

What is the perception of medical students about eLearning during the COVID-19 pandemic? A multicenter study in Peru

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ABSTRACT

Introduction: As face-to-face medical education was restricted during the pandemic; digital tools have been deployed to continue education showing a good educational impact in most countries. However, the perception of medical students in Peru on eLearning has not yet been investigated. This study assessed the perception of 440 medical students from two national universities in Peru on the characteristics and limitations of eLearning during 2021.

Materials and methods: We conducted a cross-sectional study using the self-administered survey Encuesta Virtual en Tiempos de COVID-19 (EVI-CV19) on students between the second and sixth medical year of the Universidad Nacional Mayor de San Marcos (UNMSM) and the Universidad Nacional San Luis Gonzaga (UNSLG, n=325).

Results: The majority of students were under 30 years of age (93.9% vs. 97.2%, p=0.084), and female (67% vs. 64%, p=0.107). Of the total, 63.9% and 81.5% UNMSM and UNSLG students considered the virtual platform effective in favouring feedback with recorded lectures (85.2% vs. 85.5%) and the organization of documents (61.7% vs. 80.9%), respectively (p>0.05). Seventy per cent and 46.8% of UNMSM and UNSLG students perceived that teachers were not trained (p=0.063), and 26.1% and 17.2% of students perceived that the virtual modality affected their academic performance a lot, respectively (p=0.003). About 38% of students from both universities perceived the virtual platforms as very secure. We found differences between UNMSM and UNSLG students on whether the virtual exams were fair (28.7% vs. 52.3%, p<0.001).

Conclusions: This study reported a favorable perception of medical eLearning with clear differences in the limitations of the virtual environment.

Keywords: medical education, COVID-19, eLearning, distance education, Peru

INTRODUCTION

During the shift thinking in medical education from empiricism and rationality and evidence, medicine has faced and survived the humanitarian crises unfolding across the world [1]. Nowadays, medical education is facing one of the challenging crises due to COVID-19, leading it to continue its legacy immersed in immersive virtuality.

Virtual education has functioned as a lifeline for medical students around the globe who have been deeply affected by the prevention and containment measures implemented by governments worldwide to curb the spread of SARS-CoV-2 [2]. In an unprecedented move, medical training has continued to use only digital tools while maintaining the fundamental

interconnectedness of today's globalised and technological world.

With the closure of medical schools, all educational responsibility has been based on digital platforms and the benefits they can offer to students [3]. On these tools depended the educational process, i.e. understanding human anatomy, normal and altered physiological anatomical processes, clinical assessments and diagnostic formulation of disease, treatment, monitoring and prevention [4,5]. Although these goals have been achieved heterogeneously in medical schools around the globe. Some topics such as surgery, paediatrics and internship have become critical trouble in the training of medical students using eLearning [6].

This challenge has modulated as the COVID-19 pandemic has been contained, and some practical activities have been

added to eLearning [7]. However, low- and middle-income countries have not been able to return to clinical practice because their “new normal” is still threatened by SARS-CoV-2 and the crises facing their governments [8]. Many medical schools in Latin America, both in urban and rural areas, still do not allow access to face to face classes and entirely rely on digital media. Therefore, it is crucial to understand whether eLearning leads to quality, efficient and rational medical training. Failure to meet these digital objectives can lead to poor training and be a threat that affects healthcare at all levels.

This study aims to understand the perceptions of Peruvian about the features, limitations and advantages of eLearning during the COVID-19 pandemic.

MATERIALS AND METHODS

Study Design and Settings

This study was a multicentre, cross-sectional study conducted at the Universidad Nacional San Luis Gonzaga (UNSLG) and the Universidad Nacional Mayor de San Marcos (UNMSM) during 2021. San Marcos is the top university in Peru. Its Faculty of Medicine was founded in Lima in 1856. On the other hand, the Faculty at UNSLG was created in 1962 and is one of the top universities in the Ica region (Southern Peru). Both universities are autonomous and administered by the Peruvian Ministry of Education

Population, Inclusion Criteria, and Survey

The studies included 2,140 medical students from both universities. We conducted a randomized sampling [9] and found a sample of 264 students. Inclusion criteria were Peruvian students of both sexes, over 18 years of age, between the 2nd and 6th year of studies, and enrolled in the 2021-I semester.

