

1 **The Impact of COVID-19 Pandemic on the Academic Performance of Veterinary Medical Students**

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17

1 **Abstract**

2 Many universities and colleges worldwide suspended classroom teaching due to the novel coronavirus pandemic and
3 switched to online teaching. The current cross-sectional study was carried out to analyze the impact of lockdown due
4 to coronavirus disease 2019 (COVID-19) pandemic on the academic performance of veterinary medical students and
5 researchers. Veterinary medical students and researchers were invited to answer an online google form questionnaire.
6 A total of 1398 participants were from 92 different countries answered the questionnaire with response rate of
7 94.52%. The data showed that COVID-19 pandemic lockdown affected the academic performance of most
8 participants (96.7%) with varying degrees. The mean evaluation scores for the online education in general was
9 5.06 ± 2.43 while that for the practical parts was 3.62 ± 2.56 . Although online education provides an opportunity for
10 self-study. The main challenge online education faces in veterinary medical science is how to give practical lessons.
11 Since most of the subjects are practical; therefore, it is not easy to learn it online. Students think that it is difficult to
12 fulfill the veterinary competencies only with online education system. Online education can be improved by making
13 it more interactive, showing medical procedures in real situations, giving concise information, and providing 3D
14 virtual tools to mimic the real situation.

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17 **Keywords:** academic performance; COVID-19; veterinary; online learning

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1 **Introduction:**

2 Coronavirus disease 2019 (COVID-19) is firstly identified in Wuhan city, Hubei Province, China in December 2019
3 as a pneumonia of unknown origin [1]. Later, the causative agent of COVID-19 is identified as a novel coronavirus,
4 severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). COVID-19 outbreak spreads rapidly not only in
5 China, but also worldwide, therefore, the World Health Organization (WHO) has announced it as pandemic on
6 March 12, 2020. The total number of confirmed cases and mortalities are 15,785,796 and 640,016, respectively in
7 216 countries as of July 26, 2020 [2].

8 Several governmental measures have been taken to counteract the risk of disease spreading. These measures
9 include travel restrictions, mandatory quarantines for travelers, social distancing, bans on public gatherings, schools
10 and universities closure, business closures, self-isolation, and asking people to work at home [3, 4]. Authorities in
11 several countries worldwide have declared either lockdown or curfew as a measure to break the fast spread of virus
12 infection [5]. These measures have a negative worldwide effect on the business, education, health, and tourism [6].

13 COVID-19 pandemic has affected all levels of the education system [7]. Educational institutions around the
14 world (in 192 countries) have either temporarily closed or implemented localized closures affecting about 1.7 billion
15 of student population worldwide [8]. Many universities around the world either postponed or canceled all campus
16 activities to minimize gatherings and hence decrease the transmission of virus. However, these measures lead to
17 higher economical, medical, and social implications on both undergraduate and postgraduate communities [7, 9].

18 Due to the suspension of classroom teaching in many colleges and universities, a switch to the online teaching for
19 undergraduate and graduate students becomes effective (reviewed in [10, 11]). This form of learning provides an
20 alternative way to minimize either the contact between students themselves or between the students and lecturers [6].
21 However, many students have no access to the online teaching due to lack of either the means or the instruments due
22 to economical and digital divide [12].

23 Few studies highlighted COVID-19 in relation to educational studies. COVID-19 has a profound impact on
24 medical students, dental medical students, and radiology trainee [13-18]. Recently, the American Veterinary Medical
25 Association (AVMA) showed that COVID-19 adversely impacted veterinary practices based on
26 a large survey inculing about 2000 responses [19]. However, there is no studies investigated the effect of COVID-19
27 on students in veterinary medical field. Therefore, the current study was conducted to analyze the impact of COVID-
28 19 pandemic on the academic performance of veterinary medical students and researchers during the lockdown.

