Lessons from the impact of COVID-19 on medical educational continuity and practices

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Abstract

The COVID-19 crisis necessitated abrupt transition to remote learning in medical schools. We aimed to assess the impact of COVID-19 on French undergraduate students and teachers, to identify practice changes, and to evaluate successes and areas for improvement of this remote learning experience. Data from 2 online questionnaires were analyzed with 509 participants among students and 189 among teachers from Sorbonne University. Responses to multiple choice, Likert response scale, and open-ended questions were evaluated. COVID-19 had negative impact on teaching continuity. Sixty-seven percent of students were in a dropout situation, and many suffered from psychological stress, leading to set up of a psychological support unit. Although most teachers (81%) and students (72%) had limited knowledge of digital resources, distance learning was quickly implemented, with a predominant use of Zoom. The analysis of several parameters revealed that students were significantly more satisfied than teachers by remote learning. Nevertheless, both students and teachers agreed to replace classical lectures by digital media and to promote in-person teaching in small interactive groups. This paper shares tips for faculty rapidly establishing remote learning. This comparative study of the students’ and teachers’ points of view underlines that new medical curricula should include more digital contents. We make recommendations regarding general university organization, equipment, and curricular development for long-term implementation of digital resources with reinforced relationships between faculty and students.

COVID-19; digital resources; remote learning; teachers; undergraduate student

INTRODUCTION

The coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV2), disrupted countless aspects of society and economy. On March 16, 2020, its high transmissibility led the French government to implement a confinement of the whole population for 2 mo. Preventive measures included enforced social distancing, closure of educational and public institutions, and stay-at-home orders except for essential tasks and daily exercise.

This had a profound impact on the education sector. Universities halted campus-based teaching, and supported continuing courses through online resources. Simultaneously, COVID-19 brought the health care system to the limits of its capacities. Since most teachers in medical schools combine hospital, teaching, and research duties, they were foremost mobilized to fight the disease and were less available for students. French medical students are also present in hospital wards from the second year of their curriculum (Supplemental Fig. S1; all Supplemental Figures are available at https://doi.org/10.6084/m9.figshare.14321576.v1). During confinement, many of them were encouraged to go into action and contributed in many ways to the care of patients affected by COVID-19. This brought in some anxiety but also enthusiasm with respect to their vocation. This large-scale mobilization was however at the expense of their theoretical training.

COVID-19 is not the first and will probably not be the last global health emergency that we will encounter (1, 2), but the exceptional scale of its waves urged us to rethink medical training. In particular, this catalyzed implementation of remote medical education for a period that will probably outlast this pandemic. Numerous articles have discussed the impact of COVID-19 on medical education, but they mostly consisted of editorials or opinion pieces (3–6), and as for...
studies, most of them focused on a single curricular discipline, offering a limited glimpse into the students’ global experience. Lastly, few reports have evaluated the impact of COVID-19 on undergraduate medical students before residency.

The aim of this study was thus to determine the impact of the COVID-19 outbreak on French undergraduate medical students from Sorbonne University (SU). SU, located in Paris, is a research-intensive, world-class university with three segments of education (medicine, science, and humanities) and a long tradition of academic excellence. Before COVID-19, the standard curriculum of medical students consisted of organ system block-based lectures, problem-based learning in small groups, laboratory-based classes, and apprenticeships in hospital wards. During lockdown, all theoretical classes and activities had to be conducted remotely and the possibility for students to be implicated in clinical services was very heterogeneous, going from complete cancellation of clerkship to full involvement in the front line. This study assesses the impact of COVID-19 on the continuity of theoretical medical teaching, lists the changes in practices made during that period, and evaluates the relative successes and failures of this remote learning experience. Two questionnaires were designed, one sent to all teachers from SU medical school and the other to undergraduate students before residency. Four major themes were addressed in the questionnaires: the impact of COVID-19 on the continuity of the educational program, the knowledge and experience of remote learning at the beginning of crisis, the changes in teaching formats made during that period, and the lessons drawn from this remote learning experience. The originality of this work is to provide a comparative study of the students’ and teachers’ points of view and to establish recommendations for curriculum design in the future.

Sharing this experience should benefit other medical schools or universities from different fields.

