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ORIGINAL STUDY

Key words: 2019-nCoV; COVID-19; Pandemic; Educational intervention; Medical education;

Conflict of interest: none

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Word count

- **Abstract = 172**
- **Article = 2328**
- **References = 520**

Tables number = 4
Figures number = 4
Supplementary figures number = 2

ABSTRACT

BACKGROUND

The SARS-CoV-2 (COVID-19) pandemic required a rapid surge of healthcare capacity to face a growing number of critically ill patients. For this reason, a support reserve of physicians, including surgeons, were required to be reassigned to offer support.

OBJECTIVE

To realize a survey on the educational programs deployed (face-to-face or e-learning focusing on infective area, basic gestures, COVID clinical management and intensive care medicine), and their impact on behavior change (Kirkpatrick 3) of the target population of surgeons, measured on a 5 modalities Likert scale.

DESIGN

Cross-sectional online e-survey (NCT04732858) within surgeons from the Assistance Publique – Hôpitaux de Paris network, metropolitan area of Paris, France.

RESULTS

Cross sectional e-Survey: among 382 surgeons invited, 37 (9.7%) participated. The effectiveness of the educational interventions on behaviour changes was rated within the highest region of the Likert scale by 15% (n=3) and 22% (n=6) for “e-learning” and “face-to-face” delivery modes, respectively.

CONCLUSIONS

Despite the low response rate, this survey suggests an overall low impact on behaviour change among responders affiliated to a surgical discipline.

INTRODUCTION

The SARS-CoV-2 (COVID-19) pandemic was a rapidly evolving crisis spreading worldwide in 2020, and like any natural disasters or epidemics, local healthcare capacity might be overwhelmed by the rapid surge of critically ill patients[1]. Recommendations for organization of intensive care units (ICU) in case of pandemic influenza[2,3], suggest an efficient and scalable emergency response system, prepared to surge in times of crisis. Most countries however lack sufficient medical equipment, ICU space and specialized staff to provide timely, usual critical care for a large influx of additional patients[4], in particular physicians and nurses.

For this reason, ICU and non-ICU colleagues from other areas might be asked to offer support with different tasks that are not within their usual scope of practice[1,4,5], as support reserve: the target population of surgeons in particular, given the reduction of scheduled surgical activity. Mortality, although inevitable during such pandemic outbreak, may be reduced by adequate preparation including education and training[6] to the main areas of intensive care medicine, nursing, and infection control[2,7]. Given the time shortage for trainers and trainees, time and cost-efficient programs to gain maximal benefit from short rotations for several physicians at one time are required[8]. In case of pandemics, blending face-to-face education to e-learning seems sustainable, with online resources being scalable and more cost effective than other methods[9].

The aim of this study was to realize a survey on the educational programs deployed within the hospitals of the metropolitan area of Paris, France, during the COVID-19 pandemic, and their impact on behavior change, satisfaction and knowledge of the target population of surgeons.

METHODS

This study was designed as a cross-sectional e-survey of surgeons' behaviours and knowledge after being exposed to any modality of educational interventions available within the 39 hospitals from AP-HP network (Assistance Publique-Hôpitaux de Paris, Paris, France). The study was organized in April 2020, and covered the period of the French national lock-down (March 7th – May 11th 2020). The e-survey was approved by the Institutional Review Board (IRB) Mondor (IRB#00011558, 2020-079), and registered on ClinicalTrial NCT04732858.

Timeline and overview in Figure 1.