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1 **Materials and Methods:**

2 ***Questionnaire design and participants:***

3 An online anonymous questionnaire was designed and an initial test was done on 50 participants to ensure that the
4 draft questionnaire was understandable. The aim and uses of data of the questionnaire were briefly explained at the
5 beginning of the questionnaire. An online google form questionnaire was designed and the questionnaire link was
6 shared with different veterinary groups in various social media platforms. Veterinary students and researchers were
7 asked to answer the questionnaire for a research purpose. Participants were also asked to share the questionnaire link
8 among their veterinary colleagues; therefore, the questionnaire could reach many participants. The final
9 questionnaire for this study consisted of 14 questions divided into two sections as follow: The first section included 7
10 questions about the demographic characteristics of participants (age, gender, country, university, program level,
11 academic year, and residence place). The second section evaluated the effect of COVID-19 pandemic on the study or
12 research, and the online learning during the lockdown (virtual learning tools used, time spent per day in online
13 learning, evaluation of online learning both in the theoretical or practical parts, common problems encountered in the
14 online learning, and suggestions to improve the online learning). This section consisted of 9 questions as follow: 3
15 single-choice questions, 3 multiple-choice questions, one Likert-scale question, and two question with free text
16 answer.

17

18 ***Data collection:***

19 Sample size was calculated to be 384 participants as a minimum number of participants [20]. Data collection was
20 done using a spreadsheet linked to the online google form questionnaire. Data collection was done during the period
21 from April 13 until August 10, 2020. A total of 1418 responses were retrieved of which 78 responses were excluded.
22 All procedures were done in accordance with the standards of the institutional ethics committee of the South Valley
23 University, Egypt.

24

25 ***Statistical analysis:***

26 Data were exported and analyzed using SPSS version 21.0 (IBM Corporation). Descriptive statistics were presented
27 as counts and percentages to summarize the collected data.

28

1 **Results:**

2 **Demographic characteristics of participants:**

3 A total of 1479 responses were retrieved of which 81 responses were excluded due to mismatched data. The
4 remaining 1398 responses were from 92 different countries with an overall response rate of 94.52%. However, the
5 participation rate was unequally distributed among those countries (Table. 1). Of the 1398 participants, 678 (48.50%)
6 were males, and 720 (51.50%) were females (Table. 2). The age of participants ranged from 17 to 52 years (mean \pm
7 SD = 24.05 ± 6.0 years). About 52.9% of the participants were aged 17-22 years, 38.3% were aged 23-32 years, 5.7%
8 were aged 33-42 years, and 3.1% were aged 43-52 years. The majority of the participants (80.7%, n=1128) were
9 undergraduate students while postgraduate students comprised 19.3% (n=270). About 55.65% (n=778) of students
10 were residents in a city while 44.35% (n=620) were residents in rural areas (Table. 2).

11

12 **The effect of COVID-19 pandemic lockdown on academic performance:**

13 To measure the effect of COVID-19 pandemic lockdown on academic performance of veterinary medical students, a
14 5-Point Likert Scale was used. Students' answers were converted into numeric value as follow (greatly affected = 5
15 points; considerably affected = 4 points; moderately affected = 3 points; slightly affected = 2 points; not affected = 1
16 point) [21]. The current data showed that the average evaluation was 4.03 ± 1.11 points. Most of participants 96.7%
17 (n=1352) believed that COVID-19 pandemic lockdown affected their academic performance with varying degrees.
18 Nearly half of the participants (47.6%, n=666) were greatly affected whereas 19.9% (n=278) were considerably
19 affected, 23.3% (n=325) moderately affected, and 5.9% (n=83) were slightly affected. Whereas only 3.3% (n=46) of
20 participants reported that lockdown had no effect on their academic performance (Table. 3).

21

22 **Evaluation of online education during COVID-19 pandemic lockdown:**

23 Data showed that participants used several electronic device to study online. The most used device was the
24 smartphone (51.1%) followed by laptop (32.8%) and tablet (9.6%), while the least used device was the personal
25 computer (6.5%) (Fig. 1A). The studying hours spent for online learning ranged from less than 1 h/day to 14 hrs/day
26 with an average of 3.11 ± 1.94 hrs/day. Regarding the frequency of online studying hours, about 44.78% (n=626) of
27 participants spent up to 2 hrs/day in online learning, while 49.14% (n=687) of participants spent 3-6 hrs/day, and
28 6.08% (n=85) of participants spent 7-14 hrs/day. To evaluate the online education during the pandemic lockdown, a

1 10-Point Likert Scale was used. Participants were asked to evaluate the online education in general, and the online
2 education in practical lessons during the lockdown (1 was the lowest evaluation and 10 was the highest
3 evaluation). The mean evaluation scores for the online education in general was 5.05 ± 2.43 while that for the
4 practical parts was 3.64 ± 2.57 . About 56.87% (n=795) of participants evaluated the online learning in general with 1-
5 5 of 10 points, while 78.33% (n=1095) of participants evaluated the online learning in practical lessons with 1-5 of
6 10 points (Fig. 1B).

