

# Online Biostatistics Teaching to Medical Undergraduates by Comparing Google Classroom Module with Online Lecture during COVID-19 Pandemic: An Educational Interventional Study

SABITHA ROSE JACOB<sup>1</sup>, TOM WILSON<sup>2</sup>

## ABSTRACT

**Introduction:** Coronavirus Disease-2019 (COVID-19) lockdown was an opportunity for starting online medical education in Kerala, India. It was a challenge to teach the core competency biostatistics online considering the unfamiliarity and possible network issues.

**Aim:** To assess the learning and student satisfaction of biostatistics teaching, by comparing Google classroom module and online lecture, while teaching phase-2 Bachelor of Medicine, Bachelor of Surgery (MBBS) students.

**Materials and Methods:** This was a randomised educational interventional study done in the Department of Community Medicine, Government Medical College, Manjeri, Kerala, India, from December 2020 to September 2021. A total of 89 students of phase-2 MBBS were randomly divided into two groups as online lecture group and Google classroom group and five sessions were conducted. For the lecture group, classes were conducted via Google Meet using PowerPoint presentations and for the other group, PowerPoint with audio and worked-out examples were provided in Google classroom. Immediate and retention scores of academic performance and satisfaction

level were assessed using Multiple Choice Questions (MCQs). Mann-Whitney U test using Statistical Package for the Social Sciences (SPSS) software version 28.0 were done for analysis.

**Results:** Of total 89 students participated, the mean age of the study population was  $21.2 \pm 0.73$  years, and there were 62 (69.7%) females and 27 (30.3%) males. Academic performance was similar for both groups in most of the immediate assessments, except activity on making graphs ( $p$ -value=0.001). In delayed assessment using median scores, the Google classroom group (110, IQR: 100-140) performed significantly better compared to the online lecture (100, IQR: 60-130) with ( $p$ -value=0.042). Regarding satisfaction, 68.3% of Google classroom students were satisfied, compared to 52.4% of the online lecture group. The flexibility to learn at own place, pace, and time was the main advantage of the Google classroom, while the need for self-motivation was the disadvantage. Direct interaction was the advantage of online lectures and inability for simultaneous doubt clarification and to attend at fixed timing was the disadvantage.

**Conclusion:** Online teaching of biostatistics was effective and student satisfaction level was good. Google classroom module can be considered as a supplement for traditional teaching.

**Keywords:** Coronavirus disease-2019, Google meet, Medical teaching, Online education, Satisfaction, Statistics

## INTRODUCTION

With the COVID-19 pandemic, the whole world went into a lockdown with a great impact on medical education [1]. All the universities including medical colleges were closed. To provide a better standard of clinical care, the trained doctors require a reasonable mix of knowledge and skill, and the skill needs to be cemented on the foundation of knowledge and these skills are taught through preclinical and clinical periods [2,3]. Traditional teaching of these skills is a tough task considering variations in the learning environment, learning capacity and attitude of students, uneven distribution of resources, lack of uniformity in course content delivery, and traditional curricula lacking innovative approaches [4].

Having the necessity to continue the course during COVID-19 time, medical teaching also became online after the initial confusion and it was tougher with competency-based medical education [5,6]. Even in the pre-COVID-19 era, well-designed online medical education courses seemed to offer similar or superior knowledge gains compared to traditional teachings in other countries, the barriers noted were limited time, infrastructure constraints, lack of co-operation and expertise from faculty and absence of institutional strategies [7]. A recent review after the COVID-19 pandemic identified various challenges posed by online education in the current medical

curriculum, faced by both faculty members and students, especially under the light of the competency-based undergraduate curriculum for Indian medical graduates. Among all subjects, biostatistics is one of the core competencies in a competency-based medical curriculum which is considered a necessary evil by the students [8]. It is thought to be a complex topic that is characterised by hierarchically organised counter-intuitive concepts, which focus on critical appraisal skills rather than on the ability to analyse data [9,10].