A virtual survey was carried out using Google Form™ (Google, CA, USA) with informed consent. The surveys were conducted in coordination with the coordinators of each faculty. Each survey was shared by WhatsApp LLC (Meta Platforms, Inc., MA, USA) between July and August 2021. The Virtual Survey in Times of COVID-19 (EVI-CV19) has been designed to determine the impact of digital education on university students. This 35-item Likert-scale instrument was validated in three universities in Peru with a reliability coefficient of 0.902 and is self-administered with three dimensions, as follows:

1. student attitudes about virtual education,
2. platform (interface and security), and
3. eLearning in medicine [10].

Data Processing and Statistical Analysis

SPSS v24.0 statistical software (IBM, Armonk, USA) was used to perform descriptive statistical analysis with frequency measures for categorical variables and mean and standard deviation (SD) for continuous variables. We conducted a Pearson's test analysis of association on the difficulty (four items), safety (four items), and effectiveness (10 items) of eLearning during the COVID-19 pandemic. The items of each category hold characteristics together and are related due to the processes they assess. Then, to compare the attributes of eLearning among the universities, we used the paired t-test

Table 1. Baseline characteristics of medical students (n=440)

Characteristics	UNMSM (n=115)	UNSLG (n=325)	p-value
Age			
<30	108 (93.9)	316 (97.2)	0.333
30-40	6 (5.2)	9 (2.8)	
41-55	1 (0.9)	0 (0)	
Sex			
Male	37 (32.2)	117 (36)	0.848
Female	77 (67)	208 (64)	
No binary	1 (0.9)	0 (0)	
Year of study			
I	3 (2.6)	0 (0)	0.772
II	46 (40)	70 (21.5)	
III	13 (11.3)	52 (16)	
IV	22 (19.1)	68 (20.9)	
V	6 (5.2)	70 (21.5)	
VI	17 (14.8)	65 (20)	
Previous career			
Yes	9 (7.8)	18 (5.5)	0.316
No	106 (92.2)	307 (94.5)	
Health-related work			
Yes	24 (20.9)	18 (5.5)	0.096
No	91 (79.1)	307 (94.5)	
Platform			
Blackboard	58 (51.3)	0 (0)	0.002
Zoom	30 (26.1)	325 (100)	
Google Meet	18 (15.7)	0 (0)	
Microsoft Teams	8 (6.9)	0 (0)	

and one-way ANOVA for continuous variables, and the Mann-Whitney U and Kruskal-Wallis test for categorical variables considering for all tests a significance threshold of $p < 0.05$ and a confidence interval of 95%.

Ethical Aspects

This study complied with the ethical guidelines of the Helsinki declaration [11] and had the approval of the Ethics Committee of the Norbert Wiener University (UNW-No. 015-2021-62).

RESULTS

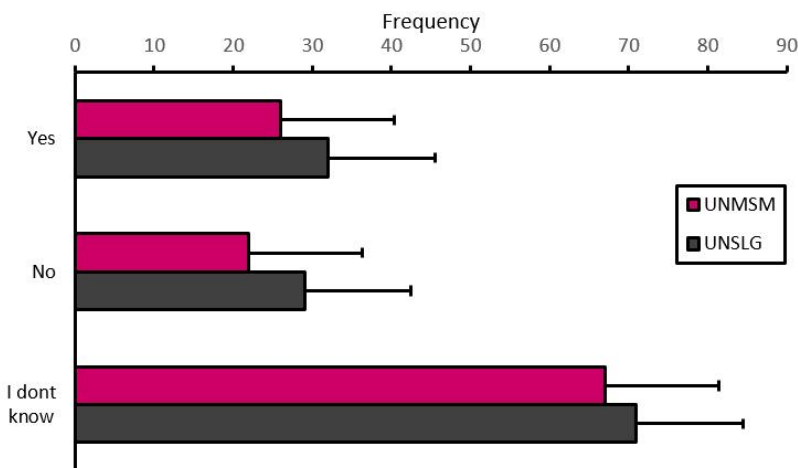
In this study, we enrolled 440 medical students whom 325 (73.8%) were from UNSLG. In both universities. The majority of the students were under the age of 30 (93.9% UNMSM vs 97.2% UNSLG, $p=0.084$). The highest frequency of students was female (67% of UNMSM vs 64% in UNSLG, $p=0.107$). In UNSLG, 68 (20.9%) students were of the 4th year, and 56 (20%) were of the 5th medical year, while in UNMSM the majority of students were from the 2nd year (46 participants, 40%) and 4th year (22 participants, 19.1%). Only 9 (7.8%) and 18 (5.5%) participants from UNMSM and UNSLG had previous careers, respectively.