7 Participants showed that the online study materials were available mostly through online classes and pdf lectures
8 followed by e-books, YouTube videos, university platforms, educational websites and educational applications (Fig.
9 2A). Different online tools had been used to access the online classes. The distribution of these online tools was as
10 follow; Zoom had the highest preference followed by WhatsApp, Google classroom, and social networks. Microsoft
11 Teams, Edmodo, Skype, and Google Meet were moderately used. While Canvas, Edpuzzle, Adobe connect, and
12 Edverum were not popular tools (Fig. 2B).

13 **Advantages of online learning of veterinary medical sciences:**

14 The advantages of online learning according to the opinion of some students could be summarized as follow:

15 • More convenient and flexible than ordinary classes
16 • Students have more time to learn and do other activities
17 • Saves time and provides an opportunity for self-study

18

19 **The common problems with online learning of veterinary sciences:**

20 The participants' responses regarding to the common problems with online learning could be summarized as follow:

21 • Loss of interest
22 • The availability of internet to students live in provincial and rural areas.
23 • Speed and cost of internet hinder proper delivery of study materials by both students and lecturers.
24 • The availability of learning devices, such as laptops, tablets and smartphones devices to access the internet
25 and view the online materials.
26 • The shortness of the available time to solve the online test, which causes panic.
27 • Lack of application in the clinical setting for the things we learned from book.
28 • Lack of online information about certain subjects, such as veterinary anatomy.

- 1 • It is hard to teach the practical lessons of clinical subjects in online basis.
- 2 • Spending long time in online learning makes the students loss their motivated to participate, also they feel
- 3 tired with sleeping issues.
- 4 • The availability of online resources, some lectures are provided in PowerPoint or pdf format, or lecturers
- 5 just read from a PowerPoint.
- 6 • Less interactive due to no contact between students, professors and animals, which makes it very boring and
- 7 easily lose concentration.
- 8 • Lack of effective communication
- 9 • Some students have the sense of loneliness

10

11 Recommendations to improve online learning in veterinary science:

12 The students' recommendations regarding improvement of the online learning were summarized as follows:

- 13 • The universities should provide platforms for online learning with easy access to the study materials.
- 14 • Provide students with electronic devices, such as computers, smart phones to access the internet.
- 15 • Improvement of internet speed and providing cheaper or even free internet package during the pandemic.
- 16 • Provide training for lecturers on e-learning tools and computer skills.
- 17 • Improve the way of teaching to encourage students to learn and attract them to study online.
- 18 • Provide virtual resources to mimic the laboratory work or live streaming directly from the laboratory.
- 19 • Enhance the interaction between students and teachers (for example with Mentimeter application).
- 20 • Practical learning throughout interactive tools, such as videos and 3D animation is significantly more
- 21 effective than text materials such as power point and pdf, voice recordings should be provided with the
- 22 lecture's text.
- 23 • Provide accessible online resources such as e-books and instructional videos for practical lessons.
- 24 • Decrease the amount of classwork could help reducing students' stress.
- 25 • Provide online quizzes and assignments after every lesson to measure the degree of students' understanding.
- 26 • Increase the available time to solve the online tests.

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1 **Discussion:**

2 The novel COVID-19 disease identified in Wuhan city, China in December 2019 spreads rapidly not only in China,
3 but also worldwide. Therefore, governments around the world have either temporarily closed or implemented
4 localized closures of educational institutions affecting over 60% of student population worldwide [8]. About 155
5 countries worldwide have introduced various tools and learning platforms as a solutions to continue the education
6 process during the pandemic [22].

7 Many universities around the world minimized gatherings through suspending or canceling all campus activities
8 including suspension of classroom teaching to decrease the rapid spread of virus. Consequently, several colleges and
9 universities worldwide switch to the online teaching for undergraduate and graduate students [10] to minimize either
10 the contact either between the students and lecturers or between students themselves [6].