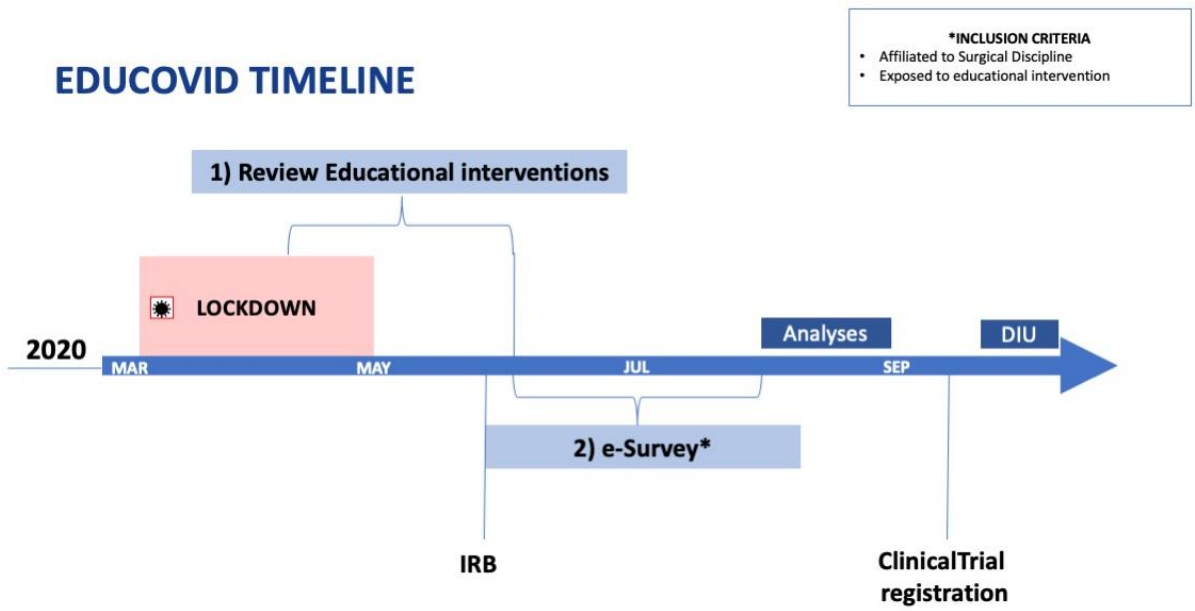

Figure 1. Educovid Study timeline. (Mar=march, Jul=July, Sep=September, IRB=Institutional Review Board)

The study was led in compliance with the Guideline for reporting evidence-based practice educational interventions and teaching (GREET)[10] and the Checklist for Reporting Results of Internet E-Surveys (CHERRIES)[11].

Definition of educational interventions available.

Following the AP-HP Emergency response plan, educational interventions were independently set within each of the 39 hospitals, and intended as any procedure or program to facilitate the acquisition of basic skills about the disease, its ramifications and treatment[2,6,7]. Educational resources were classed, according to the area covered (intensive care medicine, nursing, clinical care of COVID patients, infection control[2,7]) and the delivery mode: face-to-face or e-learning (this latter defined as any type of educational media that is delivered in an electronic form[12]). According to the GREET

checklist[10], variables as materials used, educational strategies and schedule used within each intervention were collected.

Cross-section e-Survey on the impact of educational interventions among the surgical community.

The e-survey was addressed to physicians specialized in 9 different areas of surgery, within the 39 hospitals of the metropolitan area of Paris and affiliated to the AP-HP, Paris, France, during the COVID-19 pandemic.

e-Survey Endpoints

The first three out of four levels of evaluation proposed in Kirkpatrick's model[13] (1-reactions, 2-learning, 3-behaviors) were considered to measure the educational results of teaching tools. The fourth (results, intended as *return on investment*), given its complexity, was not considered during this investigation.

Primary endpoint

The primary endpoint of the e-survey was to explore the effectiveness of educational interventions experienced by responders, considered as a whole "bundle" (and not one-by-one), among the surgeons exposed to a training program, on behavior change (Kirkpatrick level 3[13]) in their daily role during their re-affectation within a medical COVID-unit. Behavior change represents a change in the daily role of healthcare professionals (for example, referral of patients with suspected COVID to the most appropriate screening and care pathway). For this survey, we considered subjective measures (self-assessment on a Likert scale on 5 modalities) of behavior change.

Secondary endpoints

- Satisfaction rating, corresponding to the degree to which participants found the training favorable, engaging and relevant (Kirkpatrick level 1[13]), by self-assessment on a Likert scale on 5 modalities.
- Assessment of learning (Kirkpatrick level 2[13]) by the sub-objectives (self-assessment on a Likert scale on 5 modalities):
    - Knowledge acquired (i.e. factual knowledge, e.g. knowledge of the pathophysiology of COVID).
    - Improved skills (i.e, how to perform a dress-undress procedure).

e-Survey development.

The survey was developed on a secured digital platform (LimeSurvey GmbH, Hamburg, Germany), and its usability was pre-tested by 2 physicians at Henri-Mondor University Hospital–Créteil, France, before the questionnaire spreading. Changes in structure and word clarity were made in response to these feedbacks.