A study done in the early COVID-19 period in a western country recognised that, though online education is favourable for medical statistics, it cannot substitute the unique value of teaching and knowledge exchange through personal interaction [11]. Another South Indian study also observed that, online medical teaching is effective [12]. In COVID-19 setting, live demonstration classes were replaced by online lectures using PowerPoint presentations delivered through virtual platforms like Zoom, Google Meet, and Computer Information System Company (CISCO) Webex. Even in well-established settings, online education reported a lack in student retention [13]. In American perspective, online synchronous teaching was perceived as effective with the main disadvantages identified as network issues, lack of suitable learning environment, and absence of face-to-face interaction [14]. An asynchronous

self-learning module can be considered as an alternative as used in online courses. Here, authors prepared a module on basic biostatistics topics and delivered it through an asynchronous platform namely Google Classroom. To the best of authors' knowledge, such comparative studies on teaching medical statistics by online lecture versus Google Classroom modules have not been published so far. So, the present study was conducted with the primary objective of assessing the academic performance and student satisfaction in learning biostatistics by Google Classroom module, compared to online lectures

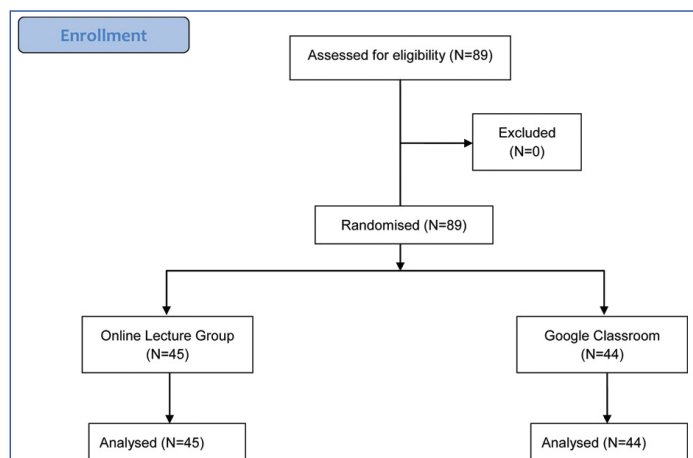
## MATERIALS AND METHODS

This was a randomised educational interventional study conducted in the Department of Community Medicine, Government Medical College, Manjeri, Kerala, India, from December 2020 to September 2021. The study was done after ethical clearance from the Institutional Ethical Committee (IEC GMCM/73 dated 28/01/2021) and informed consent was taken from students.

**Inclusion criteria:** All 89 students of 2018 batch having phase-2 clinical posting in Community Medicine who gave consent were included in the study.

**Exclusion criteria:** Students who did not give consent for the study were excluded from the study.

**Sample size calculation:** Based on findings from 30 sampled pilot study, using 95% (CI) and 80% power the minimum sample size required in a group was calculated as 37. Due to the COVID-19 crisis, batch-wise postings were not possible and all the sessions were taken as two groups for the whole batch. Students were randomly divided into two groups using a computer-generated random number table, with 44 students in Google Classroom and 45 attending online lectures. The flowchart of the study participants and the procedure has been given in [Table/Fig-1].



[Table/Fig-1]: CONSORT flowchart.

## Study Procedure

Fourth-semester basic biostatistics topics were divided into five sessions. The sessions were types of variables in statistics, data presentation methods, demonstration of data presentation, measures of central tendency, and measures of dispersion. The online lecture on these topics was delivered through Google Meet using PowerPoint presentations during morning hours between 9 am-12 pm. Same PowerPoint presentations with recorded audio were prepared and posted in Google Classroom group on the same day of a lecture class. The PowerPoint handouts in PDF were also made available in Google Classroom with the same worked-out examples and lecture notes. All lectures were pre-recorded by the investigator and were reviewed by senior faculty members. The videos were available for students in the Google Classroom for 24 hours. As there was a continuity in topics, cross over was not done. At the end of the initial posting, all students were enrolled in Google Classroom.

