

# Implementation of Remote Online Assessments in the Undergraduate Medical Education: A Students' Satisfaction Survey from a Developing Country

Syed Muhammad Hammad Ali (✉ [hali921@hotmail.com](mailto:hali921@hotmail.com))

Center for Health Sciences Research, FMH College of Medicine & Dentistry, Lahore

**Ahsan Zil-E-Ali**

Center for Health Sciences Research, FMH College of Medicine & Dentistry, Lahore

**Minahil Fatima Chaudhry**

Center for Health Sciences Research, FMH College of Medicine & Dentistry, Lahore

**Javed Khalil**

FMH College of Medicine & Dentistry, Lahore

**Malik Asim**

FMH College of Medicine & Dentistry, Lahore

---

## Research Article

**Keywords:** Medical, Education, Undergraduate, Assessment, Online, Teaching, COVID-19

**Posted Date:** April 26th, 2022

**DOI:** <https://doi.org/10.21203/rs.3.rs-1424835/v1>

**License:**   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

# Abstract

## Background

COVID-19 pandemic brought on new challenges to medical education with regards to the transition to online education and examination methods. The purpose of this study was to understand the issues encountered during the implementation of a remote online system of examination and the student satisfaction, in undergraduate settings of a low-income country.

## Methodology:

Our study includes data from a diverse population of five undergraduate classes of medicine and four classes from dentistry of a private medical school. A Remote Online Assessment (ROA) system was designed using free software to transform the traditional in-person high-stakes examination into an online equivalent. The first phase consisted of three principal activities with appropriate student training leading to a summative online exam at the end of it. Each activity was coupled with student feedback the detailed analysis of which guided the implementation process.

## Results

More than 800 students took part in the implementation process of ROA. Feedback at all three intervals showed a significantly higher level of satisfaction in the clinical year students than in the preclinical. The overall satisfaction rate was lower among female students. The highest level of satisfaction was achieved after online one-on-one training of students in smaller groups with mini-mock exams. The most commonly identified obstacles were the insufficient time for exam completion (n = 614) and internet speed and connectivity issue (n = 470). While the majority of the students regarded this novel ROA not better than the traditional in-person examination, they acknowledged its significance in helping them continue their studies and prepare for their mid-term summative exam syllabus.

## Conclusions

Unfamiliarity with online learning systems could impede the implementation of ROA in low-income countries. Conducting multiple online mock activities coupled with training in short groups with more focus on females and preclinical students can lead to satisfaction regarding such an online examination system.

## Introduction

Coronavirus disease 2019 (COVID-19) pandemic impacted various vocations including the field of medical education.<sup>(1)</sup> The CDC guidelines emphasized social distancing as primary prevention that hindered the

standard operations of teaching in undergraduate medical education (UME) leading to discontinuation of in-person classes and bedside clinical teaching.<sup>(2)</sup> This guided in developing remote learning systems through the virtual classroom and video conferencing tools.

The quick adaptation to modern online strategies assisted in building unconventional ways to restore the teaching and learning process in UME. However, the transition of summative assessments from traditional in-person and paper-based exams to virtual remote online assessments constituted another formidable challenge for medical educators, especially in the low-income developing countries with limited resources.<sup>(3)</sup> Meanwhile, this pandemic also provided an opportunity for the stakeholders in medical education to revisit the assessment and evaluation strategies and exploration of new avenues difficult to search for otherwise.<sup>(4)</sup> The medical educators in our settings were facing a similar challenge when it became imperative to transform the summative assessments into remote online format Table 1. These high-stakes, end-of-academic-year assessments are mandatory for promoting students to the next level of their UME after ensuring that the learner has sufficiently acquired the learning outcomes of their academic curriculum.

Nevertheless, developing countries have a myriad of issues and impediments in the way of successful implementation of a 'never experienced before' online teaching, learning and assessment system. Studies from several parts of the world have described different assessment strategies which were adopted in the COVID-19 lockdown as well as modifications of old assessment methods to align with the pandemic.<sup>(5)</sup> These studies give an insight into the different modes of assessment in UME which are a makeshift solution to the unforeseen pandemic. However, to the best of our knowledge, none of the studies in the literature has discussed the implementation process of such a novel remote online examination system in the developing world's UME settings. More importantly, feedback from the students on such novel interventions and their satisfaction with the newly implemented online assessment system is imperative to make improvements and to facilitate the students who are the actual stakeholders.<sup>(6),(7)</sup>

The present study describes the implementation process of the remote online assessment (ROA) program which was designed to restore curricular evaluations and assessments during the COVID-19 pandemic in our medical school. The objective was to develop a standardized, valid and reliable system of ROA and curricular evaluation which was cost-efficient, user-friendly while also retaining the essentials of traditional in-person assessments at the same time.<sup>(8)</sup> The whole implementation process accompanied student feedback and was guided by the student satisfaction level at each stage of implementation. We studied factors that correlated with the student's satisfaction with this unconventional ROA program in UME of a developing country.

