Original article

Are we ready yet for digital transformation? Virtual versus on-campus OSCE as assessment tools in pharmacy education. A randomized controlled head-to-head comparative assessment

Zelal Kharaba [a,b,c,]*, Mohammad M. AlAhmad [a,b], Asim Ahmed Elnour [a,b], Abdallah Abou Hajal [a,b], Suhad Abumweis [a,b,d], Mohammad A. Ghattas [a,b]

[a] College of Pharmacy, Al Ain University, 64141 Abu Dhabi, United Arab Emirates
[b] AAU Health and Biomedical Research Center, Al Ain University, 64141 Abu Dhabi, United Arab Emirates
[c] Faculty of Medical Sciences, Newcastle University, Newcastle upon tyne, UK
[d] Department of Clinical Nutrition and Dietetics, Faculty of Applied Medical Sciences, The Hashemite University, P.O. Box 330127, Zarqa 13133, Jordan

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ABSTRACT

Background: The global COVID-19 pandemic has influenced pharmacy education including learning, assessment, and exams. In the UAE, pharmacy instructors have adapted several innovative teaching methods to strive for quality learning outcomes. The current trial presented a head-to-head comparative assessment between on-campus versus virtual Objective Structured Clinical Examination (OSCE) with examiners' and students' perspectives.

Aim: The main aim was to compare fourth-year students' and examiners' perceptions of the feasibility (time and logistics), stress, performance, and satisfaction between on-campus versus virtual OSCE.

Method: A randomized controlled head-to-head comparative assessment between the On-campus and virtual OSCE was conducted to explore performance and satisfaction of pharmacy students and examiners towards the two OSCE settings. The virtual OSCE was carried out directly after the on-campus -OSCE and the setting was designed in a way that aligned with the on-campus OSCE but in a virtual way. Microsoft Teams® breakout room was used as a virtual stations. Respondus-lockdown-browse and Google Meet® were used for proctoring purposes.

Results: Students who sat for the on-campus assessment were more satisfied with the instructions, the orientation session, the time management, and the overall exam setting, the ability of the exam to assess their communication and clinical skills, professionalism and attitude, and the interactivity of the exam compared to the students who sat for the virtual assessment. Examiners' perceptions for both settings were the same with the exception of interaction with students ($p < 0.05$) as the on-campus OSCE was more interactive.

Conclusion: Students still prefer the on-campus OSCE to the virtual OSCE format in many aspects. Nevertheless, virtual OSCE is still a feasible and satisfactory method of assessment when on-campus OSCE is not possible. There is a need of a specialized platform to conduct the virtual OSCE from A to Z rather than maximizing the use of options in the current digital platforms.

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1. Introduction

Introduced in 1975 by RM Harden, the Objective Structured Clinical Examination (OSCE) was first announced as an alternative assessment method to the existing clinical performance assessment methods (Harden et al., 1975). Since then, OSCE has become a well-established form of assessment across pharmacy and medical schools and is considered the gold standard for evaluating clinical skills in health care worldwide (Lim et al., 2020). Compared to written examinations, OSCEs assess students' clinical knowledge, problem-solving, and communication skills in a simulated setting, in a time-sensitive manner, and in a more rigorous examination style. In OSCE, students rotate between different stations that typically assess a core skill or a combination of skills in a period between 6 and 15 min in each station (Grover et al., 2022). The skills assessed in OSCE are either practical procedures, simulated consultations, clinical examinations, or clinical data interpretation (Chisnall et al., 2015).

The OSCE environment provides a simulated model to achieve the outcome of a performance-based assessment (Branch, 2014). The value of OSCE as a summative assessment (assessing clinical knowledge and skills that contribute to the end-of-year total mark) in pharmacotherapy courses has been well demonstrated in the literature (Sturpe et al., 2010, Hastings et al., 2010). There is an increased use of OSCE in a variety of pharmacy settings (Sturpe, 2010), such as advanced pharmacy practice experience (APPE) (Mészáros et al., 2009), laboratory courses (Hughes et al., 2013), licensure and continuing education (Shirwaikar, 2015).