Assessment of learning of each topic was done on the next day using time-limited Google Forms quiz. The assessment was done after prior intimation and it was communicated that it will not be considered for internal assessment for university exam purposes, but for learning improvement only. The assessment was done six times, by using time-limited Google Forms quizzes with no negative marks. There were five immediate assessments, which were done after each session and a delayed assessment after seven months. Assessment-1 was on the topic-terms in biostatistics and types of variables. Assessment-2 was on data presentation methods and the Assessment-3 was on the demonstration of making appropriate graphs for given data set. Assessment-4 was on measures of central tendency and the Assessment-5 was on measures of dispersion. Assessment-6 was on retention of knowledge was done after seven months covering all five topics and was announced 30 minutes before the assessment. Each assessment except the 3<sup>rd</sup> had 10 MCQs and the Assessment-6 contained 15 questions which were prepared by the investigators and were validated by senior faculty of department. Maximum score for six assessments were 100, 100, 30, 100, 100 and 150, respectively. Assessment-3 on drawing graph was evaluated manually by the investigator.

The present study assessed the effectiveness of learning by comparing the proportion of students who scored both 50% or above and 80% or above in both groups and the change in percentage scores from initial assessments to delayed assessment.

Student's perception was assessed using an anonymous Google Forms prepared based on concepts of Kirkpatrick's model of evaluation, where level one and two were applicable in the present study [15]. The areas included were "stimulated my interest in the topic, helpfulness of the method for understanding concepts and satisfied with the teaching method". Each was assessed using a five points Likert scale of agreement namely strongly agree, agree, neutral, disagree and strongly disagree with strongly disagree at point 1 [16]. These three items were valid at level of significance at 0.05 with Cronbach's Alpha of 0.716. The future preference of the method to learn statistics was assessed by MCQ. The percentage response for each level of agreement was calculated. The data on positive and negative points of each method were collected by open-ended questions in the Google Forms.

## STATISTICAL ANALYSIS

The data were exported and analysed using SPSS software version 28.0. For statistical analysis, assessment scores and percentage responses to questions on perceptions were used. Academic performances of each group were compared by using the median scores of each group by Mann-Whitney U test. Authors also analysed the difference in the proportion of students in each group who scored more than 50% marks and 80% by Chi-square test. Likert scale perceptions were assessed as proportions and compared by Chi-square test. A p-value of <0.05 was considered statistically significant.

## RESULTS

A total of 89 students participated in the study. Mean age of the study population was 21.2±0.73 years. Age ranged from 20-23 years. There were 62 (69.7%) females and 27 (30.3%) males. Gender distribution was similar in both groups with 31 females in each group and 14 males in lecture group and 13 males in Google Classroom group. Regarding previous educational background, 59 (66.3 %) studied in Kerala state syllabus and 28 (31.3%) were from Central Board of Secondary Education. One student was from Indian Certificate of Secondary Education and one from Karnataka state board. Nearly 90% of them were attending classes through mobile phones. The basic information of both groups was comparable in gender distribution and background. The difference was not significant (p-value=0.52). For the first assignment, participation was less with 72 (83.7%) students. Later, it increased to almost full participation. The number of students participated in

Assignment-2, Assignment-3, Assignment-4, Assignment-5 and Assignment-6 were 86 (96.6%), 69 (77.5%), 88 (98.9%), 89 (100%) and 87 (97.8%), respectively. Participation was lowest (77.5%) for the assessment of manual creation of graphs, compared to MCQ which were easier to attempt.

**I. Assessment of academic performance:** Students' group-wise median scores for each assessment were analysed. Authors calculated and compared the median score for each assignment. For the first assessment, a higher score was obtained for Google Classroom. For Assessment-3 and 5, a higher score was obtained for the lecture group. For Assessment-3 significantly higher score was obtained for the online lecture group. For delayed assessment, the median score was higher for the Google Classroom group. These differences were statistically significant by Mann-Whitney U test, as shown in [Table/Fig-2].