An example is available at https://questionnaire.aphp.fr/index.php/441641?lang=fr

Survey administration

As anticipated, the e-survey was built on LimeSurvey, with the participating link embedded within the invitation emails, and active from June to August 2020.

To reach the largest number of surgeons, email invitations were sent out through institutional channels (Directors of surgical departments) and professional networks (scientific associations), addressed to residents, fellows, consultants and physicians of any grade and affiliated to any surgical specialty. The survey participation was on a voluntary basis, and participants were offered to receive the final, aggregated, survey results.

Given the structure of the questionnaire, items were neither randomized nor alternated. Skip logic (or conditional branching) feature was used to custom path through the survey, based on each respondent's answers. The survey included 15 items, (3 per page), distributed on 5 sections. Participants were able to monitor the questionnaire completeness through an automated "progression bar" before submission. All items but 5 provided a non-response option. During the survey, and after submission, respondents were able to review and change their answers. To minimize potential duplicate entries from the same user, participants were required to enter their initials, after the informed consent page. All questionnaires (completed and incomplete) were included and analyzed. At the end of the survey, a digital worksheet-database was extracted and hosted on a secured computer (limited access, personalized username and password). Once data completeness was controlled, each participant was de-identified (initials) and assigned to an anonymized alphanumeric code. The quality of data management was compliant to the reference methodology on personal data processing and protection (MR004), as stated by French data protection authority (*Commission Nationale de l'Informatique et des Libertés, CNIL n°22182020 v 0*).

Data analysis

Sample size

The expected sample size was 60 participants, corresponding to an expected rate of 15% of responses out of a total of 400 invitations sent.

Analysis methods

Descriptive analyses were performed on the characteristics of the participants (median and inter-quartile difference for continuous variables) and the number and percentage for categorical variables. No imputation was used in the event of missing data.

The primary endpoint, behaviour change (Kirkpatrik level 3)[13], was be measured by self-assessment on a 5-point Likert scale.

The effectiveness of the educational interventions was considered satisfactory if more than 75% of the participants gave an assessment in the highest region of the scale (4 or 5 on the 5-point Likert

scale). Result for the “e-learning” and “face-to-face” educational categories were analysed separately.

Secondary endpoints were evaluated according to the same modality. Analysis were performed using R v4.0.0 software (R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org), with *epidisplay*, *TableOne*, *ggplot2* and *likert* libraries.

RESULTS

Overall, 27 different e-Learning resources were identified (Table 1) with the network relationship among learning objectives and subgroups detailed in the figure 2.

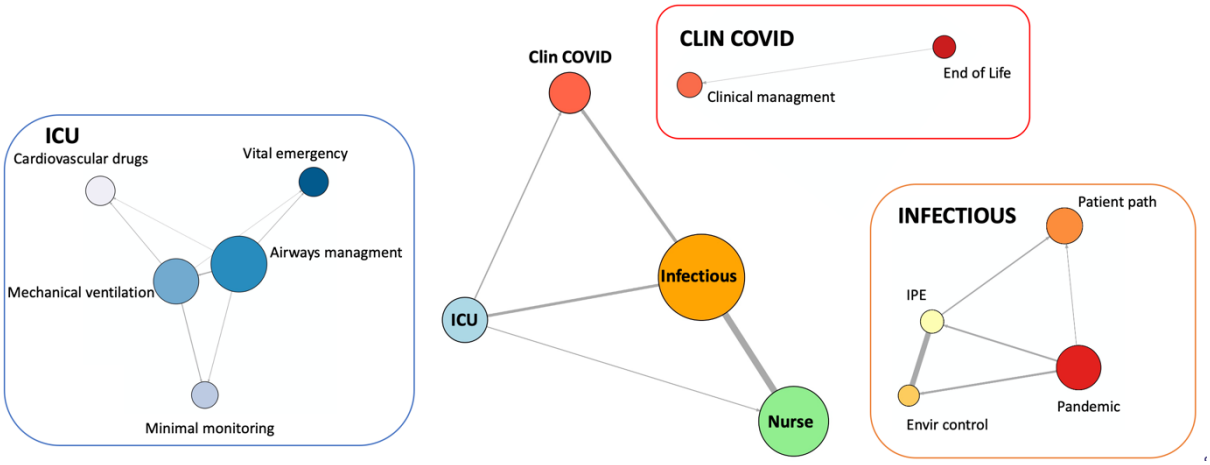

Figure 2. Network relationship between learning objectives and subgroups within the e-Learning delivery mode resources. (Clin COVID=Clinical management of COVID patients, ICU=Intensive Care Unit, DPI=Individual Protection Equipment, Envir Control=environmental control).