The most frequently used platform was Blackboard (58 participants, 51.3%) at UNMSM, and at UNSLG only Zoom was used (100%) (Table 1). We found gender differences in access to the platform ($p=0.022$) and ease of study via the Internet ($p=0.004$) in UNSLG students.

At UNMSM 84 (73%) students did not know about the virtual platform before the pandemic, while 94 (81.7%) students considered the payment for virtual classes was unfair. In contrast to UNSLG, 199 (61.2%) UNSLG students were aware of the virtual platform before the pandemic, and 254 (78.2%) considered the payment for virtual classes to be fair ($p < 0.001$). 73 (63.9%) and 265 (81.5%) students from UNMSM and UNSLG

Table 2. Frequency of attitudes about eLearning among Peruvian students during the COVID-19 pandemic [data in n (%)]

Items	UNMSM (n=115)		UNSLG (n=325)		p-value
	Yes	No	Yes	No	
Before the COVID-19 pandemic were you aware of the virtual platform you use?	31 (27)	84 (73)	199 (61.2)	126 (38.8)	0.260
Do you consider the use of virtual platforms to be effective for learning?	73 (63.5)	42 (36.5)	265 (81.5)	60 (18.5)	1
Do you consider that there are communication problems between students & teachers?	97 (84.3)	18 (15.7)	123 (37.8)	202 (62.2)	0.171
Do you consider that the virtual platform encourages student participation?	50 (43.5)	65 (56.5)	254 (78.2)	71 (21.8)	0.004
Do you consider that the tools used by the teacher are effective for student learning?	52 (45.2)	63 (54.8)	252 (77.5)	73 (22.5)	0.174
Do you consider that the payment for virtual classes is adequate?	21 (18.3)	94 (81.7)	254 (78.2)	71 (21.8)	<0.001
Have you had difficulties with the use of and access to the virtual platform?	69 (60)	46 (40)	121 (37.2)	204 (62.8)	0.122
Are the tools provided by the platform sufficient and effective?	53 (46.1)	62 (53.9)	241 (74.2)	84 (25.8)	0.574
Do you consider that the virtual classes favour the organisation, availability and classification of documents and subjects?	71 (61.7)	44 (38.3)	263 (80.9)	62 (19.1)	0.398
Do you consider that virtual platform facilitates study through the use of the Internet?	79 (68.7)	36 (31.3)	275 (84.6)	50 (15.4)	0.150
Are protocols required to enter the virtual classroom?	59 (51.3)	56 (48.7)	223 (68.6)	102 (31.4)	0.128
Are there unknown users who generate disorder during virtual classes?	25 (21.7)	90 (78.3)	57 (17.5)	268 (82.5)	0.764

**Figure 1.** Frequency of responses on the identification of unknown users during virtual classes

considered the virtual learning platform to be effective in favouring various student characteristics such as the organisation and classification of documents in 71 [61.7%] vs. 263 [80.9%], $p=0.398$, respectively. On the other hand, 97 (84.3%) students reported communication problems between students and teachers at UNMSM, while 202 (62.2%) students at UNSLG did not report these problems.

We found differences between UNMSM and UNSLG students on the ease with which virtual environments encourage student participation [65(56.5%) vs. 254(78.2%) students, $p=0.004$]. Although we determined that 69 (60%) and 121(37.2%) students had difficulties accessing the platform at UNMSM and UNSLG, respectively, there were no significant differences between the two ($p=0.122$). 56 (48.7%) students at UNMSM reported that there are no protocols for accessing the platform, but only 25 (21%) students have reported the presence of strangers in virtual classes.