Session	Google classroom Median (range) (n=44)	Lecture median (range) (n=45)	p-value
Types of variables	65 (50-70) (n=34)	60 (40-77.5) (n=38)	0.420
Data presentation	80 (60-90) (n=43)	80 (70-90) (n=43)	0.319
Activity on making graphs	20 (15-25) (n=31)	25 (20-25) (n=38)	<b>0.001</b>
Measures of central tendency	90 (71.25-90) (n=44)	90 (57.5-92.5) (n=44)	0.224
Measures of dispersion	80 (70-90) (n=44)	90 (70-90) (n=45)	0.506
Revision	110 (100-140) (n=43)	100 (60-130) (n=44)	<b>0.042*</b>

**[Table/Fig-2]:** Topic-wise knowledge score among both groups. Numbers in the bracket indicate the number of students who submitted in each assessment, as participation was voluntary the number is different for different assessments. All statistical comparisons were done using the Mann-Whitney U test. The p-values in bold font indicates statistically significant values.

Online teaching mode	Types of variables	Data presentation	Activity on making graphs	Measures of central tendency	Measures of dispersion	Revision
Percentage of students who scored 80% or above						
Google classroom	6 (15.8%) n=38	25 (58.1%) n=43	9 (29%) n=31	32 (72.7%) n=44	23 (52.3%) n=44	19 (44.1%) n=43
Lecture	8 (16.7%) n=34	31 (72.1%) n=43	24 (63.2%) n=38	24 (54.5%) n=44	23 (51.1%) n=45	15 (34.1%) n=44
p-value	0.407	0.174	<b>0.004</b>	0.076	0.912	0.334

**[Table/Fig-3]:** Comparison of academic performance based on eligibility criteria as 80%. Test of significance is Chi-square test

Online teaching mode	Types of variables	Data presentation	Activity on making graphs	Measures of central tendency	Measures of dispersion	Revision
Percentage of students who scored 50% or above						
Google classroom	30 (78.9%) n=38	41 (95.3%) n=43	20 (64.5%) n=31	43 (97.7%) n=44	41 (93.2%) n=44	41 (95.3%) n=43
Lecture	23 (67.6%) n=34	41 (95.3%) n=43	37 (97.3%) n=38	38 (86.4%) n=44	41 (91.1%) n=45	32 (72.7%) n=44
p-value	0.277	1.000	<b>0.001</b>	0.115	0.975	<b>0.009</b>

**[Table/Fig-4]:** Comparison of academic performance based on eligibility criteria as 50%. Test of significance is chi-square test

Online teaching mode	Median percentage score of first 5 assessments (cumulative)	Median percentage score of delayed assessment	Median change in percentage
Google classroom	73.7%	73.3%	+2.5%
Lecture	70.9%	66.7%	-1.2%
p-value	0.918	0.456	0.831

**[Table/Fig-5]:** Comparison of cumulative assessment and delayed assessment. Test of significance is Chi-square test

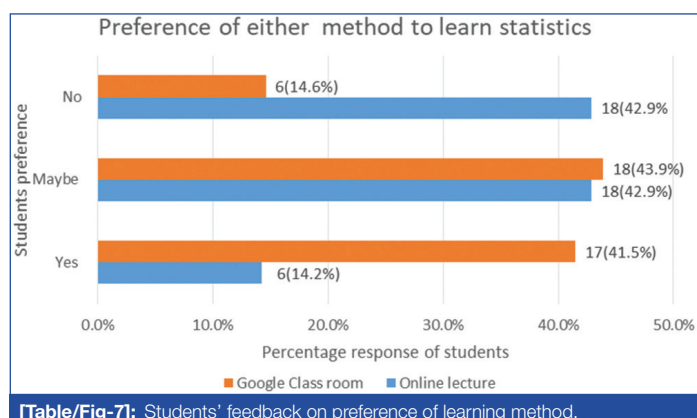
Parameters	Google classroom module (n=41)					Lecture (n=42)					p-value
	Strongly disagree score=1	Disagree score=2	Neutral score=3	Agree score=4	Strongly agree score=5	Strongly disagree score=1	Disagree score=2	Neutral score=3	Agree score=4	Strongly agree score=5	
Stimulated my interest in topic	0	3 (7.3%)	11 (26.8%)	23 (56%)	4 (9.7)	2 (4.8%)	7 (16.7%)	17 (40.5%)	13 (30.9%)	3 (7.1%)	0.12
Helped me to understand the concepts	4 (9.7%)	4 (9.7%)	10 (24.3%)	18 (43.9%)	5 (12.1%)	2 (4.8%)	4 (9.6%)	19 (45.2%)	14 (33.3%)	3 (7.1%)	0.34
Satisfied with this teaching method	3 (7.3%)	2 (4.9%)	8 (19.5%)	21 (51.2%)	7 (17.1%)	1 (2.4%)	4 (9.6%)	15 (35.8%)	21 (50%)	1 (2.4%)	0.08