During the study period e-mail invitations were sent to 382 physicians: 49 opened the e-mail and followed the embedded survey link to participate. Of these, 37 surgeons (9.7%) with a median experience of 9.0 (5.0-17.0) years and exposed to educational interventions during the study period completed the survey. Responders were mainly digestive surgeons (n=19, 51.4%), with fellowship position (n=14, 37.8%), affected to an emergency (n=13, 35.1%) or COVID unit (n=12, 32.4%), with a role of physician (n=29, 78.4%). More details in Table 2 and Figure 3.

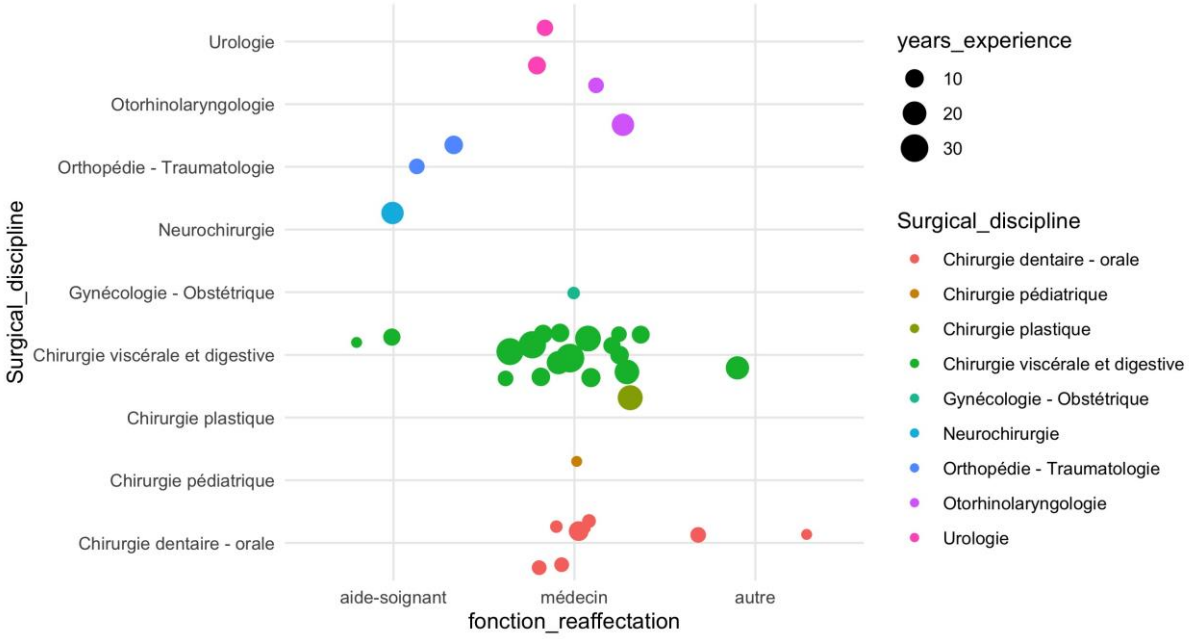

Figure 3. Scattered plot of responders (dots) classed by surgical discipline (rows-colours), experience (dot size) and position after reassignment (columns).

Among responders, only 14 (37.8%) received educational interventions before reassignment, essentially by e-Learning (n=7, 18.9%) and face-to-face in the AP-HP "Picpus" educational center (n=4, 10.8%). Nevertheless, the largest part of responders (n=20, 54.1%) were educated to the new reassignment tasks directly on the field, without any previous specific pedagogic intervention. More details in Table 3.

Primary endpoint: effectiveness of educational interventions on behavior change (Kirkpatrick level 3).

The effectiveness of the educational interventions on behaviour changes was rated within the highest region of the Likert scale by 22% (n=6) and 15% (n=3) for "face-to-face" and "e-learning" delivery modes, respectively (Figure 4).