Our results also showed no differences between UMSM and UNSLG in the frequency of communication problems between students and teachers (97 [84.3%] vs. 123 [37.8%], $p=0.171$), platform access difficulties (69 [60%] vs. 121 [37.2%], $p=0.122$), and virtual classroom access protocols (59 [51.3%] vs. 223 [68.6%], $p=0.128$) (**Table 2**).

Figure 1 shows the students' responses to the protocols for identifying unknown users. Only 23% and 32.6% of medical students from UNMSM and UNSLG indicated that there is a possibility of identification of strangers in class, and 58% and 47.7% of students responded that they do not know if any

protocols exist, indicating uncertainty about the safety of users (**Figure 1**). We found no difference between students at the two universities ($p=0.680$). Only at UNMSM did we find a gender difference in the identification of unknown users ($p=0.043$).

Only at UNMSM did we find differences between working and non-working students in their appreciation of the start time of classes ($p=0.007$) and their knowledge of the digital platform before the pandemic ($p=0.001$). We found differences between UNMSM students with a previous degree on whether exams are fair ($p=0.048$) and if there are unknown users in classes ($p<0.001$). According to medical year, we found differences between II and VI years on whether the tools used by the teacher provoke students' learning effective ($p=0.035$) and whether eLearning is a new learning model for them ($p=0.008$).

81 (70.4%) UNMSM students and 152(46.8%) UNSLG students reported that teachers had no training for virtual education during the pandemic ($p=0.063$). 69 (60%) and 110 (33.8%) students had no prior training in the management of digital platforms at UNMSM and UNSLG, respectively (**Table 3**).

We found significant differences between UNMSM and UNSLG students on whether virtual exams were fair (33 [28.7%] vs. 170 [52.3%], $p<0.001$), whether they paid attention to virtual classes (30 [26.1%] vs. 144 [44.3%], $p<0.001$), and whether eLearning is an adequate educational model (39 [33.9%] vs. 225 [69.2%], $p=0.001$). On the other hand, 98(85.2%) students at UNMSM and 278 (85.5%) students at UNSLG consider that recorded lectures generate feedback, respectively.

Table 3. Considerations on the platforms used during the COVID-19 pandemic by UNMSM and UNSLG students [data in n (%)]

Items	UNMSM (n=115)		UNSLG (n=325)		p-value
	Yes	No	Yes	No	
Do you consider that teachers are properly trained in the use of a virtual platform?	34 (29.6)	81 (70.4)	173 (53.2)	152 (46.8)	0.063
Have you had any training on the platform before the start of classes?	46 (40)	69 (60)	215 (66.2)	110 (33.8)	0.210
Do you consider that recorded classes generate continuous feedback for the students?	98 (85.2)	17 (14.8)	278 (85.5)	47 (14.5)	1.000
Do you consider that students attend virtual classes?	30 (26.1)	85 (73.9)	144 (44.3)	181 (55.7)	<0.001
Do you consider that there is a flexible timetable for the courses?	64 (55.7)	51 (44.3)	214 (65.8)	111 (34.2)	0.054
Do classes start at the scheduled time?	83 (72.2)	32 (27.8)	252 (77.5)	73 (22.5)	0.779
Do you consider the virtual exams to be fair?	33 (28.7)	82 (71.3)	170 (52.3)	155 (47.7)	<0.001
Do you consider eLearning as a new learning model to be appropriate?	39 (33.9)	76 (66.1)	225 (69.2)	100 (30.8)	0.001