11 Our data showed that 1398 participants from 92 countries answered the questionnaire, which represented an
12 overall response rate of 94.52%. Participants were 48.50% and 51.50% males and females, respectively. The
13 majority of the participants (80.7%) were undergraduate students while postgraduate students comprised 19. 3%. The
14 current data showed that COVID-19 pandemic lockdown affected the academic performance of most participants
15 96.7% with varying degrees. This is in agreement with previous studies, which reported that COVID-19 has a
16 profound impact on medical students, dental medical students, and radiology trainee [13-18]. Taking online courses
17 has a negative effect on students; reduction of students' progress and success has been reported to be associated with
18 taking online college courses, instead of traditional in-person courses [23].

19 The current study showed that the most popular device that students used to access the online materials was the
20 smart phone followed by laptop, while the least used tool was the personal computer. This results are in accordance
21 with the results reporting that students uses smart phones and laptops at higher rates followed by iPads/tablets then
22 PC to access online mathematics lessons [24] and social media [25]. It is worth to mention that many students have
23 no access to the online teaching due to lack of either the means or the instruments because of economical and digital
24 divide [12]. Unequal access to computers and internet alters the effectiveness of online learning [26].

25 The studying hours spent for online learning ranged from less than 1 h/day to 12 hrs/day. Other than live
26 streaming, students can access the online materials at any hour of the day when convenient to them. This flexibility
27 helps some students to better invest their time and efforts while it is considered as a challenge to other students who
28 cannot manage their own time [23]. Our data showed that Zoom had the highest preference followed by WhatsApp,

1 and Google classroom while Microsoft Teams, Edmodo, Skype, and Google Meet were moderately used in their
2 online learning. It has been reported that freely available software, such as Zoom, Google Meet, Microsoft Teams,
3 and WebEx are used widely in online teaching of medicine than others [27].

4 The most common problems associated with online education in general included the availability of internet in
5 provincial and rural areas, the speed and cost of internet, the availability of electronic devices to access the internet,
6 and the lack of interaction between students and lecturers. While specific problems associated with online education
7 of subjects of veterinary science included lack of application of the clinical setting, lack of online information about
8 certain subjects, such as veterinary anatomy, challenging of teaching the practical lessons online, and lack of contact
9 with animals.

10 To improve online education in general it is recommended to provide platforms for online learning, provide
11 students with electronic devices to access the internet, improve the internet speed, provide cheaper or even free
12 internet package during the pandemic, provide professional training for lecturers, and enhance the interaction
13 between students and teachers. Additionally, to improve online education in veterinary science it is recommended to
14 provide virtual resources to mimic the laboratory work, teach practical lessons by interactive tools, such as videos and
15 3D animation, and provide accessible e-books and instructional videos for practical lessons.

16

17 **Concluding remarks:**

18 Online education helps to keep the students up and running with an opportunity for self-study. However, the main
19 challenge online education faces in veterinary medical science is how to give practical lessons. Since most of the
20 subjects are practical; therefore, it is not easy to learn it online. Students think that it is difficult to fulfill the
21 veterinary competencies only with online education system. Online education can be improved by making it more
22 interactive, showing medical procedures in real situations, giving concise information, and providing 3D virtual tools
23 to mimic the real situation.

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25 **Limitation of the study:**

26 Due to distribution of the questionnaire online, some countries were represented by a few participants, however,
27 inclusion of these countries in the study provided an overview of global differences in students' perceived impacts of
28 the COVID-19 pandemic on their academic performance

29

1 **Table. 1:** Country list and the percentage of participants

COUNTRY	NUMBER	COUNTRY	NUMBER	COUNTRY	NUMBER	COUNTRY	NUMBER
Egypt	151	Belgium	14	Lithuania	5	Canada	2
India	123	Slovakia	14	Myanmar	5	Denmark	2
Philippines	102	Tanzania	13	Palestine	5	Estonia	2
Pakistan	75	Kosovo	13	Puerto Rico	5	Guatemala	2
Nigeria	63	Iraq	11	Sri Lanka	5	Hungary	2
Australia	53	Zambia	11	South Sudan	5	Mongolia	2
Indonesia	41	Brazil	10	Sudan	5	Norway	2
Somalia	41	Perú	9	Sweden	5	Portugal	2
Kenya	41	Uganda	9	Taiwan	5	Senegal	2
Poland	39	Algeria	8	Vietnam	5	Serbia	2
USA	38	Colombia	8	Cameroon	4	Syria	2
Croatia	35	Italy	7	Laos	4	Yemen	2
UK	32	Ukraine	7	Malaysia	4	Azerbaijan	1
Romania	31	Greece	7	Moldova	4	Costa Rica	1
Jordan	28	Czech republic	6	Russia	4	Gambia	1
Thailand	26	Bosnia and Herzegovina	6	The Netherlands	4	Kazakhstan	1
Ghana	26	Ireland	6	Botswana	3	North Cyprus	1
Mexico	23	France	6	Hong Kong	3	North Macedonia	1
Nepal	23	Lebanon	6	Japan	3	Switzerland	1
South Africa	18	Libya	6	New Zealand	3	Turkey	1
Bulgaria	18	Afghanistan	5	Rwanda	3		
Ethiopia	17	Albania	5	Spain	3		
Morocco	15	Argentina	5	Austria	2		
Bangladesh	14	Germany	5	Cambodia	2		