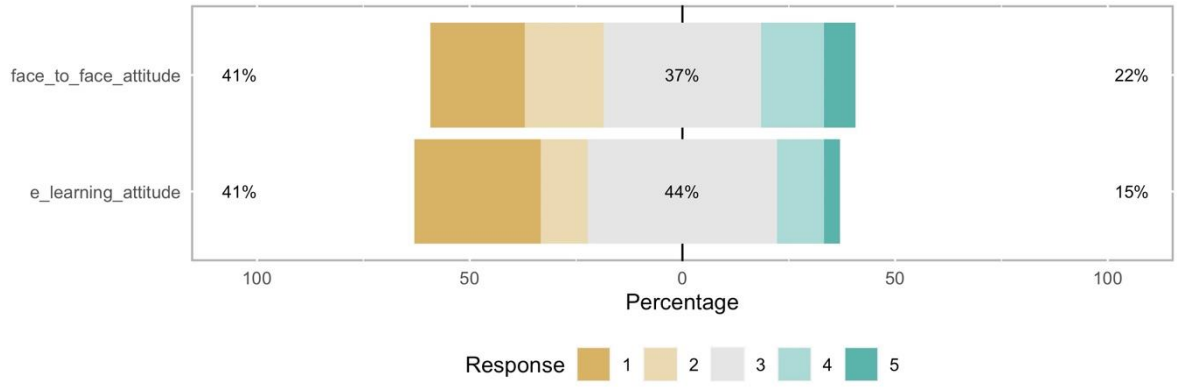

Figure 4. Likert plots representing the effectiveness of educational interventions on behaviour changes in daily attitude (Kirkpatrick 3), for each delivery mode. Response 1-2: disagree; response 3: neutral; response 4-5: agree.

Secondary endpoints

The satisfaction towards the interventions (Kirkpatrick level 1[13]) was rated within the highest region of the scale by 27% (n=7) and 33% (n=9) for "e-learning" and "face-to-face" delivery modes, respectively (Supplementary figure 1).

The assessment of knowledge acquired or improved skills (Kirkpatrick level 2[13]) was rated within the highest region of the scale by 27% (n=7) and 41% (n=11) for "e-learning" and "face-to-face" delivery modes, respectively (Supplementary figure 2).

The distribution of self-administered effectiveness scores for each delivery mode is presented in the Table 4.

DISCUSSION

This is one of the first studies carried out within the whole group of surgical disciplines involved during the COVID-19 pandemic, aiming at mapping the educational interventions available and their impact on this specific target population, within the AP-HP hospital network in Paris, France.

Both face-to-face and e-learning delivery modes of medical education were offered during the pandemic, with a wider spectrum within e-learning initiatives.

Prior to the COVID-19 crisis, medical education already documented the benefits of e-learning: increased accessibility to education, efficacy, cost effectiveness, learner flexibility and interactivity[12]. The e-learning diffusion process was significantly accelerated during the pandemic, challenging the traditional methods of teaching delivery. In this study the whole e-learning spectrum was observed, ranging from pre-registered slides, YouTube tutorials up-to virtual worlds such Second Life. The increased number of on-demand activities offered clinicians the ability to consume medical content at an unprecedented rate, accommodating a variety of personal learning styles.

Nevertheless e-learning is not an educational panacea[12], and evidence comparing e-learning versus face-to-face educational interventions reported similar satisfaction rates[14,15]. Hence research needs to further progress from simplistic pre/post-interventional designs evaluating knowledge or satisfaction: one suitable framework that is congruent with learning research is the Kirkpatrick's framework[13], and in particular level 3, considering whether the education influenced behaviour, as was used in the present study. The present study reports how for the primary outcome (effectiveness of educational interventions on behavior change - Kirkpatrick level 3), none of the educational interventions assessed was rated as satisfactory by the majority of responders (> 75%). The best result observed was about the increased knowledge after face-to-face educational interventions (secondary endpoints), hence rated as satisfactory by 41% of responders. In other words, none of the above-cited educational interventions delivery modes was rated as satisfactory by the majority of responders.

This observation seems in line with published evidence: while students are strongly supportive of digital online lab activities, the large majority of them still report a desire for a blend of online and in-person, hands-on activities[16]. Learners seems to be more engaged in the learning process when able to physically interact with an instructor[16].