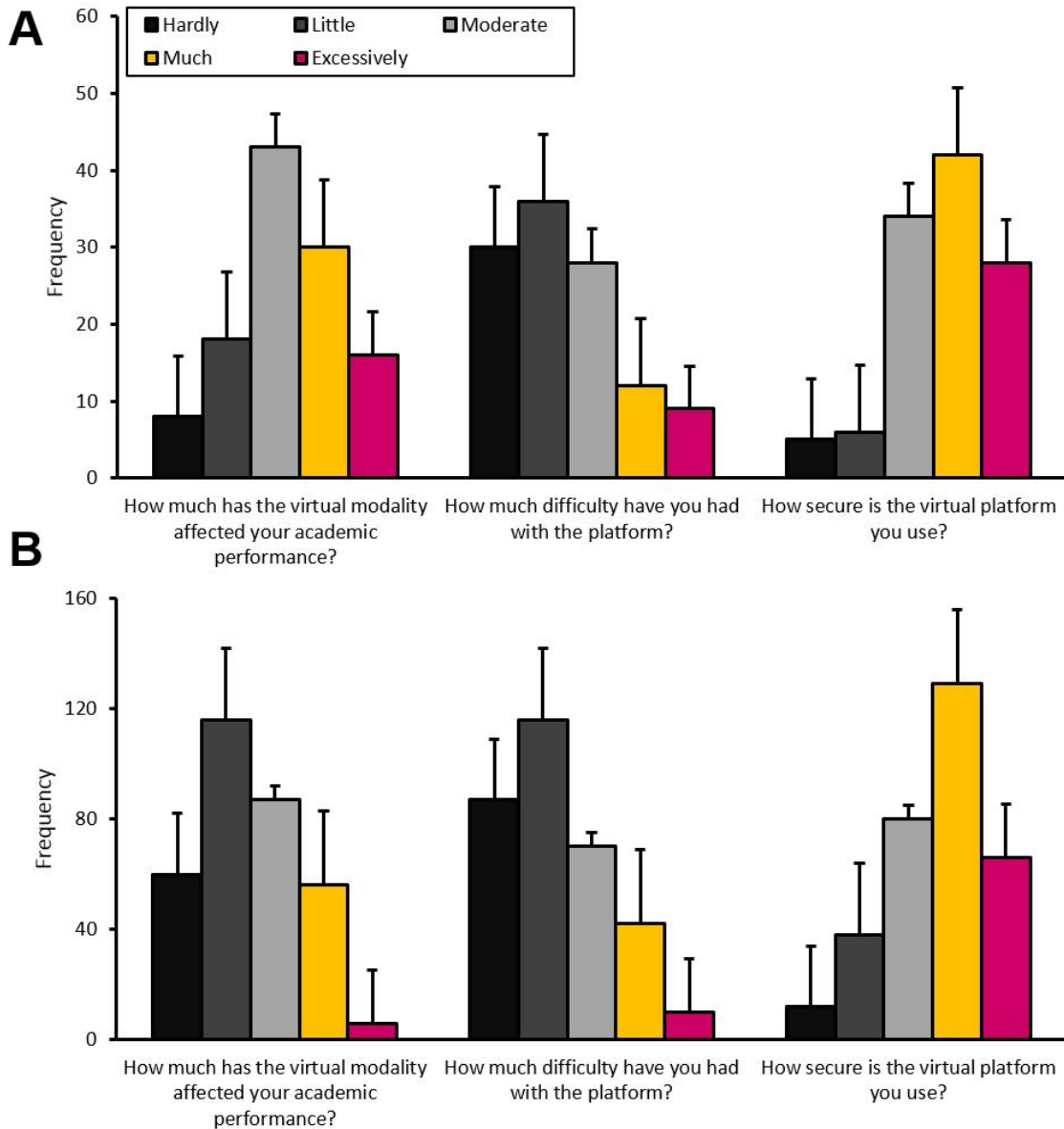


Figure 2. Perception of UNMSM (A) and UNSLG (B) students on the characteristics of difficulty of use and academic performance of eLearning (n=440)

At UNMSM 30 (26.1%) and 16 (13.9%), students perceived that the virtual modality affected their academic performance a lot and too much, respectively, while at UNSLG 87 (26.8%) and 56 (17.2%) students perceived that the virtual modality affected their academic performance moderately and a lot, respectively ($p=0.003$). Also, 30 (26.1%) and 36 (31.3%) UNMSM students and 116 (35.7%) and 87 (26.8%) UNSLG students reported that they had little or quite a little difficulty with the platform used, respectively ($p=0.769$). Finally, 41 (36.5%)

UNMSM students perceived the platform usage as secure, and 28 (24.3%) considered it too secure, whereas 80 (24.6%) and 129 (39.7%) UNMSM and UNSLG students perceived the digital platforms used during the COVID-19 pandemic as moderately secure and very secure (Figure 2).