Table 1  
Operational Definitions

<b>Assessment or examination</b>	<b>An evaluation of the learning from an outlined syllabus on written, verbal and practical formats</b>
Summative or high-stakes	Assessments that have a weight in the final grading and promoting system e.g. term examinations, end-of-year final examinations
Formative	Assessments which are carried throughout the year to promote learning e.g. informal class tests
Mock exam	Practice or model examination simulating real exam situation and pattern
Mini-mock exam	Practice exams comprising of items less than the actual exam
Remote	Physically away or at a distant location
Online	Utilizing a computer or internet
e-Proctoring	Virtual monitoring and invigilation of the examinees

## Methodology

### Data Source & Participants

This observational study includes data from the first phase of the implementation process of a new remote online assessment (ROA) program at FMH College of Medicine and Dentistry, Lahore, Pakistan. The implementation process took place from June to August 2020 and included three principal activities including two mock examinations followed by a summative mid-term exam. All students from the Bachelor of medicine (MBBS) and bachelor of dentistry (BDS) programs who participated in the implementation process were included in the study. Students absent from any of the three principal activities of the implementation process were excluded. Informed consent through online forms was sought from the participants of this study and the ethical approval was granted by the institutional review board (FMH-03-2021-IRB-876-M). This study was carried out in accordance with the Declaration of Helsinki.

### Remote Online Assessment Program

The Remote Online Assessment (ROA) program was designed to transform the traditional in-person high-stakes examinations into a completely online examination system that can be administered to the students remotely in their homes. The Medical Education department, Health Informatics and the Evaluation and Assessment Unit collaborated to shift the learning and assessment of undergraduate medical and dental students online after the COVID19 lockdown was imposed. As a result of it, a learning management system (LMS) was created using open-source software and a cloud database was formed. This LMS along with a video conferencing tool provided adequate restitution of all teaching and learning activities online. Later on, this LMS was also utilized to conduct the high-stakes curricular assessments.

The ROA program utilized a format comprising of three tools:

1. An LMS i.e. a web-based platform to administer the examination
2. A secure web browsing software to lock the examinee's display screens at the examination interface
3. A videoconferencing software for real-time e-proctoring or invigilation of the examinee

## The Implementation Process

The ROA format was piloted on a group of faculty members and students who were assigned to identify potential problems and limitations. A unanimous proposition made was to exclude the third component of the format i.e., thee-proctoring from the first phase of implementation at it was deemed complicated for the students. Also, there was a lack of proper equipment and internet bandwidth to handle the video streaming for invigilation. Therefore, to ensure student compliance and cooperation without overburdening them in times of a crisis and to stir up their confidence in the online examination system, the ROA format was implemented in two phases. The first phase focused on getting the students accustomed to the online format of examination without the e-proctoring which was planned to be introduced in the second phase of implementation. The first phase of implementation involved preparing the students through two principal mock examination activities before subjecting them to the third principal activity which was the summative mid-term examination.

The class representatives from each academic year of medical and dental courses were selected for one-on-one training by the experts from Health Informatics and Medical Education department. This was the first in-person student training which was possible with only a few students as the COVID-related public health guidelines did not allow larger gatherings. These master trainers were then assigned the task to train their colleagues via video conferencing. To aid the understanding of the format, a video tutorial and a student guidebook were shared with the students.

The first mock exam was conducted with all students attempting the exam at the same time of the same day and consisted of 30 multiple-choice questions (MCQs) and five short essay questions (SEQs) from one subject of the relevant courses. The student feedback (*1st Student Feedback*) after the first mock exam necessitated more student training followed by a second mock examination. The second mock exam was individualized for each separate class at a time. Students from each class were given an exclusive live remote online training session by the medical educationists followed by a mock exam consisting of the same number of items as the first mock exam. Following the second mock exam, the students of each particular class were invited to a live video conference session to discuss issues faced by them. Comprehensive feedback (*2nd Student Feedback*) was also taken afterward and all issues faced by the students were addressed and resolved by the experts from the health informatics department at the spot. The mock exams were then left open for unlimited time and attempts, to allow students to familiarize themselves with the program before the mid-term examination.

After the mid-term summative examination, the final student feedback (*3rd Student Feedback*) was also taken to devise future quality improvement measures Fig. 1.

# Data Collection

Feedback data were collected after all the three principal activities of the first phase of the implementation process to improve the ROA program through necessary revisions and to make the format more user-friendly. These online feedback survey forms were administered after each mock exam activity and the final mid-term summative examination. After the mid-term summative examination, the students were also administered a special online survey form to ascertain the educational impact and usefulness (EIU) of this novel ROA program. This questionnaire was devised by the authors and face-validated by the experts in medical education.

## Study Outcomes

The primary study outcomes comprised of subjective and objective categories. The objective measure was the number of total students who were able to complete their remote online assessment without interruption. Students' satisfaction with this new form of ROA was the subjective outcome measure.

The secondary outcome measure was the educational impact of this ROA program implementation on the academic progress of the students during the COVID-19 lockdown.

## Statistical Analysis

The data were entered into Microsoft Excel and IBM SPSS v.22 for analysis. Descriptive statistics were reported as percentages. Ordinal variables were examined for the normality of distribution, and the skewness along with kurtosis was checked. The ordinal variables were treated as non-normally distributed data. Kruskal Wallis-H test was used for comparative analysis and mean ranks were generated for the ordinal data. Multivariate regression models were built for the identification of factors contributing to the student's satisfaction and the adjusted odds ratios (aOR) were calculated. For achieving an optimal calibration and sensitivity of the regression model, five-point Likert scale was recategorized to a three-point scale where 'strongly satisfied' and 'satisfied' were pooled in a single group i.e. combined satisfied group and similarly, 'extremely dissatisfied' and 'dissatisfied' were grouped into 'combined dissatisfied group' leaving the 'neutral' as it is. A p-value of  $< 0.05$  was considered statistically significant for the study analysis.

