the basic food basket, and the purchase of digital devices for academic work, putting pressure on family finances.

In compliance with the second objective of the study, the VTQ UNAH 101 surgical multimedia digital repository was created and has been in operation since 2022. It currently has twenty (20) ODAs designed following the precepts of the TCAM, approved by the INCP Ethics Committee and validated by expert surgeons from other universities. It is a response to the perception of the majority of participants (52%) of a lack or shortage of surgery videos on YouTube or similar platforms and facilitates multimedia teaching in face-to-face, virtual or hybrid mode. It was widely accepted by participants (97%) with terms such as " *eye-catching, useful, interesting, beneficial, demonstrative, of a good level*" , proving to be an effective complement to the academic training of students, raising the pass rate in Surgery I (16%), academic performance (3.8%) and the satisfaction and motivation of Surgery students.

Our study complements the information reported by Shamim (4) in his descriptive quantitative study who refers to the training of undergraduate surgery students through the use of multimedia educational material *already available on the Internet* , concluding that sessions based on surgery videos are effective in teaching general surgery by increasing levels of knowledge retention; ours is distinguished by its qualitative approach, by the *creation of videos in the form of digital learning objects, following a specific techno-pedagogical design and the precepts of the TCAM, hosted in a free access* surgical multimedia digital repository (VTQ UNAH 101), in Spanish, with *validation by external experts* in surgery and widely accepted by participants (97%).

Likewise, the results provide conclusive information in the sense that ODAs designed following the principles of TCAM (visual and auditory information processed in different channels, working memory with limited capacity and adequate information processing) have greater potential to achieve significant learning, as stated by Mayer (3) when formulating TCAM.

VTQ UNAH 101 is multiplatform, freely accessible, and can be inserted into Moodle virtual classrooms as a teaching resource or freely accessible through an alphanumeric or visual link. It is therefore concluded that VTQ UNAH 101 was a viable and effective alternative to complement the academic training in surgery for the study participants, in conjunction with the Telehealth teaching tools and content used. However, its limited sample size requires validation in larger populations and by other educational institutions in the Health Sciences. The creation of surgical videos as ODAs to be implemented in teaching allows for the creation of literary scripts adapted to our idiosyncrasies, language, and circumstances; and is a reflection of the educational and healthcare reality in the country's health system. The establishment of a National Telehealth Program in Honduras, as well as a national legal and regulatory framework, is necessary, as well as its inclusion in the curriculum of Health Sciences courses in order to reverse the digital divide. It is necessary to establish programs for the detection and intervention of psychological disorders in the academic community in order to preserve emotional health.

## 5. Conclusions

- Telehealth showed wide acceptance as a teaching strategy for the majority of participants (95% of students and 80% of teachers) during the COVID-19 pandemic in blended or hybrid (b-learning) mode.

- Its advantages include optimized study time, reduced physical fatigue, improved self-management and time organization, financial savings, and greater availability of digital learning resources. However, it is limited by the digital literacy of teachers and students, a lack of training in virtual education (92%), internet access problems (56%), and a lack of holistic understanding of the term. Continuous training in the use of health information technologies is necessary, as well as their formal inclusion in health sciences curricula and the establishment of a national legal and regulatory framework.

- The VTQ UNAH 101 surgical multimedia digital repository is a viable and effective educational resource to complement academic training in surgery for study participants, having been classified as " *excellent, useful and of good level* ", although its limited sample and conditions of use require validation in larger populations by other educational institutions of Health Sciences. It is multiplatform, open access, validated by external peers, designed according to the principles of TCAM and has the approval of the Ethics Committee of the hospital where it was carried out. It can be a useful teaching resource to complement the academic training of students in hospitals with limitations in physical space, overcrowding of students, lack of PPE or with inadequate infrastructure for teaching in the operating room. This study has the potential to scale its results for generalization by replicating it, expanding its population and including other Health Sciences faculties.

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**Authors' contributions** : The author is entirely responsible for the content of the article.

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