The association results are presented in Figure 3. The association analysis between all eLearning difficulty items in UNSLG students ($p<0.05$), while at UNMSM the association between access difficulties and access protocols ($p=0.048$),

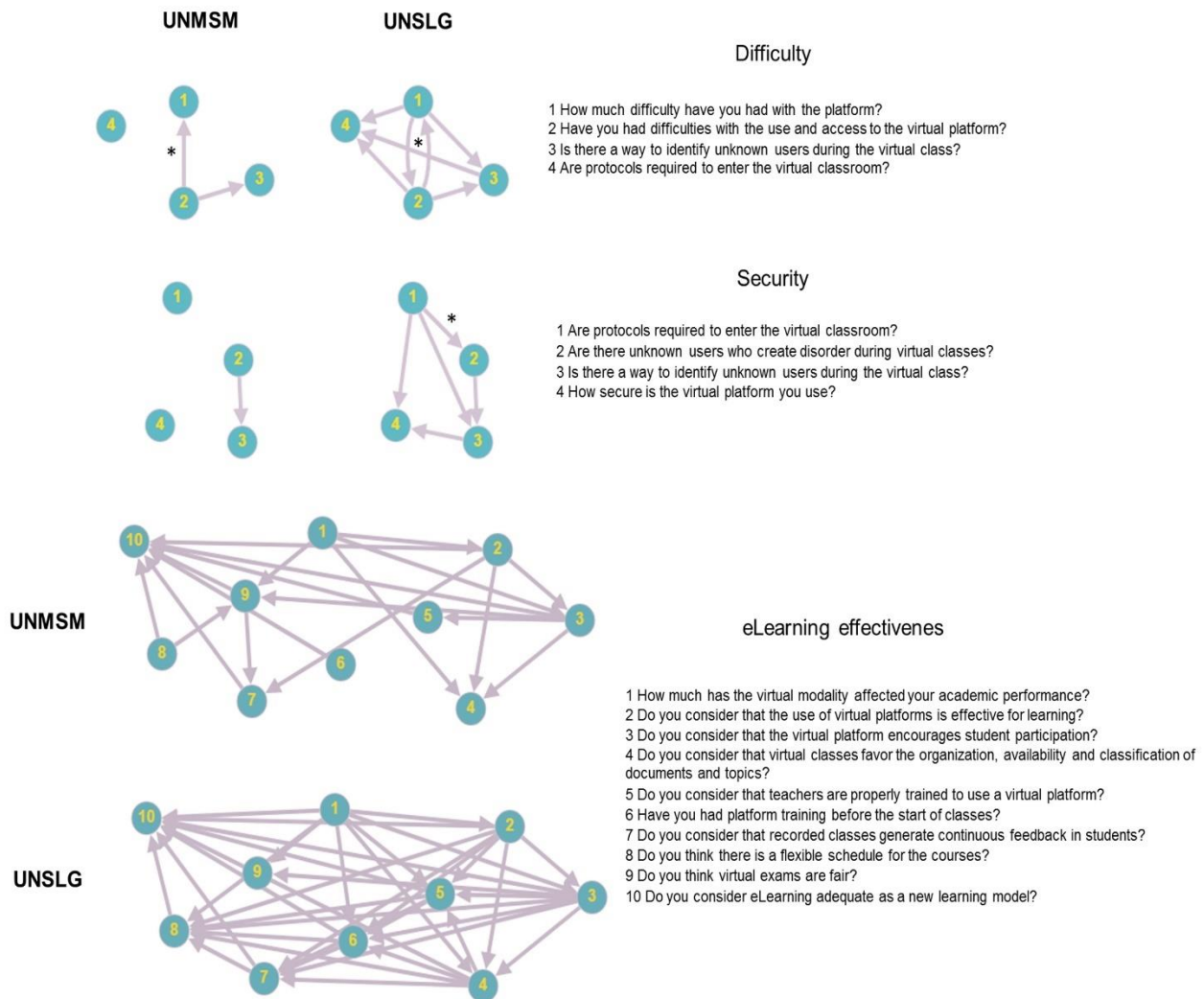


Figure 3. Association model among the components of safety, difficulty, and effectiveness of eLearning in Peruvian students. The arrows indicate the association between the components of each question and * shows negative association

determining an amount of difficulty ($p=0.001$). The processes of identifying unknown users were associated with user difficulties during virtual classes ($p=0.049$) at UNMSM. However, at UNSLG there were associations between all except these items ($p=0.374$).