## Results

A total of nine classes; five from the school of medicine (1st to final year MBBS) and four from the school of dentistry (from 1st to final BDS) participated in the ROA implementation process. The faculty members from 33 departments participated in the student training activity to prepare them for the summative mid-term assessment. The overall satisfaction level was highest after the second mock examination and training session activity Table 2. At all the three principal activities, the preclinical students had significantly lower satisfaction rates with this new form of ROA than the clinical students i.e., the mean ranks for satisfaction level were higher among the clinical students after the first and second mock and the mid-term assessment,  $p < 0.001$ ,  $p = 0.005$  and  $p < 0.001$ , respectively.

Table 2  
Comparison of Overall Satisfaction of Clinical & Preclinical Students with the Remote Online Assessment System at various Intervals of the Implementation Process

Feedback Interval	Satisfaction						Means Ranks	p value <sup>a</sup>
	Extremely dissatisfied n (%)	Not Satisfied n (%)	Neutral n (%)	Satisfied n (%)	Very Satisfied n (%)	Total n (%)		
Feedback-1								< 0.001*
Preclinical	88 (27.4)	91 (28.3)	115 (35.8)	25 (7.8)	2 (0.6)	321 (38.6)	372.81	
Clinical	70 (13.7)	202 (39.6)	108 (21.2)	109 (21.4)	21 (4.1)	510 (61.3)	443.18	
Total	158 (19.0)	293 (35.3)	223 (26.8)	134 (16.1)	23 (2.8)	831 (100)		
Feedback-2								0.005*
Preclinical	8 (2.5)	13 (1.4)	119 (37.8)	151 (47.9)	24 (7.6)	315 (36.0)	409.00	
Clinical	7 (1.3)	17 (3.0)	171 (30.5)	312 (55.7)	53 (9.5)	560 (64.0)	454.31	
Total	15 (1.7)	30 (3.4)	290 (33.1)	463 (52.9)	77 (8.8)	875 (100)		
Feedback-3								< 0.001*
Preclinical	12 (3.8)	157 (50.0)	52 (16.6)	79 (25.2)	14 (4.5)	314 (37.9)	380.13	
Clinical	10 (1.9)	220 (42.8)	54 (10.5)	177 (34.4)	53 (10.3)	21 (4.1)	435.50	
Total	22 (2.7)	377 (45.5)	106 (12.8)	256 (30.9)	67 (8.1)	828 (100)		
<sup>a</sup> p-value generated using Kruskal-Wallis H test								

## First Mock Assessment

Out of a total of 864 students, 831 successfully attempted the exam. Thirty-three students were unable to attempt the exam due to incompatible devices. Several problems were identified following the first mock assessment with most students finding time allotted for the exam insufficient, 614 (73.9%) and facing internet speed and connectivity issues, 470 (57%). The solutions of all the identified issues were devised

later on before moving to the second mock assessment Table 3. The overall satisfaction rate with this new form of ROA was extremely low after the first mock assessment with only 156 (18.9%) students opting for 'satisfied' and 'very satisfied', combined. Students from the preclinical years were more likely to fall into the combined dissatisfied group, (aOR: 3.00, 95%CI: 1.88–4.81). Similarly, students who did not find the exam format & interface user-friendly (aOR: 3.21, 95%CI: 2.17–4.75), the allotted time sufficient (aOR: 1.91, 95%CI: 1.25–2.90), and those who did not face an internet speed or connectivity issue (aOR: 1.90, 95%CI: 1.26–2.87) were more likely to be in the combined 'dissatisfied' category Table 4.

Table 3

Problems Identified along with the solutions devised during the First Mock Remote Online Examination

<b>Problem(s) indentified*</b>	<b>Solution(s) devised</b>
Incompatible devices or software; Students unable to attempt exam (n = 33)	All students urged to use personal computers or laptops & facilitate them with compatible software
Internet connectivity or speed issues (n = 470)	Students to arrange a standby internet source e.g. cell phone's mobile data (4G) & enable students to switch network connections during the exam
Power/Electricity loss (load shedding phenomena that is common in developing countries); Students facing interruption (n = 197)	Split exam into smaller components with break-time in between. Won't affect overall exam and will allow student to make arrangements for next exam component
Complexity of exam interface; Students finding interface less user-friendly (n = 301)	Make relevant changes in the exam interface to make it more user-friendly
Total time allotted for exam completion; Students finding time insufficient (n = 614)	Give an extra time period window to access the software and log in; also to account for minor delays in navigating exam questions
Access and attempt; Students finding it difficult to access and attempt the exam through laid procedure (n = 258)	Conduct separate live online training sessions smaller groups and administer mini-mock exams with troubleshooting sessions afterwards; address students' problems & queries at the spot
Grievance redressal for those students who will face genuine issues leading to exam disruption or rendering their exam incomplete	Formulate mechanism to address such grievances and make an alternate mode of retaking the exam e.g. online viva voce or written on-campus in-person exam. Allow students to retake exam in only those components which were affected
* Based on analysis of feedback and exam data gathered after 1st mock exam	
N = 864, Attempted Exam = 831	