## MATERIALS AND METHODS

### Study Populations

This observational study was conducted in SU School of Medicine and was approved by the Data Protection Department from SU. It was based on the analysis of data from two online surveys. The first survey was sent to all teachers from SU medical school (n = 750) (see Supplemental Table S1; all Supplemental Tables are available at [https://doi.org/10.6084/m9.figshare.14380994.v1](https://doi.org/10.6084/m9.figshare.14380994.v1)). The second survey was dedicated to undergraduate students from the second to the sixth year of the curriculum, before residency (n = 2,103) (see Supplemental Table S2). First-year students were not implicated since they take a competitive exam and only a small proportion of them can continue the course of medical studies. The SU students of the second to the sixth year represent a homogeneous group of students who take theoretical courses at the university and follow part-time training in hospital departments (Supplemental Fig. S1). At the end of the sixth year, there is a national classifying exam serving as an entrance examination for residency. Residents working full time at the hospital were not included in this study.

### Survey Design

Questionnaires were designed by two investigators and combined multiple choice and Likert scale questions, with the option to provide further free text responses for some of the questions, as well as an overall reflection. Before sending out the survey, a representative focus group of teachers (n = 10) and students (n = 10) was conducted to ensure that questions were clear and cohesive. The whole project was validated by three home-institution staff members from the educational supervisory board. Questions from the survey were aimed at evaluating the overall impact of COVID-19 on the continuity of theoretical training and at establishing the main difficulties encountered by teachers and students. It collected the developments made on remote teaching. Participants rated their satisfaction regarding remote learning resources and expressed their views regarding distance teaching for the future.

### Survey Implementation

Responses to the survey were collected and managed using the Survey Monkey online platform. An invitation to participate in the survey via an electronic link was sent out by email, together with an introductory message from the educational supervisory board. Data were collected from June 10th to July 21st.

### Data Analyses

Statistical comparison was conducted in R (version 4.0) using chi-square tests and chi-square tests for trends. Graphs were generated in GraphPad Prism 6 software. Frequency distributions were represented by pie charts for binary variables and histograms for multinomial variables. The number of responses for multiple choice and Likert scale questions was always greater than 115 for teachers, and always greater than 378 for students. Differences were considered significant when P < 0.05. Free text comments from teachers (n = 271) and students (n = 996) were studied by two independent investigators. Comments representative of major thematic contents were extracted for illustration. Word cloud representations were also used to evaluate the importance of specific issues in free responses.

## RESULTS

### Participation Rate

A total of 189 teachers out of 750 responded to the survey with a response rate of 25%. All teaching departments were represented covering 40 medical disciplines (Supplemental Table S3). Five-hundred and nine students among 2,103 responded to the survey, with a participation rate of 24%. All years from the second to the sixth of the medical curriculum were represented. Respondents consisted of 144 second-year students (26%), 99 third-year (19%), 120 fourth-year (24%), 86 fifth-year (17%), and 12 sixth-year students (12%).

### Impact of COVID-19 on the Continuity of the Educational Program

One of the most immediate changes induced by COVID-19 was the broad cancelling of in-person classes. The capacity
of teachers to maintain distance teaching was very heterogeneous (Fig. 1A). As many as 15% of teachers were not in a situation to do any of their usual teaching duties, 50% maintained less than half of their classes, and only 13% of teachers gave all of the scheduled lessons. When we now consider remote lessons available during that period of time, follow-up by students was also very uneven: 6% of students did not follow any lesson, 36% less than half of courses, and 21% used all resources available. In open-ended questions related to this issue, there were 104 comments from students reporting incomplete courses and lack of clarity in digital media. Forty students reported the poor quality of sound and image in videos, which was a hurdle for the follow-up of many courses.