At UNMSM, the associations were heterogeneous. All items were associated with the eLearning item as a new learning model ($p>0.05$). The impact of eLearning on academic performance ($p=0.031$), the effectiveness of eLearning on learning ($p=0.001$) and encouraging student participation in class ($p=0.017$) were associated with the item favouring eLearning to organise and classify documents. Finally, the feedback item about recorded lectures was associated with the item about eLearning benefits for documents organisation and classification. ($p=0.003$) and the effectiveness of eLearning on learning ($p<0.001$).

At UNSLG, 8/10 items did not correlate with eLearning favourability for organising and classifying documents ($p>0.05$). However, it was associated with the item of student participation ($p=0.029$) and with the impact of eLearning on academic performance ($p=0.024$). Likewise, the last one was not associated with feedback from recorded lectures ($p=0.086$). All other items showed a positive association.

DISCUSSION AND CONCLUSIONS

In this study, we highlight the heterogeneous perception of Peruvian medical students from UNMSM and UNSLG about eLearning during the COVID-19 pandemic that was considered an effective model that provides new tools for learning, organization, feedback and class classification. There are differences between students at both universities and between years of medical study concerning the ease of use of virtual environments, access difficulties, prior training of teachers and students, and security protocols for access to virtual platforms. In addition, virtual education minimally affected the academic performance of medical students, although the assessments were not considered fair.

This is the first multicentre study of medical students that develops a comprehensive evaluation of the characteristics of medical eLearning. During the first two years of the COVID-19 pandemic in Peru, limited manuscripts have been published that narrated the problem of eLearning without characterizing, evaluating and understanding the medical student population during the COVID-19 pandemic [12-14]. Other studies have been single-centred and have evaluated only some characteristics linked to medical education, such as perception of eLearning [15], student satisfaction [16], and quality of sleep,

anxiety, depression during virtual education [17,18]. Nevertheless, these studies have not assessed the main aspects of long-distance education such as platform security, prior training or effectiveness.

To prevent the spread of COVID-19, the Peruvian Ministry of Education (MINEDU) ordered the suspension of courses at universities, technical-productive education centres, public and private colleges and higher education schools on an extraordinary basis on March 12th, 2020 [19]. This stipulation was extended until May 4, the suspension of face-to-face educational service was official [20], suspending virtual classes. In addition to challenges, this crisis has revealed an unlimited boost of potential educational resources for educational institutions around the globe [2]. In asynchronous classes, recordings have been one of the benefits. In our group, 85% of students consider it crucial for feedback. It has been reported that the acceptance of these tools was obvious. Class videos have made it possible to access lectures several times, pausing and taking notes [21].

Other digital tools have influenced the online teaching-learning model [21]. Our findings reveal that document organization and class flexibility are major benefits for more than half of the students in long-distance medical classes. The study in [22] agrees with our results as American students perceived a significant increase in accessibility to technology. In addition, the researches in [23,24] have reflected the flexibility of virtual classes by reducing commuting time to the study centre. However, clinical courses that require practical classes (such as surgery and anatomy) have not benefited from virtuality [25,26].

Distance educational effectiveness remains a challenge for medical schools, although several experiences in telemedicine have provided significant results and have allowed education to continue during the COVID-19 lockdown [27,28]. Low and middle-income countries have seen education blocked and have made efforts to address this situation, managing to establish virtual models of medical education. Although long-distance education has continued, it has also notably limited medical practice [29]. Although our results indicate that distance education has been beneficial for 68-84% of medical students, a complete overview of medical education in the region is not usable. In addition, several recent reviews have not reported the impact, effectiveness, and limitations of eLearning in Latin American countries [27,30-33]. More studies are needed to understand the effect of COVID-19 on medical education in Latin America (particularly in Peru) since investments and scientific response policies have not prioritized educational aspects during the lockdown [34,35].