Table 4  
Multinomial regression analysis of Feedback 1 i.e. after the first mock exam†

Independent (Predictor) variables	Outcome variable (Students' satisfaction) <sup>a</sup>			
	Not Satisfied <sup>b</sup>		Neutral <sup>b</sup>	
	OR (95% CI)	p value	OR (95% CI)	p value
Gender				
Female (n = 576)	1.17 (0.78–1.75)	0.456	2.01 (1.24–3.29)	0.005*
Male (n = 255)	Ref		Ref	
Professional Year				
Preclinical (n = 321)	3.00 (1.88–4.81)	0.000*	4.84 (2.90–8.08)	0.000*
Clinical (n = 510)	Ref		Ref	
Did you find the Exam format a user-friendly?				
No (n = 530)	3.21 (2.17–4.75)	0.000*	4.24 (2.67–6.73)	0.000*
Yes (n = 301)	Ref		Ref	
Do you find the allotted time for Exam sufficient?				
No (n = 614)	1.91 (1.25–2.90)	0.003*	1.32 (0.81–2.13)	0.264
Yes (n = 217)	Ref			
Did you face an Internet speed or connectivity issue?				
No (n = 361)	1.90 (1.26–2.87)	0.002*	3.03 (1.90–4.82)	0.000*

Goodness-of-fit test of overall model (Likelihood ratio): Chi-square  $\chi^2 = 142.88$ , df = 10, p value = 0.000. Pseudo-R-Square = 0.183

Ref: Refers to categories taken as reference in the Multinomial Logistic Regression analysis

OR (95% CI): Odds ratio (95% Confidence Interval), calculated from exponentiation of the coefficients (B)

† Sample size = 831 students

<sup>a</sup> Reference category is 'Satisfied'

Independent (Predictor) variables	Outcome variable (Students' satisfaction) <sup>a</sup>			
	Not Satisfied <sup>b</sup>		Neutral <sup>b</sup>	
	OR (95% CI)	p value	OR (95% CI)	p value
Yes (n = 470)	Ref		Ref	
Goodness-of-fit test of overall model (Likelihood ratio): Chi-square $\chi^2 = 142.88$ , df = 10, p value = 0.000. Pseudo-R-Square = 0.183				
Ref: Refers to categories taken as reference in the Multinomial Logistic Regression analysis				
OR (95% CI): Odds ratio (95% Confidence Interval), calculated from exponentiation of the coefficients (B)				
† Sample size = 831 students				
<sup>a</sup> Reference category is 'Satisfied'				

<sup>b</sup> Categories are merged for the ease of analysis and interpretation. The combined group 'Not Satisfied' is equal to 'Extremely dissatisfied' plus 'Not satisfied' (Likert item values 1 and 2 respectively). Combined group 'Satisfied' is equal to 'Satisfied' plus 'Very Satisfied' (Likert item values 4 and 5 respectively).

\* p value is considered statistically significant at less than 0.05

## Second Mock Assessment

A total of 875 students attempted the second individualized mock assessment/training session. All students completed the mock exam. After the completion of the second mock activity, the overall student satisfaction with this new form of ROA improved with the majority of the students, 540 (61.7%) opting for 'satisfied' and 'very satisfied' Table 2. Students from the preclinical years (aOR: 0.69, 95%CI: 0.52–0.92), those who did not find the exam easy to access (aOR: 0.07, 95%CI: 0.04–0.14), those who did not have a standby alternate source of the internet (aOR: 0.20, 95%CI: 0.11–0.38) were less likely to be in the combined 'satisfied' and 'very satisfied' category Table 5.

Table 5  
Ordinal Logistic Regression analysis of Feedback set 2 i.e. after the second mock exam†

Independent (Predictor) variables	Outcome variable (Students' satisfaction) <sup>a</sup>	
	OR (95% CI)	p value
Gender		
Female (n = 590)	0.90 (0.67–1.22)	0.491
Male (n = 285)	Ref	
Professional Year		
Preclinical (n = 315)	0.69 (0.52–0.92)	0.011*
Clinical (n = 560)	Ref	
Did you find it easy to access the Exam?		
No (n = 38)	0.07 (0.04–0.14)	0.000*
Yes (n = 837)	Ref	
Did you have a standby alternate source of internet?		
No (n = 44)	0.20 (0.11–0.38)	0.000*
Yes (n = 831)	Ref	
Was your alternate source of internet the mobile phone data?		
No (n = 536)	1.16 (0.88–1.55)	0.297
Yes (n = 339)	Ref	
Goodness-of-fit test of overall model (Likelihood ratio): Chi-square $\chi^2 = 150.60$ , df = 5, p value = 0.000		
Pseudo-R-Square = 0.128		
Ref: Refers to categories taken as reference in the Ordinal Logistic Regression analysis		
OR (95% CI): Odds ratio (95% Confidence Interval), calculated from exponentiation of the coefficients (B)		
† Sample size = 875 students		

<sup>a</sup> Reference category is 'Satisfied'

<sup>b</sup> Categories are merged for the ease of analysis and interpretation. The combined group 'Not Satisfied' is equal to 'Extremely dissatisfied' plus 'Not satisfied' (Likert item values 1 and 2 respectively). Combined group 'Satisfied' is equal to 'Satisfied' plus 'Very Satisfied' (Likert item values 4 and 5 respectively).