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1 **Table2.** Sociodemographic characteristics of participants

2

3 Variables	4 Number	5 Male	6 Female
Total number	1398	678 48.50%	720 51.50%
Educational level			
Undergraduate students	1128 (80.69%)	494	634
- 1 st year students	205 (14.66%)	103	102
- 2 nd year students	269 (19.24)	120	149
- 3 rd year students	233 (16.67%)	103	130
- 4 th year students	195 (13.95%)	71	124
- 5 th year students	145 (10.37%)	51	94
- 6 th year students	81 (5.79%)	46	35
Postgraduate students	270 (19.31%)	184	86
- Diploma	110 (7.87%)	82	28
- Master students	104 (7.44%)	67	37
- PhD students	56 (4.01%)	35	21
Residential area			
- City	778 (55.65%)		
- Rural area	620 (44.35%)		

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1 **Table 3.** Impact of COVID-19 lockdown on participants' performance.

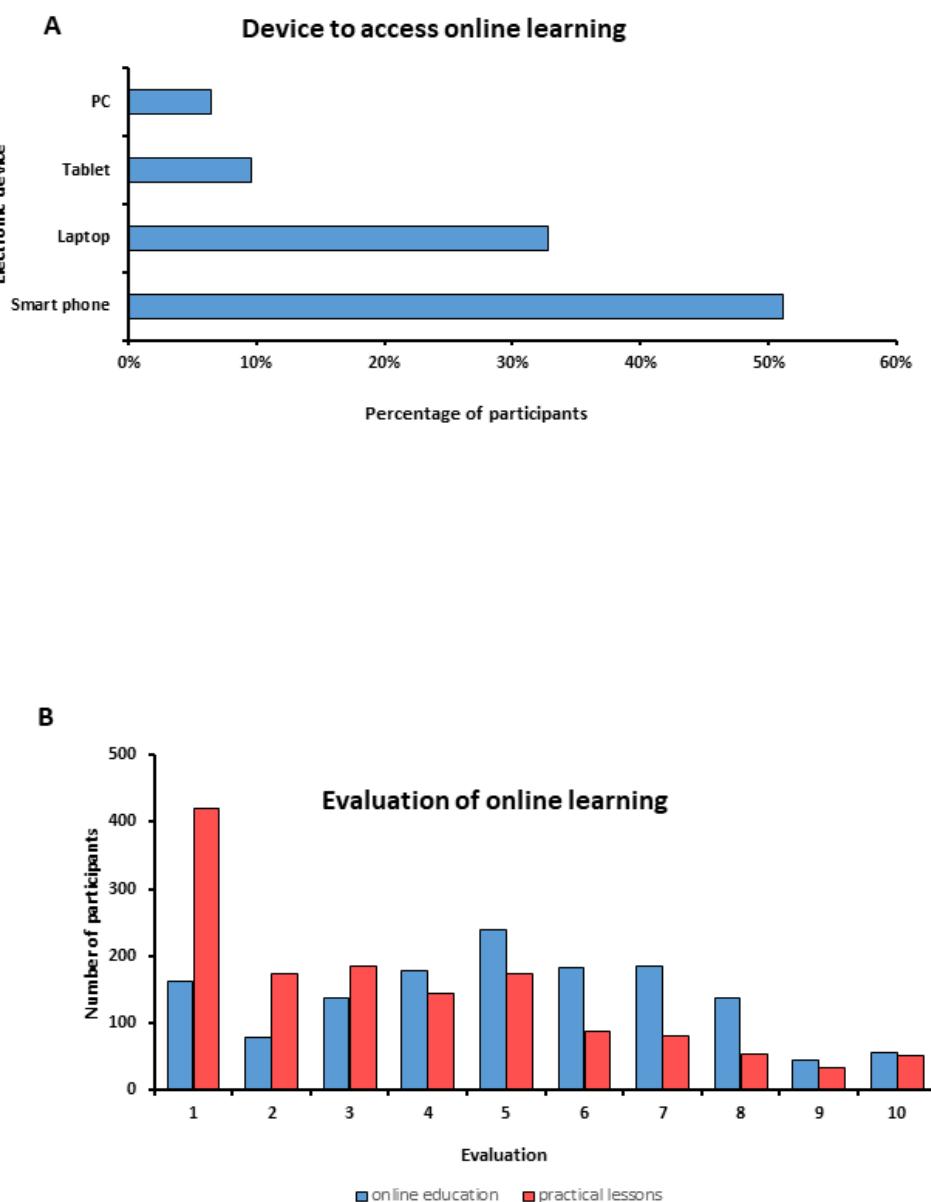
Variables	Greatly affected (5)	Considerably affected (4)	Moderately affected (3)	Slightly affected (2)	Not affected (1)
Undergraduate students					
- 1 st year students	92 (44.9%)	46 (22.4%)	51 (24.9%)	11 (5.4%)	5 (2.4%) ²
- 2 nd year students	126 (46.8%)	44 (16.4%)	69 (25.6%)	22 (8.2%)	8 (3.0%) ³
- 3 rd year students	116 (49.8%)	54 (23.2%)	49 (21.0%)	10 (4.3%)	4 (1.7%) ⁴
- 4 th year students	97 (49.7%)	43 (22.1%)	41 (21.0%)	9 (4.6%)	5 (2.6%) ⁵
- 5 th year students	77 (53.1%)	34 (23.4%)	28 (19.3%)	5 (3.5%)	1 (0.7%) ⁶
- 6 th year students	41 (50.6%)	17 (21.0%)	15 (18.5%)	5 (6.2%)	3 (3.7%) ⁷
Postgraduate students					
- Diploma	52 (47.3%)	8 (7.2%)	33 (30.0%)	9 (8.2%)	8 (7.3%) ¹² ¹³
- Master students	45 (43.2%)	19 (18.3%)	27 (26.0%)	7 (6.7%)	6 (5.8%) ¹⁴
- PhD students	20 (35.7%)	13 (23.3%)	12 (21.4%)	5 (8.9%)	6 (10.7%) ¹⁵