In Al Ain University, College of Pharmacy offers a five-year bachelor of pharmacy degree. Practice-oriented courses within the curriculum are offered in many courses that include but are not limited to pharmacotherapeutic, patient assessment, pharmacy practice, and experiential education courses starting in the second semester of the third year in the program.

However, the balance between the resources needed for OSCE and the opportunity for students to practice OSCEs is challenging (Branch, 2014). Indeed, OSCE is a time-long, stressful, staff-intensive, resource-consuming and structured with complexity (Shirwaikar, 2015). Furthermore, examiners' evaluations of students' performances bear some inconsistency and lack accuracy (Emadzadeh et al., 2017).

The global COVID-19 pandemic has influenced pharmacy education in terms of learning, assessment, and examinations. In the United Arab Emirates (UAE), colleges of pharmacy educators have adapted several innovative teaching methods that strive for quality learning outcomes. Recently, virtual OSCE (V-OSCE) has gained popularity during the COVID-19 pandemic. The use of V-OSCE may assist student performance, enhance learning, and lessen staff workload and cost and contribute to easing the fore-mentioned drawbacks of conventional On-campus OSCE (OC-OSCE) (Daniel et al., 2021, Prettyman et al., 2018, Lim et al., 2020).

V-OSCE has served as a potentially feasible alternative to the OC-OSCE due to the ongoing pandemic that complicates the delivery of such assessment tool. A study conducted during COVID-19 lockdown found that V-OSCE has key advantages compared to the OC-OSCE in terms of attendance despite physical distance, ease of setup, teaching, students' and examiners' feedback that indicate effectiveness of learning (Prettyman et al., 2018). However, there is a lack of studies that compare head-to-head the delivery of the OC-OSCE to the V-OSCE for pharmacy /medical students. Existing studies mainly focus on the implementation or advantages of either virtual or on-campus OSCE delivery. It is important to know the students' and examiners' perceptions of delivering OSCE in different settings to help us identify aspects that need improvement and enhance the quality of the given exam to meet our program learning outcomes. The question to be addressed, therefore, is whether students and examiners perceive OSCE assessments differently if performed on-campus or virtually. However, and to the best of our knowledge, no study was found to compare head-to-head virtual to the on-campus OSCE, which gives the importance of our study.

Therefore, the current study describes and evaluates students' and examiners' perception of the use of virtual OSCE compared to the on-campus OSCE to assess the competency acquired during the pharmacotherapy course.

The objectives of our study were to compare head-to-head the OC versus V-OSCE in terms of feasibility (time and logistics), stress, performance, and satisfaction of fourth-year pharmacy students registered for the pharmacotherapy course at Al Ain University, along with the perceptions of their examiners toward the examined assessment methods. The null hypothesis of this work is that students and examiners perceive both settings similarly.

2. Method

The methods in the current study were conducted according to the CONSORT Consolidated Standards of Reporting Trials.

In Al Ain University, College of Pharmacy offers a five-year bachelor of pharmacy degree which has a national accreditation from a CAA (Commission of Academic Accreditation) of the Ministry of Education UAE and an international accreditation from ACPE (Accreditation Council of Pharmacy education) UAS. Practice-oriented courses within the curriculum are offered in many courses that include but are not limited to pharmacotherapeutic, patient assessment, pharmacy practice, and experiential education courses starting in the second semester of the third year in the program. OSCE is used as an assessment tool in different clinical courses for the third and fourth year pharmacy students and constitute a summative score of 10% for the assigned courses. The conduction of OSCE is carried out to resemble clinical settings rather than a lecture hall setting and is used to assess competencies of clinical skills where examiners rate students using a predefined checklist.

In this study, two different settings (on-campus and virtual settings) described in details below were conducted using a total of six-OSCE stations for each setting.