\* p value is considered statistically significant at less than 0.05

## **Summative Mid-Term Assessment**

A total of 828 students attempted the mid-term assessment and the same number of students responded to the feedback sought after this summative activity. The overall satisfaction rate fell with only 323 (39%) of students opting for the combined 'satisfied' and 'very satisfied' category Table 2. Female students (aOR: 1.50, 95%CI: 1.09–2.05), students from the preclinical years (aOR: 1.68, 95%CI: 1.21–2.32) and those who did not find the mock exams and training sessions helpful (aOR: 5.67, 95%CI: 2.18–14.76), were more likely to fall into the 'combined dissatisfied' category Table 6. Grades scored in the mid-term summative assessments had no significant correlation with the satisfaction level.

Table 6  
Multinomial regression analysis of Feedback 3 i.e. after the mid-term exam†

Independent (Predictor) variables	Outcome variable (Students' satisfaction) <sup>a</sup>			
	Not Satisfied <sup>b</sup>		Neutral <sup>b</sup>	
	OR (95% CI)	p value	OR (95% CI)	p value
Gender				
Female (n = 556)	1.50 (1.09–2.05)	0.012*	2.20 (1.31–3.70)	0.003*
Male (n = 272)	Ref		Ref	
Professional Year				
Preclinical (n = 314)	1.68 (1.21–2.32)	0.002*	1.85 (1.15–2.99)	0.011*
Clinical (n = 514)	Ref		Ref	
Do you find the Mock Exams and Training Sessions helpful in attempting this formal exam?				
No (n = 62)	5.67 (2.18–14.76)	0.000*	13.81 (4.97–38.39)	0.000*
Yes (n = 766)	Ref		Ref	
Grades scored in the Mid-Term exams				
	1.49 (0.47–4.70)	0.499	0.64 (0.12–3.39)	0.597
Goodness-of-fit test of overall model (Likelihood ratio): Chi-square $\chi^2 = 67.015$ , df = 8, p value = 0.000				
Pseudo R square = 0.090				
Ref: Refers to categories taken as reference in the Multinomial Logistic Regression analysis				
OR (95% CI): Odds ratio (95% Confidence Interval), calculated from exponentiation of the coefficients (B)				
† Sample size = 828 students				

<sup>a</sup> Reference category is 'Satisfied'

<sup>b</sup> Categories are merged for the ease of analysis and interpretation. The combined group 'Not Satisfied' is equal to 'Extremely dissatisfied' plus 'Not satisfied' (Likert item values 1 and 2 respectively). Combined

group 'Satisfied' is equal to 'Satisfied' plus 'Very Satisfied' (Likert item values 4 and 5 respectively).

\* p value is considered statistically significant at less than 0.05

## Educational Impact & Usefulness (EIU)

A total of 828 students responded to the educational impact and usefulness (EIU) questionnaire after the completion of summative mid-term ROA. The majority of the students, 367 (44.3%) disagreed with the fact that this new remote online version of assessments was better than the traditional in-person, face-to-face examinations. Moreover, a higher number of the students agreed to the statements '*I prepared the syllabus for the mid-term exam very well*', '*It is a reliable way to formulate the GPA based on this ROA*' and '*This ROA motivated me very much to study for the mid-term exams*'. However, a smaller number of students agreed to the statements asking whether this ROA program is suitable for conducting the final end-of-year professional exams and whether this ROA is appropriate to assess the capability to pass the final end-of-year professional exams Fig. 2.

## Discussion

COVID19 pandemic challenged undergraduate medical education where all in-person teaching and learning activities were disrupted. The healthcare systems were overwhelmed and faced shortages of frontline workers including doctors and nurses. It became imperative to continue the UME courses to ensure the timely graduation of the medical students. Given that, we went through a well-organized and comprehensive implementation process of the ROA program which aimed at transforming all in-person summative curricular assessments into remote web-based assessments during the lockdown. Our findings and first-of-its-kind experience in a developing country's UME system gives a larger perspective into the feasibility of making such a transition from in-person learning to remote online; a system on which the future of medical education heavily relies.<sup>(9)</sup>

The overall satisfaction with the ROAs was lower among the preclinical students as compared to the clinical students. This was an important finding that led us to focus more on the preclinical students who are in the initial phase of their medical studies. Additional teachers from the faculty and experts from the IT department were allocated to the preclinical year classes for time to time troubleshooting and guidance.<sup>(10)</sup> After the first mock assessment, several technical aspects and problems were identified that were causing the students to experience unsuccessful attempts at the exam, problems completing them or interruptions during the remote online exams.

Incompatible devices, power outages due to load shedding, poor internet speed and connectivity were the major problems that were identified. One of the major problems is the lack of uninterrupted power supply and adequate internet connectivity which are the backbone of any online educational activity or assessment.<sup>(11)</sup> These problems are common and prevalent in the developing world with limited resources.<sup>(12)(13)</sup> Lack of an alternate source of the internet was identified as a major impediment to smooth exam completion and resulted in frequent interruptions encountered by the students. Our

regression analysis after the first feedback also showed that students' dissatisfaction with ROA was significantly associated with the complexity of the exam interface as the students found it difficult to access and attempt their assessments online. Similarly, dissatisfied students found the allocated exam time insufficient which was mainly because they were given SEQ type questions requiring typing in of answers through keyboards and pads which they never practiced before.