**[Table/Fig-6]:** Student's response on the level of satisfaction with online teaching methods. Test of significance is Chi-square test with Yates correction

The effectiveness of teaching methods lies in helping students to perform for qualifying internal exam, which is usually 50% marks. Comparison of the proportion of students who scored both 50% or above and 80% or above among two groups is shown in [Table/Fig-3,4]. There was a difference in performance based on topic, but no specific trend was observed. Taking 50% as pass criteria, both methods were effective to make students cross the eligibility criteria. The lowest performance was 77.5% for creating graphs. The percentage of total score of first five assessments and late assessment were calculated as given in [Table/Fig-5]. Change in percentage score was calculated. The median of percentages were compared between both groups. Though the change was positive for Google Classroom, there was no statistical significance.

**II. Student satisfaction:** As participation was voluntary the response to feedback question was sent by 41 students of Google Classroom and 42 students of online lecture group. Regarding the response to satisfaction, despite some neutral responses, agree and strongly agree responses were more compared to disagreement. The pattern was similar for both groups, but Google Classroom had more positive responses. A 56% agreed that teaching in Google Classroom made them interested in the topic compared to 30.9% of lecture group. A 43.9% found teaching through Google Classroom helped them to understand the topic, while 33.3% was the agreement in lecture group [Table/Fig-6]. Though general satisfaction with teaching method was similar for both groups, a significantly higher percentage strongly agreed with satisfaction level regarding Google Classroom. A total of 68.3% of Google Classroom students were satisfied, compared to 52.4% of the online lecture group. Another question was about their preference for the particular method for learning statistics in the

future with options yes, no and may be. For this too, the response “may be” was opted by nearly equal number proportions (41.3% versus 43.2%). Online lecture was less (13.6%) preferred compared to the Google Classroom module (43.5%) which is shown in [Table/ Fig-7]. The difference in students’ preference was found statistically significant when tested with Chi-square test with a p-value=0.003.



[Table/Fig-7]: Students’ feedback on preference of learning method.

Authors further explored the positive and negative points regarding each teaching method as an open-ended question. This provided a better insight into learning, from a student’s perspective and how the transition to online teaching affected them. The most frequent positive response about Google Classroom was the provision to attend classes multiple times and at their convenient time and place and pace of learning. They appreciated the availability of videos and class notes to look back on, if in doubt. Another advantage pointed out is that they can take a break if it becomes tiring. Connectivity issues were less reported as there was flexibility in watching time.

Students feedback on learning methods: Comment by a student “students can access classes at any place, any convenient time. They can take their own time to read and understand. Assignments improve understanding. Files are provided in a well-ordered manner, studying becomes ordered and systematic. Students can refer to videos and documents containing the instructions provided in the classroom while trying to create charts as many times as they want, which is not possible in a simple online video lecture class”. Negative feedback was that simultaneous doubt clarification is not possible and they had to spend more time clarifying it on their own. Lack of interpersonal interaction was perceived as another issue. Other comments were on learning behaviour. Some found it difficult to learn the subject of statistics alone and to self-motivate for learning. The flexibility of time made some postpone it forever and finally miss it, which encourages a monitoring from teachers side.