2.1. OSCE setting

The current study design was a randomized controlled comparative assessment of performance and satisfaction of pharmacy students and examiners towards the OC versus V-OSCE. The examiners were all teaching/research assistants ($n = 6$) with an MSc in pharmacy and the patients were 5th-year pharmacy students at the College of Pharmacy, Al Ain University. All examiners and patients were oriented to the OSCE exam and attended two workshops performed by the primary investigator, who had been trained with similar OSCE clinical scenarios to the OSCE exam materials.

2.2. Students' recruitment

All students registered in the two clinical courses (Patients assessment and pharmacotherapy for cardiovascular disorders) were recruited by a word of mouth to participate in the objective structured clinical examination through their course instructors. The total number of students who attended the OSCE was

(n = 51), who had been randomized as on-campus (n = 26 controls) and virtual (n = 25 interventions) groups. This was performed in a random fashion based on the students' cumulative Grade Points Average (cGPA) as a scoring scale to distribute the students. This was important to avoid bias between the two groups and to ensure homogeneity in comparison. The scale distribution is detailed in Supplementary document-1.

All students who participated in the OSCE exam completed the study survey and hence the response rate is 100%.

2.3. Randomization among groups

The random allocation of the students was computed by the study investigators who did not interfere with the students' OSCE exam assessment [Supplementary document-2]. The distribution of students in both groups was performed in a way that assured each group contained the same number of students in each score scale to assure consistency among groups and avoid bias in calculating the performance. The two OSCE settings (on-campus and virtual) were carried out on the same exam day and followed each other after a short break for examiners and patients.

2.4. Training for OSCE (TOSCE)

For students, the six OSCE training sessions were delivered in the study room, College of Pharmacy premises, Al Ain University (AAU), Abu-Dhabi Campus for the on-campus group and via Microsoft Teams software® (Microsoft Teams Version 1.5.00.17656 (64-bit)) / (Microsoft,2017) for the virtual group. A total of six training sessions were performed (three for each group) between November and December 2021.

Both training sessions focused on practicing different OSCE stations, including history taking and medication optimization for the two clinical courses; pharmacotherapy of cardiovascular disorders and patients' assessment courses. The 6-workshops (virtual and on-campus) were attended by all students (n = 51) who were trained on the two OSCE settings without being aware of which setting they would be assigned to on the day of the OSCE exam.

In addition, a video demo for both OSCE setting formats was shared with students and posted on Al Ain's website and social media platforms (Facebook and Instagram) to orient and familiarize students with both settings and the roles of students, examiners, and patients [Supplementary documents-3].

In the training sessions for students, the role of the student would alternate between the history-taking stations and medication optimization, thereby giving students the chance to practice skills and contribute to the feedback for their peers. Concomitantly, the examiners reviewed participant performance in each clinical scenario and provided individual constructive feedback for each student, thereby opening space for reflection. At the end of each training session, the examiners went collectively over the pre-designed marking scheme with each group of students with the aim of exploring how to approach a similar station. The medication optimization station was delivered in a group-teaching format, whereby the examiners discussed scenarios with the students and offered methods, advice, and tips on tackling a similar station in the exam. Furthermore, a Multiple Option Checking Test (MOCK) practice OSCE exam was placed on the Moodle for more student–student peer rehearsal.

2.5. On-Campus OSCE

A total of 25 students attended the OC-OSCE. Each session had a total of six-OSCE stations, organized as two opposite rows (Fig. 1), with three stations in each row; each row contains one clinical scenario. At each station, one examiner and one role-play patient sat

awaiting the student to arrive at the station. The time allowed for each student in each station was 10-min, divided as follows: 3-min to read the case scenario, 6-min to be examined, and 1-min to move to the next station. Six students arrived at six stations and at the minute-9, the bell rang and students were instructed to switch to the opposite station that has the other clinical scenario. This allowed us to save time as in each 10-min, 6-students existed in 6-stations and the other 10-min, students switched to the opposite station, so in each 20-min, a total of 6-students were examined in 2-clinical scenarios. At the end of each session, the students who finalized their OSCE exam were instructed to sit in an exit room to answer the survey of the study and then were requested to leave home. The other upcoming 6-students were examined in the same setting; the same clinical scenarios with the same trained examiners and patients, and answered the same survey, which ensured consistency. Details of the OSCE exam is provided in Supplementary document-4.