The IT experts made relevant changes in the exam interface following the preferences shared by the students (like adding a Wifi button that allowed them to change their internet connection during the exam). Also, we split an entire exam into three short components, each of which can be attempted and submitted separately. This allowed the students to take small breaks in between and safely submit their exam components once they were complete. This prevented the whole exam to be jeopardized due to any interruption like a power outage or internet breakdown. This also led us to formulate a student-friendly and lean redressal policy for those who experienced technical issues and interruptions during their exams. Such students were allowed to re-take a new exam later on but only in that component that was affected during their primary exam. Also, a few minutes were added to the total allocated time to account for the time consumed in logging in and accessing the exam.

The second training activity comprised an online tutorial session to demonstrate the process of attempting and submitting the exam by teachers and IT experts. These sessions were conducted with a smaller group of students and were followed by a mini-mock exam. The students were then asked to share their concerns and issues which were dealt with and resolved at the spot. This led to the highest satisfaction afterward as all the problems that were previously faced by the students were rectified. Our findings also suggest that having an alternate source of internet other than the 3G or 4G mobile data leads to higher satisfaction among the students with online assessments.<sup>(14)</sup> These are important considerations to make online assessments successful in developing countries.

After the first online summative mid-term exam, more than forty-five percent of the students showed dissatisfaction which was higher than the second mock exam feedback. This indicates that the students had concerns with taking summative assessments online which were to be counted in their final GPA grading calculation. Further exploration into the 3rd feedback showed that the females and preclinical students were more likely to be dissatisfied which reiterates the findings of earlier feedback. Females in our cultural settings are less computer-friendly and are inexperienced with the technology. This calls for attention towards their training and guidance in computer technology.<sup>(15)</sup> The grades scored in the mid-term exams were not associated with the satisfaction level which authenticates our findings as the scores achieved in examinations can be a potential confounder to satisfaction with the exam system.<sup>(16)</sup> The students, while responding to the educational impact and usefulness (EIU) questionnaire, did not agree that these online assessments were better than traditional online exams, by large. However, the majority of the students agreed to the fact that these ROAs are reliable to formulate their GPA and that this assessment program motivated them to study for the exam and prepare their curriculum.<sup>(17)</sup>

Collectively, these findings suggest that students are satisfied with the ROAs as far as these are formative. This also highlights the importance of designing formative assessments in such a way as to promote learning throughout the year. Overall, this ROA program in our settings achieved its goal by a continuation of the remote learning and assessment process through a combined effort of the technical staff, teaching faculty and the students. This yielded productive outcomes for undergraduate medical education which thrived remotely during the period of complete social isolation and lockdown. This implementation process and the findings from our students' feedback provide a fertile ground for designing and conducting advanced remote online assessments in the future.

This study is limited by the availability of data from the first phase of implementation which tested a remote online assessment system without live online proctoring and invigilation. Our second phase of implementation included online proctoring using the examinee's mobile phone camera, however, the data regarding satisfaction with the ROA after incorporating the online proctoring was not available at the time of this study. Also a broad horizon geographically and inclusion of multiple institutions can provide us with even more substantial results that can help enhance the virtual learning and assessment systems.

## **Conclusion**

Developing countries have indigenous issues that require a thorough consideration throughout the planning and implementation phase of remote online assessments in the medical education system. Preclinical and female students are more likely to be dissatisfied with the online exam system thereby requiring special attention and training. Institutions need to allocate more resources on live one-on-one online training of the students in smaller groups followed by a series of mock examinations. A user-friendly exam format and interface along with individualized troubleshooting sessions lead to higher satisfaction among the students and better outcomes of remote online assessments.

## **Declarations**

Ethical Approval & consent to Participate::

Ethical approval was granted by the institutional review board of FMH College of Medicine & Dentistry, Lahore, Pakistan (FMH-03-2021-IRB-876-M). Participants were informed about the aim of collecting feedback data including the use for quality improvement measures and presentation in print media in the form of publication. All participants participated voluntarily without any compulsion or compensation. This study was carried out in accordance with the Declaration of Helsinki.

Consent to Publish:

Not applicable

Competing interests:

The authors declare that they have no competing interests.

## Acknowledgements:

The authors are grateful to the information technology department of Fatima Memorial System for their constant support in the process of implementation of remote online assessments; especially to Mr. Khyber Khan for round the clock support and assistance in collection of this study data.

## Funding:

The authors declare no source of funding for this article.

## Availability of data and materials:

All data relevant to this article is with the corresponding author which may be requested at any instance.