The reasons accounting for this gap in teaching continuity were not the same for teachers and students (Fig. 1B). Teachers reported a number of reasons, which were not mutually exclusive, to explain the absence of courses: cancellation by the education supervisory board (74%), hospital work overload (31%), difficulties in using new informatic tools (16%), lack of a receptive mind due to the stressful

Figure 1. Impact of COVID-19 on the continuity of the educational program. A: impact of COVID-19 on teaching duties. Left: repartition of teachers according to the proportion of lessons that they maintained. Right: repartition of students according to the proportion of courses that they followed. B: reasons accounting for the lack of teaching continuity. Top: reasons reported by teachers. Bottom: reasons mentioned by students. C: proportion of students in a dropout situation.
context (6%), difficulties in organization of family life (5%),
lack of a quiet place to work (3%), medical reasons (3%),
and lack of access to an internet connection at hospital (2%).
Additional reasons were added by students, mostly related
to mental health and well-being. They mentioned a lack of
motivation because of isolation feeling (53%), psychological
stress (46%), difficulties in personal organization of family
life (33%), lack of a quiet place to work (27%), hospital work
overload (26%), absence of internet access at home (7%),
medical reasons (4%), lack of internet access at hospital
(3%), technical difficulties in using new informatic tools
(3%), and lack of access to a computer (2%).
This strong impact of COVID-19 on the continuity of edu-
cational program was further underlined by the very high
proportion of students declaring to have fallen behind in
their teaching with a partial dropout rate of 51% and a com-
plete dropout in 16% of cases (Fig. 1C).

Knowledge and Experience of Remote Learning at the
Beginning of COVID-19 Crisis

SU was challenged by the abrupt transition to entirely
remote learning and we evaluated if students and teachers
felt prepared for this complete shift towards online educa-
tion. Only half of the teachers (52%) declared being aware of
technological tools and resources available for remote learn-
ing (Fig. 2A). Most teachers (81%) and students (72%) had no
experience in remote learning (Fig. 2B). For most teachers
(66%) and students (45%), their motivation to participate in

![Figure 2. Situational analysis of remote
learning at the beginning of COVID-19 cri-
sis. A: knowledge of resources available
for remote learning among teachers. B:
previous experience in using online
resources for distance teaching. C: moti-
vation level for distance teaching, as com-
pared with previous teaching formats.](http://advan.physiology.org)
remote learning was moderate, as compared with classical classes (Fig. 2C).

**Analysis of Changes in Teaching Format during COVID-19 Pandemic**

We did not identify any major innovation in the educational tools developed during that period of time. The first objective of teachers was to quickly adapt to remote learning. A very high number of teachers (77%) used video conference tools, especially Zoom (Fig. 3A). Students were highly supportive of this type of change, 147 of them praising the use of Zoom in free comments. The crucial role of Zoom for distance teaching was further underlined by a word-cloud analysis of free responses relative to the digital

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**Figure 3.** Implementation of distance teaching during COVID-19 outbreak. A: tools used by teachers to provide distance teaching. B: word cloud representations of free responses relative to the changes in teaching practice proposed by teachers (left), and most appreciated by students (right). C: perception of the interaction quality between teachers and students. D: perception of the quality of remote learning, as compared with in-person classes.
resources most used by teachers and most appreciated by students during confinement (Fig. 3B). Only 38% of teachers used e-learning platforms for submitting course materials, even though the Moodle online learning site of SU was already available before COVID-19. Lectures were also recorded with videos and audios in Panopto, allowing students to review contents at any time. During confinement, 27% of teachers used videos and 13% proposed new written course materials. Some teachers (5%) also tried to facilitate interactions with students using Wooclap, which was very appreciated. Additional initiatives were taken, such as the creation of practice exchange groups, forums, and video chats. Free comments from teachers revealed three main concerns regarding the implementation of these changes.

Figure 4. Lessons from the remote learning experience during COVID-19 crisis. A: overall satisfaction on distance teaching of teachers (left) and students (right). B: comparative need for training on new online resources in teachers (left) and students (right). C: regret for the lack of face-to-face teaching during confinement expressed by teachers (left) and students (right). D: opinions of teachers (left) and students (right) on the proportion of distance course to be kept in the future.
First, they did not have professional licenses to use Zoom or Skype. Second, they expressed the need to reinforce the secretariat for digital resources in charge of technical issues, with allocation of a dedicated staff. Finally, they lacked computers equipped with good cameras and microphones. The presence of tight firewalls on hospital computers, where many physicians were stuck because of the pandemic, has also considerably limited the implementation of distance learning.