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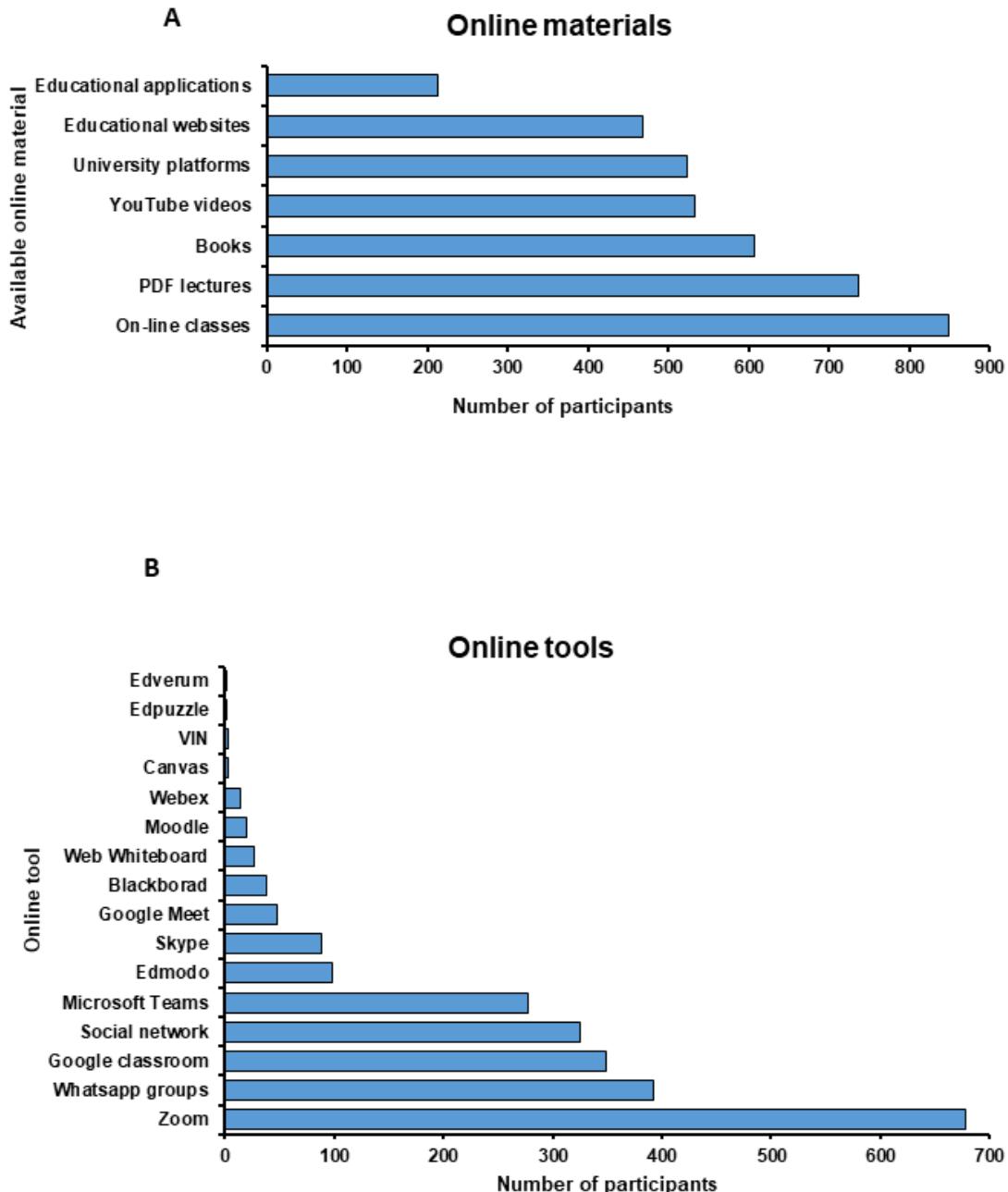
1 **Fig. 1:** A diagram showing (A) the device used by participants to access online materials, (B) Evaluation of
2 online learning