2.6. Virtual OSCE

The V-OSCE was carried out directly after the OC-OSCE as shown in Fig. 1. The setting of the virtual OSCE was designed in a way that aligned with the on-campus OSCE but in a virtual way. Microsoft Teams® (Microsoft Teams Version 1.5.00.17656 (64-bit)) / (Microsoft, 2017) was used as a platform for this purpose. Before the exam date, a team for the exam was created on MS-teams and students were added to the teams. Students who were assigned to the virtual OSCE (n = 26) were all signed in to the exam team. The team contained 6-breakout rooms (that represent virtually the stations of the on-campus OSCE). In each breakout room, one trained examiner and one trained patient were assigned whereas the students were waiting in the MS-teams main lobby in order to be located to the examination room. For proctoring purposes, Respondus-lockdown-browser (LockDown Browser for Windows, version 2.0.8.07)/(Respondus, 2015) was used as a proctoring software to maintain integrity. In addition, Google Meet® (Google, 2017) was used as an additional proctoring aid. Students in the waiting room were also requested to sign in to Google Meet via their cellphones and fix their cellphones in a way that one invigilator will invigilate their screen and keyboard to assure integrity. Then, one of the research team (ZK) with the help of an IT-Personnel assigned 6-students to 6-breakout rooms and counting the 10-min assigned for each student. At the minutes-9, students in the 3-breakout rooms that examined a clinical scenario-1 were shifted to the parallel breakout rooms that represented clinical scenario-2 and spent the same assigned time in those rooms. After students finalized the assigned time, they were relocated to the exit room where they answered the survey directly at the end of the exam session. The other upcoming 6-students were examined in the same clinical scenarios as the firsts 6-students are still in the exit room filling the survey, however, the clinical scenarios were changed every after 12-students to maintain the integrity of the exam (Fig. 1).