One of the possible solutions to combine the advantages of both educational delivery modes may be the "blended learning", defined as the combination of traditional face-to-face learning and asynchronous or synchronous e-learning[17]. This educational solution appears to have a consistent positive effect in comparison with no intervention, and to be more effective than - or at least as effective - as nonblended instruction for knowledge acquisition in health professions[17]. In summary, blended learning could be promising and worthwhile for further application in health professions[17].

This study presents several limits. First, the participation rate was extremely low during the study period, that might be due to the physician's overexposure to interviews and surveys during the pandemic, similarly registering low rates of participations (COVID-IMPACT, HOP-COVID, COVIPRO, as well as similar discipline-oriented surveys as surgery and COVID, surgical emergency and COVID, surgical schedule and COVID…). The absence of incentives for the e-survey participation should be probably taken into account.

Moreover, the use of a self-assessed questionnaire might expose the survey's answers to a potential subjective bias.

Three more limits of the e-survey:

- Target population of surgeons: the extension of the survey to medical disciplines would probably had increase the response rate.
- Despite invitations were sent to some 390 physicians from 9 surgical disciplines, the largest part of responders (51.4%) were digestive surgeons. This bias is probably associated to the "snowball effect" or networking among the surgical discipline of the first author (RB).
- The survey was limited to the geographical - administrative perimeter of the AP-HP Hospital network. The national/international extension of this e-survey would be probably more informative.

In conclusion, this study allowed pointing out the range of educational interventions (face-to-face and e-learning) available during the pandemic, as well as the overall low satisfaction rate towards them. The impact of COVID pandemic should be seen as the occasion for a massive bench-test on health education: research agenda should focus on whether knowledge generated through e-learning, face-to-face or blended delivery modes is able to be re-contextualized into clinical practice, and influence sustained clinical behaviour change and patient outcomes. A largest survey beyond the AP-HP network and addressed to medical disciplines might offer insights on the value of such programs, to decide of their perennation in case of pandemic.

The data that support the findings of this study are available from the corresponding author, RB, upon reasonable request.

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Table 1. General characteristics of e-learning based educational resources.	
	(N=27)
Organizers	
Public Hospital	16 (59.3%)
Scientific Societies	5 (18.5%)
Private company	4 (14.8%)
ARS	1 (3.7%)
Ministry of Health	1 (3.7%)
Target	
Physicians	18 (66.7%)
Nurses	9 (33.3%)
Theories	
cognitivism	21 (77.8%)
behaviorism	5 (18.5%)
constructivism	1 (3.7%)
Learning Objectives	
Infectious	21 (77.8%)
Basic gestures for nurses	17 (63.0%)
COVID Clinical managment	11 (40.7%)
Intensive care medicine	10 (37.0%)
Material provided	
Videos	16 (59.3%)
MOOC	3 (11.1%)
Mixed	3 (11.1%)
Serious Game	3 (11.1%)
Guides	1 (3.7%)
Digital silmulation	1 (3.7%)
Incentives	
none	27 (100%)
Modes delivery	
Internet	25 (92.6%)
Independent study package	25 (92.6%)
Both	1 (3.7%)
Environment	
Computer based	27 (100%)
Schedule, frequency	
NA	25 (92.6%)
Weekly	2 (7.4%)
Schedule, sessions (n)	
Median [Min, Max]	6.00 [1.00, 37.0]
Missing	14 (51.9%)
Schedule, duration (hours)	
Median [Min, Max]	8.00 [1.00, 720]
Missing	10 (37.0%)
ARS=Agence Regionale de Santé, MOOC=Massive Online Open Course, NA=Not available n=number.	

Table 2. Characteristics of responders

	(N=37)
Surgical discipline	
Digestive surgery	19 (51.4%)
Oral surgery	8 (21.6%)
Orthopedics - traumatology	2 (5.4%)
Othorinolaringoyatry	2 (5.4%)
Urology	2 (5.4%)
Pediatric surgery	1 (2.7%)
Plastic and reconstructive surgery	1 (2.7%)
Obstetrics and Gynecology	1 (2.7%)
Neurosurgery	1 (2.7%)
Position	
Resident	8 (21.6%)
Fellow	14 (37.8%)
Registar	2 (5.4%)
Lecturer	2 (5.4%)
Consultant	8 (21.6%)
Professor	3 (8.1%)
Reassignment	
N	2 (5.4%)
Y	35 (94.6%)
Reassignment, fonction	
Triage or Emergency Department	13 (35.1%)
COVID Unit	12 (32.4%)
Regulation	8 (21.6%)
COVIDOM	6 (16.2%)
ICU	1 (2.7%)
DREPADOM	1 (2.7%)
Other	3 (8.1%)