The perception of the quality of interaction during remote lessons was different between teachers and students \((P = 4 \times 10^{-16})\). Less than half of teachers (40%) ranked it as “good” or “very good” against 63% of students (Fig. 3C). When the majority of students underlined the necessity of part-time face-to-face teaching for better interactivity, a small number of students reported feeling less shy about asking questions during remote courses. In free comments, many teachers emphasized the irreplaceable value of attending some sessions in person, lauding the real-time feedback and exchange that develop in class.

Teachers were less convinced than students by the overall quality of distance teaching, as compared with in-person classes \((P = 7 \times 10^{-15})\). More than half of the teachers (56%) considered remote learning less contributive and ranked it as “far less good” or “less good” than classical in-person teaching. Only 32% of students shared the same opinion, 41% evaluating it as equivalent, and 27% ranking it as “better” or “far better” (Fig. 3D).

Lessons from Remote Learning during COVID-19 Crisis

Regarding the overall satisfaction of distance teaching, students were more satisfied than teachers \((P = 5 \times 10^{-7})\) (Fig. 4A). Indeed, 62% of students declared to be rather satisfied or very satisfied, as compared with 39% of teachers with a similar satisfaction level.

There was a crucial need for training on digital resources among teachers, 75% of them expressing their wish for additional training, when only 13% of students had the same need (Fig. 4B).

The regret of not having face-to-face teaching was more present among teachers (70%) than among students (55%) \((P = 3 \times 10^{-3})\) (Fig. 4C).

Students were also more prone than teachers to keep a high percentage of remote learning in the future \((P = 1 \times 10^{-13})\). Among them, 42% wished to have more than half of their classes online, whereas only 10% of teachers expressed the same wish (Fig. 4D). The two main reasons reported by students in free comments to explain their attachment for remote learning were saving time in public transport and a better organization in daily life. Nevertheless, the great majority of them considered that direct contact with teachers and classmates was a real necessity for their psychological well-being, social life and for proper acquisition of knowledge and skills. The great majority of teachers considered that the curriculum should combine face-to-face and distance teaching. When considering all comments, the emerging consensus was to replace in-person lectures by recorded digital media combined with a higher number of interactive sessions in small groups.

### DISCUSSION

Remote learning has gained popularity in higher education over the last decade, yet its integration into the French medical curricula has been relatively slow. While students had the possibility to use some digital resources, most courses were still in-person, a format that students seem more and more disinterested by. The abrupt transition to remote learning due to COVID-19 led to rapidly develop different means of delivering courses to meet complex learning objectives, and precious lessons can be learned to benefit medical education (Table 1). A number of findings from our study could be expected, such as the overall negative impact of COVID-19 on the continuity of teaching, the need for training in digital resources, or the pronounced interest of students in distance teaching. However, we had no idea of the relative perception that teachers and students might have of the large-scale development of distance teaching implemented simultaneously in all teaching departments and in all years of the curriculum. In addition, we did not expect to find so many students in a dropout situation, and we thought that there would be a greater diversification of teaching materials offered by teachers for distance learning.

A number of studies have shown that quarantine is associated with negative psychosocial outcomes, including depressive symptoms, anxiety, and stress \((7–9)\). Our study underlines the negative impact of confinement on medical students. They did show deterioration in their study performances, more than 65% of them declaring to have fallen behind in their curriculum. They especially reported isolation feeling and psychological stress. Many felt disconnected from medical school and missed the positive effect of socialization associated with studying and working together. To try to circumvent this phenomenon, a psychological support unit was set up in April 2020, each student receiving phone calls from a dedicated mentor to keep a link and identify potential difficulties. We think that such initiatives should

### Table 1. Resources needed for the development of remote teaching, based on the experience of COVID-19 crisis

| General Organization | Equipment | Medical Curriculum | Continuing Medical Education |
|----------------------|-----------|--------------------|-----------------------------|
| Department for digital resources with dedicated staff | Professional licenses for videoconference tools (Zoom, Wooclap, Skype . . .) | Recorded digital media to replace traditional in-person lectures | Training on digital resources, especially for teachers |
| Coordination board for remote learning integration, made of faculty leaders and administrative staff | Laptops equipped with cameras and microphones available for teachers | Higher number of interactive sessions dedicated to small groups of students | |
| Psychological support unit for students, mobilizable at any time in situation of health crisis | Financial support for precarious students in need of informatic equipment or internet access | | |

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be encouraged in the future. In addition, due to COVID-19, an exceptional measure was implemented in SU for grading of students in 2020. Usually, a student who fails an exam for a given subject in the first test in June and in the retake exam in September, repeats the academic year. In 2020, students who failed in a single subject were able to pass into the next academic year with a debt, which consists of retaking that exam the following year. Only 15 students out of the 750 were affected by this exceptional measure.