2.7. OSCE integrity

In both OSCE settings (on-campus and virtual), the integrity of the OSCE exam was maintained in several ways. In the OC-OSCE, the six-stations were placed at a reasonable distance from each other and separated with closed partitions, students were placed in the adjacent outside hall, refrained from any material such as cell phones, and the distancing was maintained as per COVID-19 policy at the university. The venue was monitored by the safety personnel and one invigilator who supervised the movement of students from the waiting hall to the exam hall (bell technique was utilized).
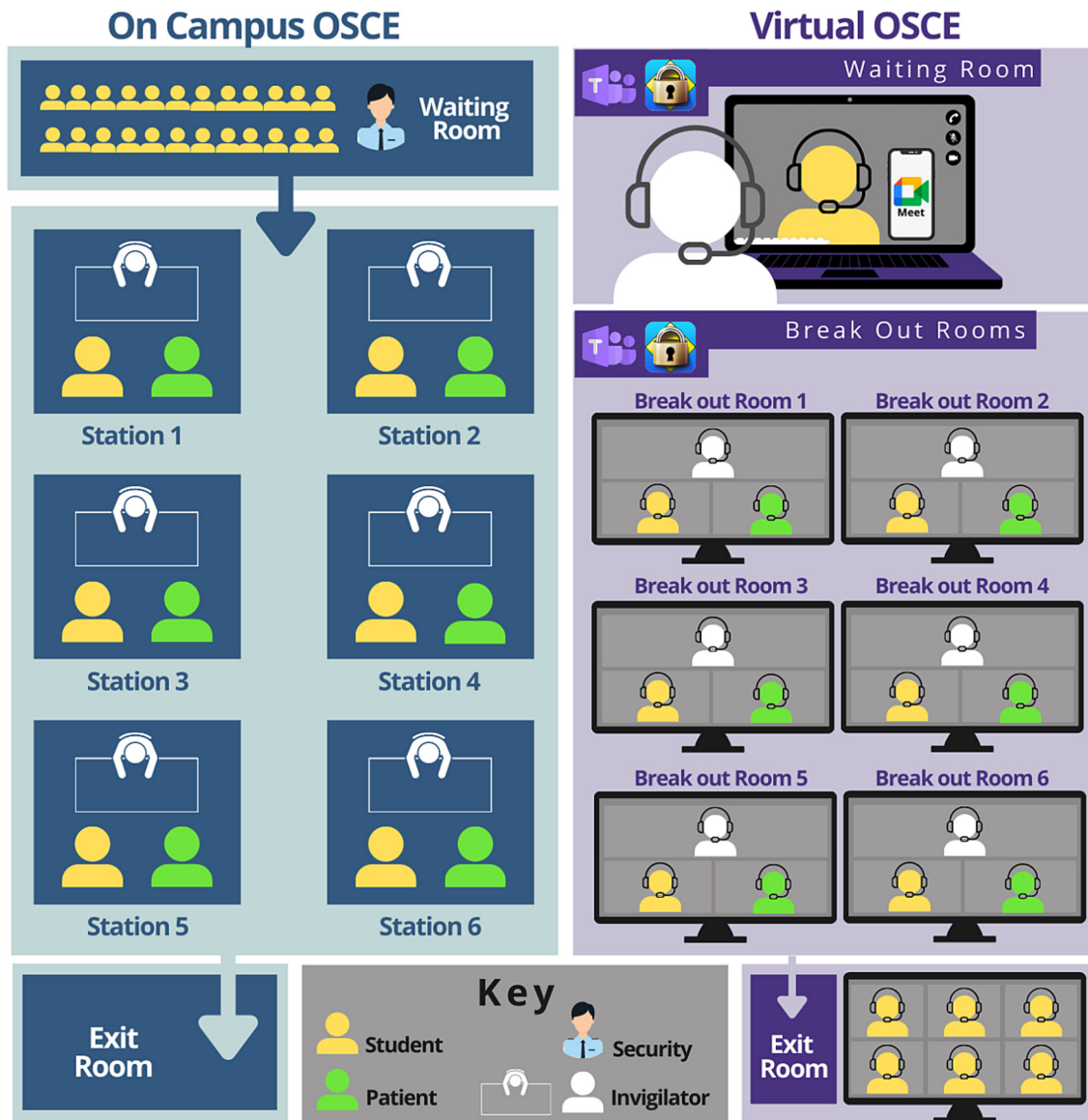
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Fig. 1. On campus and virtual OSCE environments.

In the V-OSCE setting, the waiting room and the breakout rooms in MS-Teams, were monitored by invigilators who navigate between rooms, Google Meet on the smart phone was used to monitor students' screens and keyboards, and Responds-lockdown browser was used to maintain integrity. Additionally, in V-OSCE, clinical case scenarios were changed after every 12-students completed their exam. The clinical scenarios were all created by the course instructors, and content validity was discussed with the entire research team and approved by the OSCE exam committee of the College of Pharmacy, Al Ain University, to ensure fair evaluation among groups.

2.8. The OSCE survey

We have developed a post OSCE survey for both students and the examiners depicted in [Supplementary document-5,6]. The survey used in our study was modified from the study published by (Grover et al., 2022).