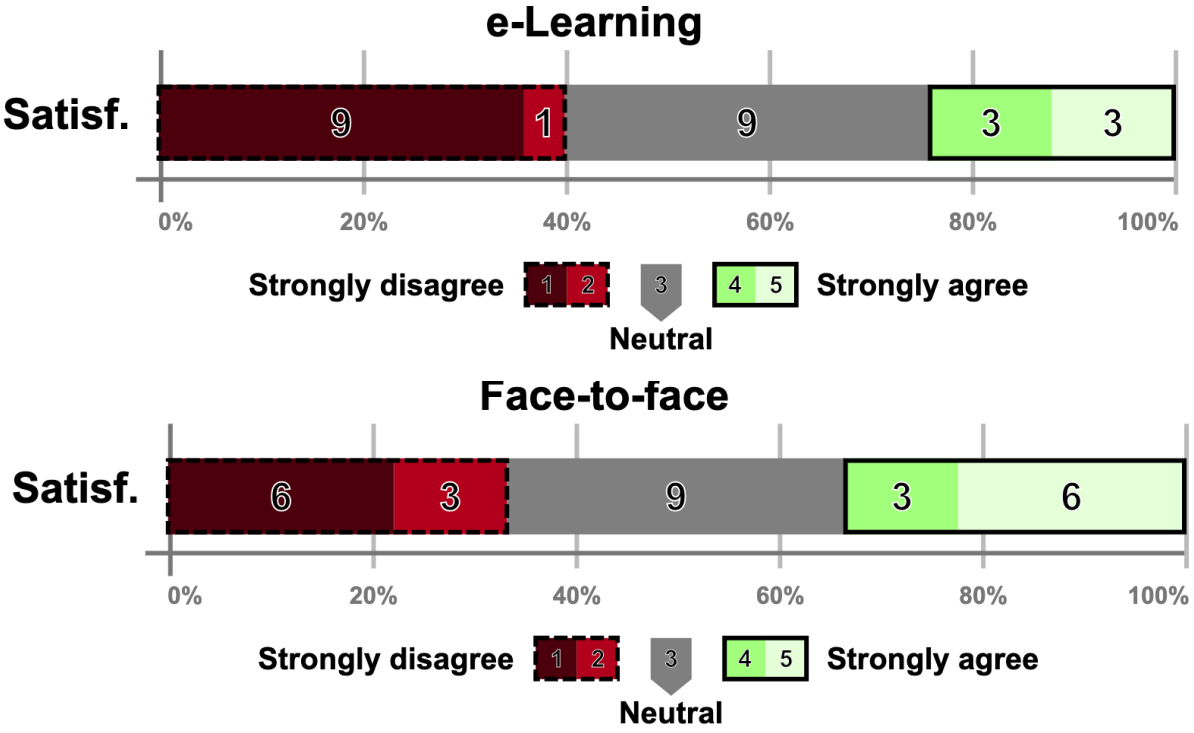
Table 3. Responders and Educational interventions

	(N=37)
Educational intervention before reassignment	
N	22 (59.5%)
Y	14 (37.8%)
N/A	1 (2.7%)
If not, Educational interventions would have been desired	
N	5 (13.5%)
Y	9 (24.3%)
Maybe	9 (24.3%)
N/A	14 (37.8%)
e-Learning	
N	29 (78.4%)
Y	7 (18.9%)
N/A	1 (2.7%)
Face-to-face, APHP "Picpus" Educational center	
N	32 (86.5%)
Y	4 (10.8%)
N/A	1 (2.7%)
Face-to-face, Nurse Schools (IFSI)	
N	36 (97.3%)
Y	0 (0%)
N/A	1 (2.7%)
Face-to-face, within the department of reassignment	
N	31 (83.8%)
Y	5 (13.5%)
N/A	1 (2.7%)
Face-to-face, "field training"	
N	16 (43.2%)
Y	20 (54.1%)
N/A	1 (2.7%)
Other (paper-based education)	
N	27 (73.0%)
Y	9 (24.3%)
N/A	1 (2.7%)