## Authors Contribution:

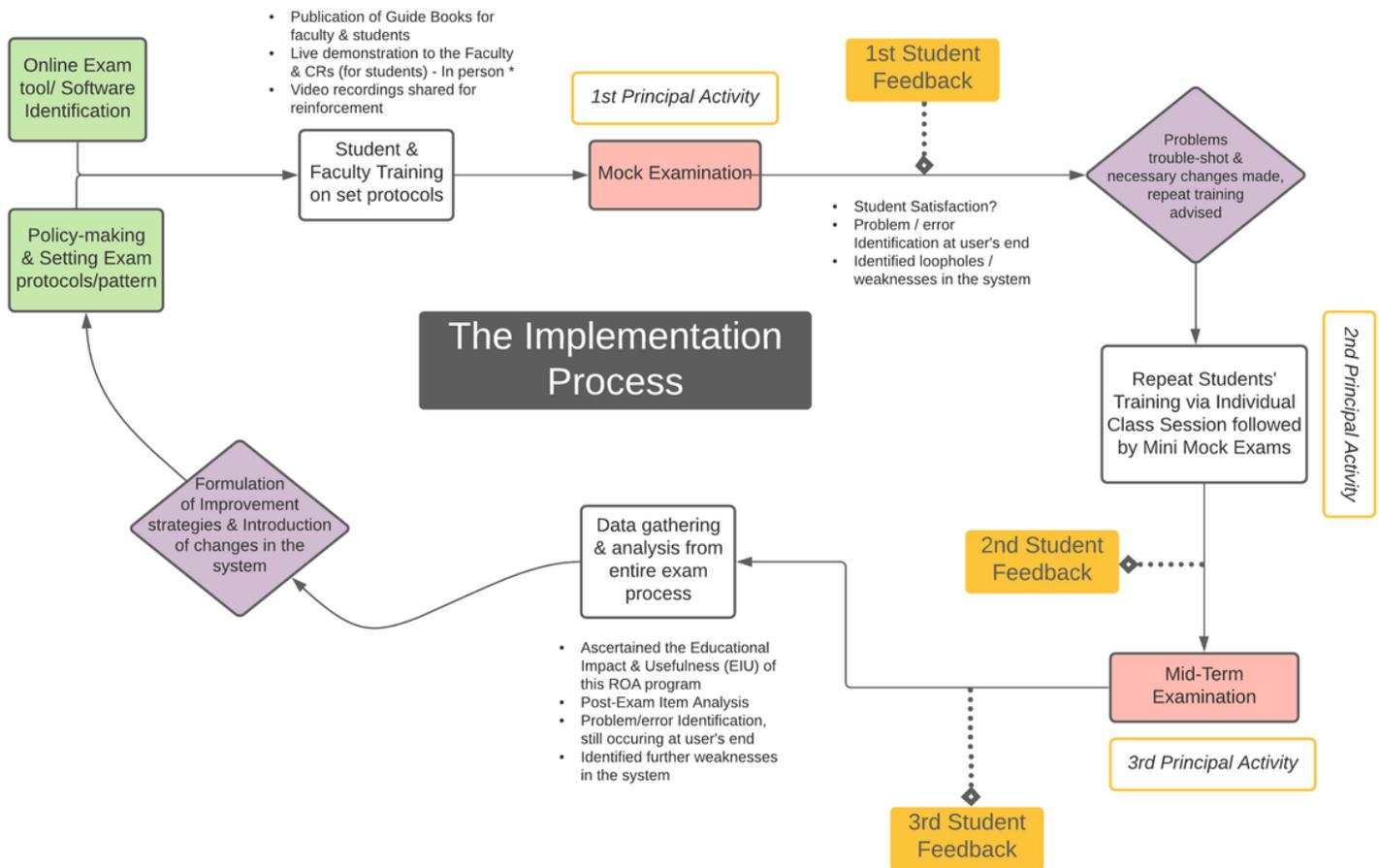
SMHA and AZA conceived the idea. JK and SMHA collected and analyzed the data. MFC prepared the figures and tables. AZA, SMHA, MFC and AM contributed to the write-up of the manuscript. All authors reviewed the manuscript approved the final version.

## References

1. Woolliscroft JO. Innovation in response to the COVID-19 pandemic crisis. *Acad Med.* 2020;95(8):1140–2.
2. Considerations for Institutions of Higher Education (IHEs).
3. Farooq F, Rathore FA, Mansoor SN. Challenges of online medical education in Pakistan during COVID-19 pandemic. *J Coll Physicians Surg Pakistan.* 2020;30(1):S67–9.
4. Reid MD, Sam AH. Reflections on assessment in the wake of change from the COVID-19 pandemic. *Med Educ.* 2021;55(1):128–30.
5. Sabzwari S. Rethinking Assessment in Medical Education in the time of COVID-19. *MedEdPublish.* 2020;9(1):1–6.
6. Alkhowailed MS, Rasheed Z, Shariq A, Elzainy A, El Sadik A, Alkhamiss A, et al. Digitalization plan in medical education during COVID-19 lockdown. *Informatics Med Unlocked [Internet].* 2020;20:100432. Available from: <https://doi.org/10.1016/j.imu.2020.100432>
7. Shehata MH, Abouzeid E, Wasfy NF, Abdelaziz A, Wells RL, Ahmed SA. Medical Education Adaptations Post COVID-19: An Egyptian Reflection. *J Med Educ Curric Dev.* 2020;7:238212052095181.
8. Schuwirth LWT, Van Der Vleuten CPM. General overview of the theories used in assessment: AMEE Guide No. 57. *Med Teach.* 2011;33(10):783–97.
9. Summary E. National Telemedicine Initiatives: 2009;600–10.