Students were requested to fill out the survey at the end of each OSCE session for both OC and V-OSCE after consent. The survey aimed to compare both on-campus and virtual OSCE using the feasibility in terms of time and logistics, stress satisfaction, and perceptions of the 4th year pharmacy students as factors of comparison. The students had consented to take part in the survey for both on campus and virtual settings. The OSCE survey is composed of two sections. The first section contains the respondent's demographic data (name, student's ID, age, gender and cumulative grade points average [cGPA]) in addition to a few relevant closed-questions. Students were asked if they have ever taken any OSCE examinations (excluding the current OSCE exam), if they have received an OSCE orientation prior to exam day, if they have received any OSCE training prior to this exam, and the type of OSCE exam they have taken currently. The second section (26 statements) contains five domains (feasibility [12], content [4], assessment [3], adequacy and applicability [3], and satisfaction [4]). Furthermore, a Likert-scale was used to assess the extent of agreement and disagreement with the survey statements. We used a 5-point Likert-scale ranging from "strongly disagree" (a score of 1) to "strongly agree" (a score of 5). The last conclusive quality questions were added at the end of the survey for more elaborative information: what did you enjoy the most about this session and what could be done to improve the OSCE session in the future.

2.9. Validation of the study Questionnaire.

A validation test was conducted for the edited version of the students' and examiners' survey. A draft of the survey was sent to a panel of experts in the Pharmacy Practice and Clinical Pharmacy at Al Ain and Sharjah Universities, UAE, to test the content validity of the questionnaire. Content validation of the survey was examined, including the length, clarity, conciseness, time, language, appropriateness, and bias of questions (16).

2.10. Reliability testing of the study questionnaire

The survey was also revised based on a reliability test piloted on 15-students and 3-examiners to achieve the most acceptable Cronbach's values of 0.64. Additionally, a preliminary pilot test was carried out to ensure the practicality and understandability of the questionnaire.

2.11. OSCE student's evaluation

We have used a predefined checklist to evaluate the student performance (standardized marking scheme) during the OSCE sessions, which are performed by the course instructors [Supplementary document-7]. Before the OSCE, examiners were briefed on the marking scheme, and a training session was held to ensure that all students were evaluated fairly. In addition, Examiners were oriented about the marking scheme before the OSCE day and a training session was conducted to assure the fair evaluation of all students. The OSCE summative exam mark constitute 10% of the final course mark.

2.12. Examiner post OSCE survey

The examiners were given a questionnaire asking them to state how strongly they agreed or disagreed with the same comparative parameters regarding virtual and on-campus OSCE teaching and whether they felt that online-based OSCE teaching would be useful for learning after the pandemic.

Examiners were asked if they had ever a previous exposure to any OSCE examinations (excluding the current OSCE exam), the number of summative OSCE exams they dealt with at pharmacy school, if they had ever received any OSCE training before the current OSCE exam, and the type of OSCE they handled.

The second section (25 statements) contains five domains (feasibility [8], content [2], assessment [4], adequacy and applicability [3], and satisfaction [8]). Furthermore, a Likert-scale was used to assess the extent of agreement and disagreement with the survey statements.

2.13. Statistical analysis

All statistical analyses were conducted using IBM Corporation's statistical package for the social sciences (SPSS) software version 21.0 (IBM Corporation, Armonk, NY, USA). Descriptive categorical variables were presented as frequencies and percentages [n (%)], and descriptive continuous data as mean ± standard deviation (Mean ± SD). The Independent Student t-test was used to compare the two groups for continuous variables with a normal distribution. The scores for each item response, measured on a 5-point Likert-scale, in the study OSCE questionnaires were treated as ordered categorical data and so were presented as median and quartiles. The scores were found to be skewed at p less than 0.05 significance level when visually checked and, thus, the Mann-Whitney U test and Wilcoxon signed rank test were used to compare responses between independent and dependent groups, respectively. A significance level of ≤0.05 was used in all analyses.

2.14. Sample size

Our study was is the first study to compare the two settings and thus sample size of our study was calculated based on the sample size rule of thumb described by Julious SA (Julious, 2005). In addition, this sample size represented all students enrolled in the mentioned clinical courses who stated OSCE as method of assessment.

2.15. Ethics approval

The current research received the required ethical approval from the research ethics committee (REC) at Al Ain University-Abu-Dhabi Campus (AAU-REC-B3-Nov 2021).