### III. Feedback on the online lecture method to learn biostatistics:

The positive feedback on the online lectures was the direct online interaction which helped in better understanding. They felt hearing is better than reading and it is easier to learn, if someone is there to walk through with the help of videos. Negative feedback was on the timing of the class, both in terms of duration and relative early hours to learn from the home environment. Net connectivity issues interrupted sessions in between that affected understanding of new concepts and thereby, made to lose interest in learning.

A student’s comment: “It is not that online lectures are not effective. I can not concentrate on this small screen for more than 10 minutes. I could not follow any of my online clinical postings. Any method other than offline classes is a big ‘No’ for me. All teachers doing great with their lectures. It is too straining for my eyes and I also got back pain with this. I started wearing glasses. I’m done with this online mode. I request you to open college as soon as possible and shift back to offline mode. These online classes are draining me out”.

## DISCUSSION

The study comparing the effectiveness of online lectures with the online module in Google Classroom in teaching biostatistics to undergraduates demonstrated that both methods were effective in imparting knowledge on all selected topics. The proportion of students who scored above selected cut-off percentages was also similar among both groups. The retention of knowledge after months was also remarkable and comparable. Though not fully agreed upon, a high level of satisfaction was expressed by students of both groups in considering the COVID-19 scenario. Regarding future preference for the online methods to learn statistics, Google Classroom had a better preference. From students’ written feedback, it is understood that in resource-restricted setting, the online module is inadequate to motivate and retain the interest of majority of students, despite the advantage of learning at their own pace, place, and convenient timing.

Articles comparing the effectiveness of Google Classroom module with online lectures, while teaching medical statistics were not much available. A South India based study published in the early 2020s among private and government medical students of Kerala and Tamil Nadu, India on attitude and factors affecting online medical education had comparable observations like 94% resorted to mobile phones for learning. Learning at leisure was the top reason why students liked online classes, whereas network problems and lack of sufficient interaction was the top reason, why students disliked them. More than half of the students did not want to continue online classes after COVID-19 lockdown as per their findings [12]. As the present study compared two online methods rather than comparing with traditional teaching, students preferred Google Classroom over online lecture.

One randomised study from India which compared onsite training of biostatistics and research ethics with online course among scientist volunteers observed that, there was marked and similar improvement in knowledge immediately and three months after the course completion among both groups as observed in the present study [17]. Contrary to their observation, in the current study late assessment scores were higher for Google Classroom group, the reason could be that they have learned on their own and the late assessment questions were from must-know areas only. Authors also compared the change in score from cumulative assessment to late assessment and found that the change was higher for the Google Classroom group which can be due to the opportunity to reinforce learning in Google Classroom later. One meta-analysis involving 124 online interventions on courses related to different areas of health research also demonstrated a gain in knowledge and skills [18]. One of the studies before the COVID-19 pandemic had the observation on digital learning that students extensively used digital sources for self-directed learning most commonly before the examinations, so availability of learning modules will be of great help there [19].

The present study also compared students’ satisfaction with both methods. In a cross-sectional survey by AIQhtani A et al., level of satisfaction was either high or neutral when online teaching was compared to class room teaching [20]. In the present study, both group gave similar levels of agreement on areas of stimulating interest in learning, helping to understand concepts and satisfaction with the particular teaching method. A Polish study among medical students about online medical education during the COVID-19 pandemic, also identified the main advantages of online learning as the ability to stay at home (69%), continuous access to online materials (69%), learning at own pace (64%), and comfortable surroundings (54%), just as the current study observations. The majority of respondents chose lack of interactions with patients (70%) and technical problems with Information Technology (IT) equipment (54%) as the main disadvantages. There was no statistical difference between face-to-face and online learning in terms of

opinions on the ability of the learning method to increase knowledge ( $p$ -value=0.46). E-learning was considered less effective than face-to-face learning in terms of increasing skills ( $p$ -value <0.001). Yet the study which included medical students from different backgrounds and phases of medical teaching rated the online teaching as an enjoyable experience in spite of their characteristics [21]. Another systematic review on e-learning identified internal factors like poor engagement, poor perception and motivation, lack of students' self-discipline and low efficacy, as barriers of online learning as pointed by the present study students [22].