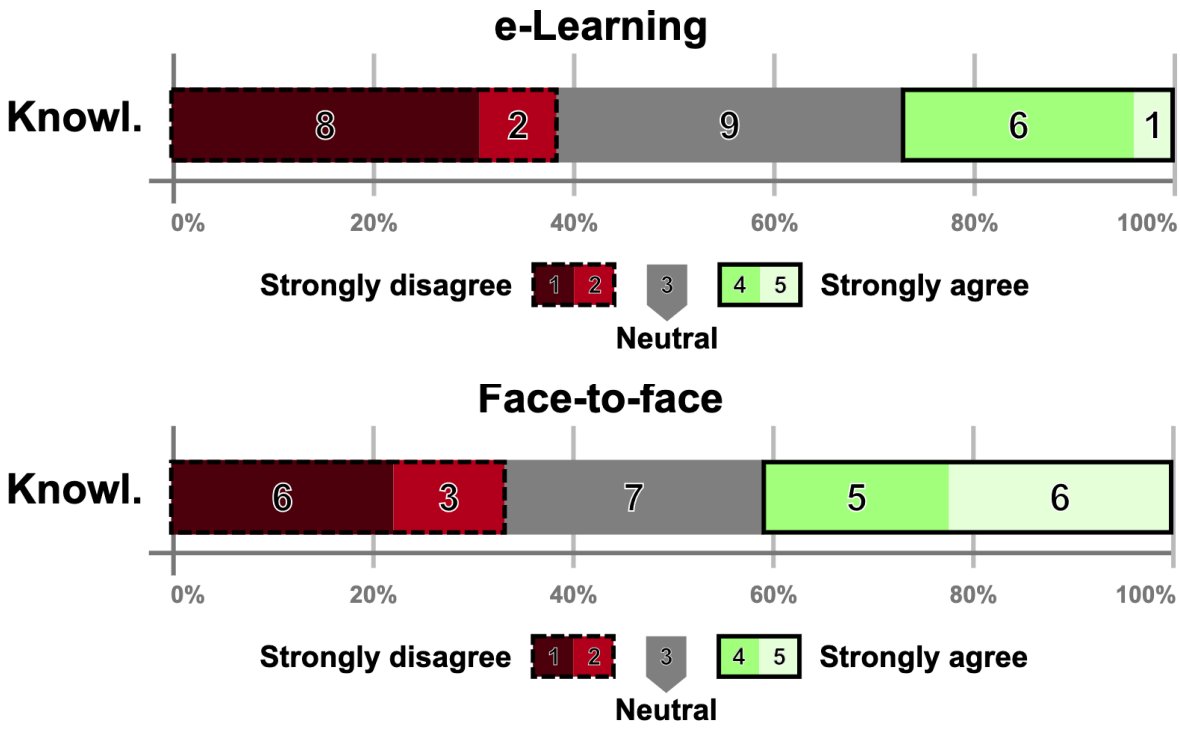
Table 4. The distribution of self-administered effectiveness scores for each delivery mode

Delivery mode	Likert	n	
e-Learning			
Satisfaction			
	1	26	35% (9)
	2		4% (1)
	3		35% (9)
	4		15% (4)
	5		12% (3)
Knowledge			
	1	26	31% (8)
	2		8% (2)
	3		35% (9)
	4		23% (6)
	5		4% (1)
Attitude			
	1	26	31% (8)
	2		12% (3)
	3		46% (12)
	4		12% (3)
	5		0% (0)
Face-to-face			
Satisfaction			
	1	27	22% (6)
	2		11% (3)
	3		33% (9)
	4		11% (3)
	5		22% (6)
Knowledge			
	1	27	22% (6)
	2		11% (3)
	3		26% (7)
	4		19% (5)
	5		22% (6)
Attitude			
	1	27	22% (6)
	2		19% (5)
	3		37% (10)
	4		15% (4)
	5		7% (2)

SUPPLEMENTARY FIGURES



S_Figure 1. Likert plots representing the satisfaction of educational interventions (Kirkpatrick 1), for each delivery mode. Satisf=satisfaction.



S_Figure 2. Likert plots representing the effectiveness of educational interventions on improved knowledge (Kirkpatrick 2), for each delivery mode. Knowl.=knowledge.