3. Results

A total of 51-students participated in this study. The mean age of the students was 21.8 ± 0.24 and about 86% of the students were females. The mean cGPA was 2.91 ± 0.60. There were six examiners (five females and one male) with an age mean of 25.7 ± 3.6. The mean of total grades for students in the on-campus setting (n = 25) out of 40 points was 24.5 ± 5.6 (95% CI: 22.3 – 26.7). While the mean of total grades for students in the virtual setting (n = 26) was 26.2 ± 5.6 (95% CI: 23.8 – 28.3). There was no difference in total grades achieved between the two OSCE formats (p-value = 0.319). Table 1. describes student perception of the OSCE assessment. About 60% of the students who were assessed on-campus or virtually agreed that appropriate instructions including written guides demo videos, and orientation sessions were given prior to and after the exam. About 60% of these students were satisfied with time management system and the time either provided to move from one station to another or allocated to complete the tasks. While, 40% or less of students who set virtually for the exam were satisfied with time management system and the time either provided to move from one station to another or allocated to complete the tasks. Students agreed that the OSCE reflected what they learned previously, for either the on-campus or the virtual assessments. Regarding the other content of the OSCE assessment, 80% of students assessed on-campus agreed that the interaction with the simulated patients and the examiners was realistic. However, only 55% of the students who were assessed virtually found the interactions realistic. About 50% of the students agreed that the difficulty level of the OSCE cases was similar to the in-class case studies. About 60% of the students assessed on-campus and less than 40% of the students assessed virtually highly agreed that the OSCE assessed their clinical and communication skills as well as professionalism and attitudes. Students who sat for the on-campus exam highly agreed by 50% that the OSCE stations were engaging and interactive, while only less than 30% of the students who performed the assessment virtually highly agreed on that. About 25% of students who sat for both OSCE formats highly disagreed that the OSCE was less stressful than other typical assessment methods (i.e. quizzes, exams, presentations, etc). Finally, the majority of students agreed that the OSCE made them feel more like pharmacists than students.

To find the actual differences in the students' responses set for the two OSCE formats, Table 2 compares the Likert scale scores presented as median (25th-75th percentile) of perceived evaluation of the both OSCE formats. With reference to statements of the Feasibility domain, students performing the on-campus assessment were more satisfied with the following features compared to students who performed the virtual assessment: Appropriate instructions were given during the OSCE exam; The orientation session was helpful for the student to understand how the system will work; During the OSCE exam, the time management system

Table 1
Students' perception of the OSCE assessment performed on-campus and virtually (*n* = 51).