Two difficulties shared by many teachers and students during the first wave of COVID-19 were hospital work overload and difficulty in organization of daily life. Hospital resources were stretched in efforts to contain the outbreak. Many teachers were called in to work and, with schools and daycares being closed, it was a challenge to work and take care of children at the same time. Many students were also directly involved in the management of the health crisis and could not work and study at the same time. This resulted in medical training taking a back seat. About one-third of students felt that their living conditions were not conducive to remote learning. This was primarily attributed to a lack of a quiet space to study, bad internet connection, or lack of a computer. In this regard, a plan to help students to buy computers at reduced costs has been set up. A plan to make laptops equipped with good cameras and microphones available for teachers seems also necessary.

When confinement started in Paris, two-thirds of the school year had already passed, so that many students ended their year without too much disturbance. Thanks to the work of committed faculty and staff as well as the resilience and adaptability of students, medical education continued despite the circumstances, which significantly affected the delivery of planned courses. A huge effort has been made by teachers and students to develop and use distance learning tools, given the little experience they had. An additional improvement would be to create a coordination board, involving school leaders and department faculty, for remote learning integration into the medical curriculum.

COVID-19 has been a trigger to leverage technology for medical education. Recent events have allowed us to take a step back and carefully examine our own teaching practices (10). We have learned that many curricular elements can be delivered just as well virtually as in classrooms and amphitheaters. Videoconferencing applications such as Zoom offer live streaming functions, which are very useful for interactive and problem-based solving sessions (11, 12). These changes, brought on by necessity, will probably have lasting impact on medical training (13–15), especially since digital resources have proven to increase student commitment to learning (16). The younger generations are perhaps best equipped to integrate innovative online settings into learning practices. The current study reveals that most students will readily embrace this shift to e-learning, valuing the personalized and flexible learning experience. In contrast, it would be very useful for many teachers to get additional training for some of these tools, as done in other universities (17). It seems now obvious that new curricula, which are being transformed (18), should combine remote learning and in-person teaching. The main concern is that the replacement of in-person classes with online equivalents might create a loss of interaction. Direct interactions with students are certainly decisive to develop critical thinking, lifelong learning engagement, and a collaborative state of mind. We propose to favor in-person small-sized group activities that focus on collaborative case-based or problem solving, simulation, and learning of technical skills. This should reinforce relationships between students and teachers in the spirit of companionship.

Medical education is not only imparting of knowledge (19). Involvement of students in the crisis management might have contributed to the development of noncognitive skills. Many students were in charge of unexpected tasks (20, 21), such as development of telehealth medicine, which will be an essential new tool in medicine practice. Some students were implicated on the front line in the management of COVID-19 cases, thereby being taught important lessons in courage, empathy, and teamwork. Lessons have also been taught in the rational management of limited resources, such as personal protective equipment and isolation facilities. These learning opportunities can be hard to come by in classical training and are also important for future healthcare professionals.

This study, which summarizes how COVID-19 has reshaped education in SU, allows us to draw positive lessons. This should help medical schools to create new curricula including more virtual learning and more in-person small-sized group activities to reinforce relationships between faculty and students. Sharing experiences across the globe should lead to major pedagogical advances throughout educational systems and specifically medical education.

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DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

C.V., A.C., A.H., and I.J. conceived and designed research; C.V., M.R., N.S., and I.J. analyzed data; I.J. prepared manuscript; C.V., A.C., M.R., N.S., A.H., and I.J. edited and revised manuscript; C.V., A.C., M.R., N.S., A.H., and I.J. approved final version of manuscript.

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