3 **Fig. 1**



1 **Fig. 2:** A diagram showing (A) the available online materials and (B) online tools used by participants to
 2 access the study materials online.

Fig. 2



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1 **REFERENCES:**

2 [1] Zhu N., Zhang D., Wang W., Li X., Yang B., Song J., et al. 2020. A novel coronavirus
3 from patients with pneumonia in China, 2019. *N Engl J Med.* **382**(8): p. 727-33 DOI:
4 10.1056/NEJMoa2001017.

5 [2] WHO. Coronavirus disease (COVID-19) Pandemic. 2019 [cited 2020 21/07]; Available
6 from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>.

7 [3] Bedford J., Enria D., Giesecke J., Heymann D.L., Ihekweazu C., Kobinger G., et al. 2020.
8 COVID-19: towards controlling of a pandemic. *Lancet.* **395**(10229): p. 1015-18 DOI:
9 10.1016/s0140-6736(20)30673-5.

10 [4] Gostin L.O. and Wiley L.F. 2020. Governmental public health powers during the
11 COVID-19 pandemic: Stay-at-home orders, business closures, and travel restrictions.
12 *JAMA.* DOI: 10.1001/jama.2020.5460.

13 [5] Paital B., Das K., and Parida S.K. 2020. Inter nation social lockdown versus medical care
14 against COVID-19, a mild environmental insight with special reference to India. *Sci.
15 Total Environ.* **728**: p. 138914 DOI: <https://doi.org/10.1016/j.scitotenv.2020.138914>.

16 [6] Pragholapati A. 2020. DOI: 10.17605/OSF.IO/NUYJ9. <https://edarxiv.org/895ed/>

17 [7] Nicola M., Alsafi Z., Sohrabi C., Kerwan A., Al-Jabir A., Iosifidis C., et al. 2020. The
18 socio-economic implications of the coronavirus pandemic (COVID-19): A review. *Int J
19 Surg* **78**: p. 185-93 DOI: <https://doi.org/10.1016/j.ijsu.2020.04.018>.

20 [8] UNESCO. Education: From disruption to recovery. 2020 [cited 2020 24/05]; Available
21 from: <https://en.unesco.org/covid19/educationresponse>.