Medical curriculum of India envisages the role of life learner as one of the prime role of Indian medical graduates. To achieve that role, one needs to be trained in self-directed learning [23]. While planning online Continuing Medical Education (CME), one needs to consider this factor, that qualitative study among practising physicians finding lack of self-discipline is an important barrier in completing online learning [24]. If any revolution of complete online medical education for all is to come, it is still far from a reality. Self-motivated and capable students can perform well in any platform. It is evident that students with weak academic backgrounds and other risk factors struggle most in fully online courses, creating larger socio-economic gaps in outcomes than those in traditional classroom environments [14].

### Limitation(s)

The present study had some limitations in terms of absence of cross over and topic selection for online education. It is debatable whether, biostatistics is an ideal subject for assessing effectiveness of online medical education. Here assessment of learning was done by MCQs, which may not be sufficient to assess higher levels of cognition of all topics.

### CONCLUSION(S)

Within the limitations, the present study concluded that online medical education was a great help in imparting knowledge during the pandemic crisis, with Google Classroom giving a better gain in knowledge and more satisfying learning experience. It cannot substitute traditional teaching with definite interpersonal interaction, but can supplement always. The conclusion would be that though online learning can assist medical education in many aspects, it cannot solve many inherent issues in teaching and learning and it is effective in low resource setting to impart knowledge for those motivated students. Thus, the authors conclude that online learning module will definitely have a part to play in lifelong learning of Indian medical graduates. The success for the medical educator lies in ensuring engagement with the learning, whether it is an online teaching or offline teaching.

### REFERENCES

- [1] Qarajeh R, Tahboub F, Rafie N, Pirani N, Jackson MA, Cochran CD. The effect of COVID-19 pandemic on US medical students in their clinical years. *Int J Med Students*. 2020;8(2):172-74.
- [2] Dhaliwal U, Supe A, Gupta P, Singh T. Producing competent doctors- The art and science of teaching clinical skills. *Indian Pediatr*. 2017;54(5):403-09.