10. Ram K. The Satisfaction Level of Undergraduate Medical and Nursing Students Regarding Distant Preclinical and Clinical Teaching Amidst. 2021;
11. Journal I, Students M, Covid- LCD, Author P, Vimbainashe C, Degrees G, et al. Online Final Medical School Exam in a Low-Income Country During COVID-19 Pandemic. :2–5.
12. Singal A, Bansal A, Chaudhary P, Singh H, Patra A. Anatomy education of medical and dental students during COVID-19 pandemic: a reality check. *Surg Radiol Anat* [Internet]. 2021;43(4):515–21. Available from: <https://doi.org/10.1007/s00276-020-02615-3>
13. Nyagorme P, Qua-Enoo AA, Bervell B, Arkorful V. The Awareness and Use of Electronic Learning Platforms: A Case of a Developing Country. *World J Comput Appl Technol*. 2017;5(2):13–23.
14. Venter G. Optimising Internet Bandwidth in Developing Country Higher Education.
15. Joseph MK, Andrew TN. Convergence opportunities and factors influencing the use of internet and telephony by rural women in South Africa and India towards empowerment. 241:1–20.
16. Krouska A, Troussas C, Virvou M. Comparing LMS and CMS platforms supporting social e-learning in higher education. 2017 8th Int Conf Information, Intell Syst Appl IISA 2017. 2018;2018-Janua:1–6.
17. Amoroso DL (Appalachian SU. Use of Online Assessment Tools to Enhance Student Performance in Large Classes. *Isecon* [Internet]. 2004;21(4):1–8. Available from: <http://proc.isecon.org/2004/3142/ISECON.2004.Amoroso.pdf>

## Figures



**Figure 1**

Outline of the First Phase of Implementation Process of Remote Online Assessment System

## Student Feedback on the Educational Impact of an Online Exam

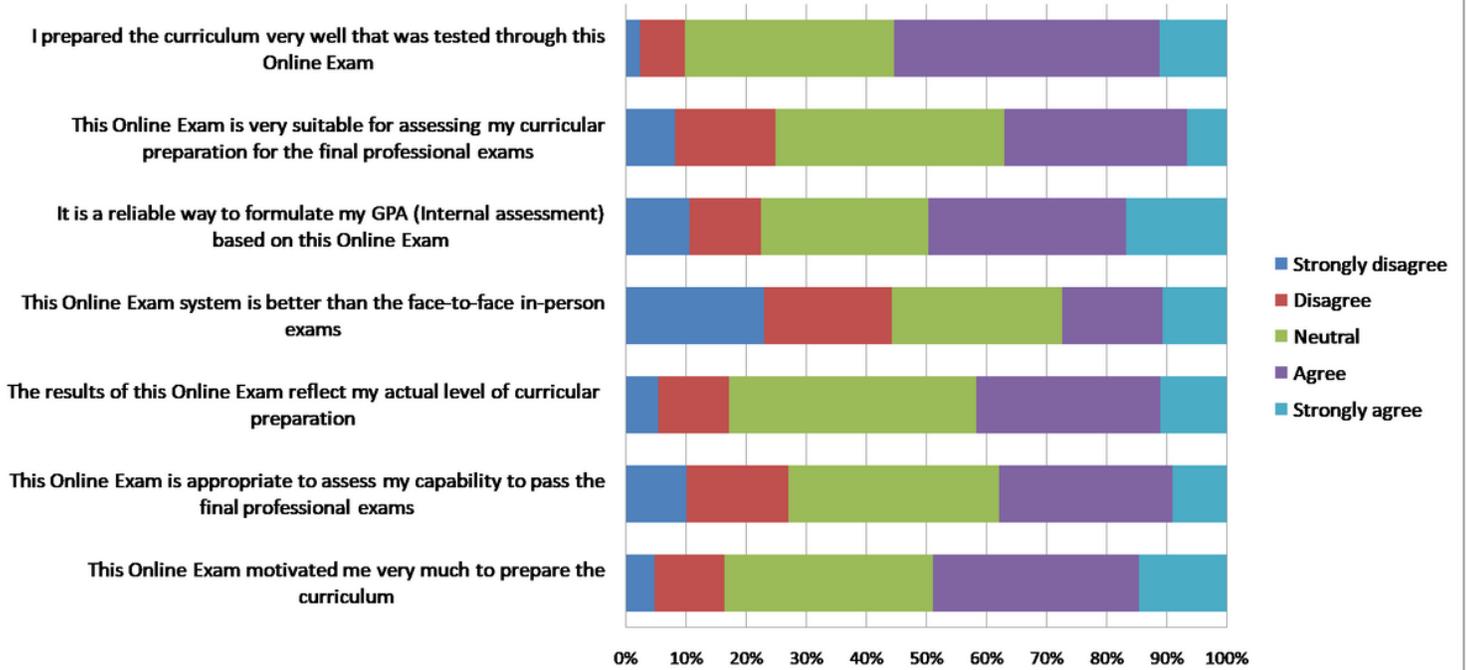


Figure 2

100% Stacked Bar Chart showing the Educational Impact & Usefulness of Remote Online Assessment Implementation during the COVID19 lockdown