22 [9] Esposito S. and Principi N. 2020. School closure during the Coronavirus Disease 2019
23 (COVID-19) pandemic: An effective intervention at the global level? *JAMA Pediatrics.*
24 DOI: 10.1001/jamapediatrics.2020.1892.

1 [10] Sahu P. 2020. Closure of universities due to Coronavirus Disease 2019 (COVID-19):
2 Impact on education and mental health of students and academic staff. *Cureus*. **12**(4): p.
3 e7541-e41 DOI: 10.7759/cureus.7541.

4 [11] Yamin M. 2020. Counting the cost of COVID-19. *International journal of information*
5 *technology : an official journal of Bharati Vidyapeeth's Institute of Computer*
6 *Applications and Management*. p. 1-7 DOI: 10.1007/s41870-020-00466-0.

7 [12] UNESCO. Universities tackle the impact of COVID-19 on disadvantaged students. 2020
8 [cited 2020 24/05]; Available from: <https://en.unesco.org/news/universities-tackle-impact-covid-19-disadvantaged-students>.

10 [13] Iyer P., Aziz K., and Ojcius D.M. 2020. Impact of COVID-19 on dental education in the
11 United States. *J Dent Educ*. DOI: 10.1002/jdd.12163.

12 [14] Alvin M.D., George E., Deng F., Warhadpande S., and Lee S.I. 2020. The impact of
13 COVID-19 on radiology trainees. *Radiology*. DOI: 10.1148/radiol.2020201222.

14 [15] Mian A. and Khan S. 2020. Medical education during pandemics: a UK perspective. *BMC*
15 *Medicine*. **18**(1): p. 100 DOI: 10.1186/s12916-020-01577-y.

16 [16] Rose S. 2020. Medical student education in the time of COVID-19. *JAMA*. DOI:
17 10.1001/jama.2020.5227.

18 [17] Kanneganti A., Sia C.-H., Ashokka B., and Ooi S.B.S. 2020. Continuing medical
19 education during a pandemic: an academic institution's experience. *Postgrad. Med. J.* p.
20 137840 DOI: 10.1136/postgradmedj-2020-137840.

21 [18] Sandhu P. and de Wolf M. 2020. The impact of COVID-19 on the undergraduate medical
22 curriculum. *Med. Educ. Online*. **25**(1): p. 1764740 DOI:
23 10.1080/10872981.2020.1764740.

1 [19] AVMA. COVID-19 impact on veterinary practices. 2020 [cited 2020 26/04]; Available
2 from: <https://www.avma.org/resources-tools/animal-health-and-welfare/covid-19/covid-19-impact-veterinary-practices>.

4 [20] Dean A., Sullivan K., and Soe M., OpenEpi: Open Source Epidemiologic Statistics for
5 Public Health, Version. . 2013.

6 [21] Mayer J.D. and Cavallaro R., Brief Mood Introspection Scale (BMIS): Technical and
7 scoring manual (3rd Edition). 2019.

8 [22] UNESCO. National learning platforms and tools. 2020 [cited 2020 09/06]; Available
9 from: <https://en.unesco.org/covid19/educationresponse/nationalresponses>.

10 [23] Bettinger E.P., Fox L., Loeb S., and Taylor E.S. 2017. Virtual Classrooms: How online
11 college courses affect student success. *Am Econ Rev.* **107**(9): p. 2855-75.

12 [24] Mulenga E.M. and Marbán J.M. 2020. Is COVID-19 the gateway for digital learning in
13 mathematics education? *Contemp. Educ. Technol.* **12**(2): p. ep269.

14 [25] Wickramanayake L. and Muhammad Jika S. 2018. Social media use by undergraduate
15 students of education in Nigeria: a survey. *The Electronic Library.* **36**(1): p. 21-37 DOI:
16 10.1108/EL-01-2017-0023.

17 [26] Xu D. and Xu Y. 2019. The promises and limits of online higher education:
18 Understanding how distance education affects access, cost, and quality. *American
19 Enterprise Institute.* p. 1-40.

20 [27] Rashid A.A., Rashid M.R.A., Yaman M.N., and Mohamad I. 2020. Teaching medicine
21 online during the COVID-19 pandemic: A Malaysian Perspective. *Bangladesh Journal of
22 Medical Science.* **19**: p. S 77-S 81 DOI: 10.3329/bjms.v19i0.48170.

23