- [3] Sahu PK, Chattu VK, Rewatkar A, Sakhamuri S. Best practices to impart clinical skills during preclinical years of medical curriculum Website: *J Educ Heal Promot*. 2019;8:57.
- [4] Solanki A, Kashyap S. Medical education in India: Current challenges and the way forward. *Med Teach*. 2014;36(12):1027-31.
- [5] Stoehr F, Müller L, Brady A, Trilla A, Mähringer-Kunz A, Hahn F, et al. How COVID-19 kick-started online learning in medical education-The digimed study. *PLoS One*. 2021;16(9):e0257394.
- [6] Nimavat N, Singh S, Fichadiya N, Sharma P, Patel N, Kumar M, et al. *Educn 2. Adv Med Educ Pract*. 2021;12:237-43.
- [7] O'Doherty D, Dromey M, Loughheed J, Hannigan A, Last J, McGrath D. Barriers and solutions to online learning in medical education-an integrative review. *BMC Med Educ [Internet]*. 2018;18(1):130. Available from: <https://doi.org/10.1186/s12909-018-1240-0>.
- [8] Miles S, Price GM, Swift L, Shepstone L, Leinster SJ. Statistics teaching in medical school: Opinions of practising doctors. *BMC Med Educ [Internet]*. 2010;10(1):75. Available from: <http://www.biomedcentral.com/1472-6920/10/75>.
- [9] Astin J, Jenkins T, Moore L. Medical students' perspective on the teaching of medical statistics in the undergraduate medical curriculum. *Stat Med*. 2002;21(7):1003-06.
- [10] MacDougall M, Cameron HS, Maxwell SRJ. Medical graduate views on statistical learning needs for clinical practice: A comprehensive survey. *BMC Med Educ*. 2019;20(1):01-17.
- [11] Rota M, Peveri G, Fanelli M, Torelli L, Rocchi MB, Specchia C. Satisfaction with online teaching of medical statistics during the COVID-19 pandemic: A survey by the Education Committee of the Italian Society of Medical Statistics and Clinical Epidemiology. *Teach Stat*. 2021;43(3):129-39.
- [12] Thomas A, Shenoy MT, Shenoy KT, Kumar SS, Sidheeque A, Khovidh C, et al. Survey among medical students during COVID-19 lockdown: The online class dilemma. *Int J Med Students*. 2020;8(2):102-06.
- [13] Poll K, Jeanne Widen Me, Weller S. Six instructional best practices for online engagement and retention. *J Online Dr Educ ISSN Online*. 2014;1:2330-4391.
- [14] Baum S, McPherson M. The human factor: The promise & limits of online education. *Daedalus*. 2019;148(4):235-54.
- [15] Heydari MR, Taghva F, Amini M, Delavari S. Using Kirkpatrick's model to measure the effect of a new teaching and learning methods workshop for health care staff. *BMC Res Notes [Internet]*. 2019;12(1):01-05. Available from: <https://doi.org/10.1186/s13104-019-4421-y>.
- [16] Sullivan GM, Artino AR. Analysing and interpreting data from likert-type scales. *J Grad Med Educ*. 2013;5(4):541-42.
- [17] Aggarwal R, Gupte N, Kass N, Taylor H, Ali J, Bhan A, et al. A comparison of online versus on-site training in health research methodology: A randomized study. *BMC Med Educ*. 2011;11(1):01-10.
- [18] Cook DA, Levinson AJ, Garside S, Dupras DM, Erwin PJ, Montori VM. Internet-based learning in the health professions: A meta-analysis. *JAMA [Internet]*. 2008;300(10):1181-96. Available from: <https://doi.org/10.1001/jama.300.10.1181>.
- [19] Scott K, Morris A, Marais B. Medical student use of digital learning resources. *Clin Teach [Internet]*. 2018;15(1):29-33. Available from: <https://doi.org/10.1111/tct.12630>.
- [20] AlQhtani A, AlSwedan N, Almulhim A, Aladwan R, Alessa Y, AlQhtani K, et al. Online versus classroom teaching for medical students during COVID-19: Measuring effectiveness and satisfaction. *BMC Med Educ [Internet]*. 2021;21(1):452. Available from: <https://doi.org/10.1186/s12909-021-02888-1>.
- [21] Bączek M, Zagarczyk-Bączek M, Szpringer M, Jaroszyński A, Wozakowska-Kaplon B. Students perception of online learning during the COVID-19 pandemic: A survey study of polish medical students. *Medicine (Baltimore)*. 2021;100(7):e24821.
- [22] Regmi K, Jones L. A systematic review of the factors-enablers and barriers-affecting e-learning in health sciences education. *BMC Med Educ*. 2020;20(1):91.
- [23] Peine A, Kabino K, Spreckelsen C. Self-directed learning can outperform direct instruction in the course of a modern German medical curriculum-Results of a mixed methods trial. *BMC Med Educ [Internet]*. 2016;16(1):01-11. Available from: <http://dx.doi.org/10.1186/s12909-016-0679-0>.
- [24] Gagnon MP, Légaré F, Labrecque M, Frémont P, Cauchon M, Desmarts M. Perceived barriers to completing an e-learning program on evidence-based medicine. *Inform Prim Care*. 2007;15(2):83-91.

#### PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Community Medicine, Government Medical College, Manjeri, Kerala, India.
2. Assistant Professor, Department of Community Medicine, Government Medical College, Manjeri, Kerala, India.

#### NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Sabitha Rose Jacob,  
Assistant Professor, Department of Community Medicine, Government Medical College,  
Manjeri, Vellarangal-676121, Malppuram District, Kerala, India.  
E-mail: sabitha1020@gmail.com

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