On the other hand, distance education has revealed that students' attitudes towards educational technology directly affected their learning process [21,36]: A student who experienced unsatisfactory Internet access at home is more likely to be less effective in online education [37]. In this study, we had a low frequency of problems inaccessibility to virtual platforms, in agreement with what was reported in other studies where a low number of students had a poor internet connection that made e-learning difficult [24,38]. Unfortunately, there are differences in the quality of the internet and the effectiveness of distance education. This was reflected in the disproportionate impact that the pandemic had on the most vulnerable populations [2], where attitudes, and therefore, the student's perception of virtual education (included knowledge of COVID-19) differs depending on the

variation of certain factors (such as geographical area, internet access) [39,40]. Peru, being a multicultural country with demographic variations, faces inequalities in the quality and effectiveness of medical education [41]. Our previous results have shown a low perception of the eLearning effectiveness in provincial students, where connection quality and access to local networks have influenced this process [34].

Teacher preparation stands out as part of another challenge for medical eLearning during adaptation to the pandemic. The rapid switch to online education [30] has not given enough time to train teachers. Our results indicate that between 46-70% of teachers were not prepared for online education, coinciding with previous reports [34,38]. Being linked to software tools, teachers can use digital skills that allow them to improve the construction of a virtual learning community to generate debate on topics proposed in chats and forums, where the student develops a feeling of belonging that encourages their learning process. In this way, the students note the improvement in the capacities of the teachers, to the use of technological tools and virtual education [21], as well as in the development of their capabilities to participate successfully in educational technology, through the knowledge of new learning tools (video analysis/creation, online quizzes, etc.) [24].

The interaction of teachers and students in the online process also leads to the assessment of academic performance, referring to the evaluation of medical training competence. A few years ago, a study by the University of San Andrés in Peru showed that e-learning has improved the quality of education, with an unprecedented increase in average approval ratings (99.6%) for participatory and collaborative learning [42]. Although more than half of the students in the study felt that e-learning had a small impact on academic performance, only 28% to 52% felt that virtual testing was fair. These high-grade records during online medical education should be deeply examined as they may contain biases about the actual learning of students, so follow-up studies should be carried out to see if high performance is associated with better learning and quality. Distance education, more than with the ease of taking the exams, the use of notes, and overvalued scores (J. Moya-Salazar, personal communication).

Two years after the start of the lockdown in Peru—on February 8, 2022—the MINEDU finally approved the gradual and flexible return to face-to-face classes in universities, through hybrid teaching models and in strict compliance with the prevention and control measures of the coronavirus. COVID-19 [43]. In this post-COVID era, medical e-learning methods must be incorporated into the comprehensive curricular structure, based on the advantages and limitations offered by virtual environments [5,24,32,34].

The first limitation of this study is that it was conducted at two national universities. While there may be differences with private universities, our previous study has shown similar characteristics of eLearning but differences in study habits and use of internet [34,44,45]. Second, due to the study design, students were not followed up during the years of study in virtual media. Third, this study has not included an analysis of emerging forms of communication applied to medical undergraduate education (i.e., memes), so future studies should analyse the role of this “new language” in both distance education and face-to-face education [46]. Fourth, eLearning has not been differentiated during the medical internship, pre-internship placements, or surgery and medical anatomy

programs that require a hands-on component. Education delays have pushed virtual continuity even in courses that need many hours of practice and where virtuality has yet to establish itself as the *non-plus-ultra* educational instrument due to its limitations. The virtual teaching of clinical-practical courses should be evaluated to determine the students' perception, the impact on academic performance, and the deficiencies and benefits of eLearning in this field.

Peruvian medical students have a favourable perception of eLearning, positioning it as an effective, multi-tool and flexible study resource during the COVID-19 pandemic. The recorded lectures were the most favourable resources. Despite the lack of teacher and student training, security protocols, a lack of fairness in the exams, and the cost of the platform were the main limitations.

The educational platforms created can enhance the development of the virtual medicine initiative and the autonomous distance learning of students by using cognitive tools for students to make the maximum use of their learning potential, decide on the tasks to be performed, how to carry them out, deepen the topics and assume self-control of their work. However, the medical education scheme needs to be organised according to the requirements of each subject, and the necessary infrastructure needs to be provided to achieve a uniform performance.

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