	Settings	Strongly disagree %	Disagree %	Neutral %	Agree %	Strongly agree%
Feasibility						
Appropriate instructions were given prior the OSCE exam:-	On-campus	0	3.8	3.8	23.1	69.1
	Virtual	0	8.0	4.0	32.0	56.0
Appropriate instructions were given during the OSCE exam:-	Fact-to-face	0	3.8	3.8	26.9	65.4
	Virtual	4.0	8.0	20.0	32.0	36.0
I was fully aware of the nature of the exam process and the skills required: -	Fact-to-face	0	0	19.2	15.4	65.4
	Virtual	0	4.0	20.0	40.0	36.0
The allotted time was sufficient for me before entering each OSCE station: -	On-campus	11.5	7.7	7.7	19.2	53.8
	Virtual	0	24.0	32.0	20.0	24.0
The written guide provided was helpful for me to understand how the system will work: -	On-campus	3.8	0	19.2	11.5	65.4
	Virtual	4.0	4.0	20.0	36.0	36.0
The demo videos provided were helpful for me to understand how the system will work: -	On-campus	3.8	0	23.1	3.8	69.2
	Virtual	0	8.0	16.0	36.0	40.0
The orientation session was helpful for me to understand how the system will work: -	On-campus	0	3.8	0	23.1	73.1
	Virtual	0	8.0	12.0	48.0	32.0
During the OSCE exam, the time management system worked well: -	On-campus	15.4	3.8	7.7	23.1	50.0
	Virtual	20.0	20.0	32.0	16.0	12.0
I am satisfied with the time interval provided to move from station to station during OSCE: -	On-campus	15.4	3.8	7.7	11.5	61.5
	Virtual	8.0	20.0	20.0	28.0	24.0
Overall, I am satisfied with the OSCE time management system: -	On-campus	23.1	3.8	15.4	11.5	46.2
	Virtual	8.0	36.0	28.0	16.0	12.0
The allotted time was sufficient to complete the tasks at each OSCE station: -	On-campus	19.2	15.4	3.8	11.5	50.0
	Virtual	20.0	4.0	32.0	24.0	20.0
The allotted OSCE setting was neat, well-defined and well-structured: -	On-campus	7.7	0	7.7	19.2	65.4
	Virtual	0	8.0	32.0	28.0	32.0
Content						
The OSCE cases are reflecting on what have been previously learned: -	On-campus	0	7.7	7.7	30.8	53.8
	Virtual	0	4.0	20.0	44.0	32.0
The interaction with the simulated patients was realistic: -	On-campus	3.8	3.8	11.5	19.2	61.5
	Virtual	0	12.0	32.0	36.0	20.0
The interaction with the examiners was realistic: -	On-campus	3.8	3.8	3.8	26.9	61.5
	Virtual	0	8.0	32.0	28.0	32.0
The difficulty level of the OSCE cases was similar to the in-class case studies: -	On-campus	7.7	15.4	26.9	19.2	30.8
	Virtual	4.0	4.0	32.0	36.0	24.0
Assessment						
The OSCE seem to adequately assess my skills in performing clinical real-case scenarios: -	On-campus	3.8	0	19.2	15.4	61.5
	Virtual	4.0	8.0	28.0	24.0	36.0
The OSCE seems to adequately assess my communication skills: -	On-campus	3.8	3.8	7.7	15.4	69.2
	Virtual	0	4.0	24.0	40.0	32.0
The OSCE seems to adequately assess my professionalism and attitudes appropriately: -	On-campus	0	3.8	15.4	11.5	69.2
	Virtual	4.0	4.0	20.0	36.0	36.0
Adequacy and Acceptability						
The OSCE stations are so engaging: -	On-campus	7.7	0	23.1	19.2	50.0
	Virtual	4.0	4.0	20.0	44.0	28.0
The OSCE stations are interactive: -	On-campus	0	3.8	7.7	26.9	61.5
	Virtual	8.0	4.0	24.0	40.0	24.0
The OSCE assessment allows me to develop my clinical skills: -	On-campus	3.8	3.8	3.8	23.1	65.4
	Virtual	4.0	4.0	12.0	52.0	32.0
Satisfaction						
The OSCE exam was less stressful than the written exams: -	On-campus	26.9	11.5	26.9	11.5	23.1

Table 1 (*continued*)

	Settings	Strongly disagree %	Disagree %	Neutral %	Agree %	Strongly agree%
The OSCE exam was less stressful than other pharmacy practice assessment tools (team-based tutorials, role plays, lab. cases..etc):	Virtual	20.0	16.0	12.0	24.0	28.0
	On-campus	30.8	15.4	26.9	3.8	23.1
The OSCE is a purposeful assessment method: -	Virtual	20.0	24.0	16.0	20.0	20.0
	On-campus	0	3.8	23.1	23.1	50.0
	Virtual	0	4.0	16.0	40.0	40.0
The OSCE allowed me to feel more like a pharmacist than a student: -	On-campus	3.8	7.7	15.4	23.1	50.0
	Virtual	0	8.0	12.0	40.0	40.0

worked well; The allotted OSCE setting was neat, and; well-defined and well-structured. The median Likert scale scores were higher for the on-campus setting (median = 5 [4–5]) compared to the virtual setting (median = 4 [3–5]) regarding two statements; The realistic of the interaction with the simulated patients, and; examiners in the content domain. Moreover, students who performed the on-campus assessment agreed more that the exam has adequately assessed their communication skills, professionalism, and attitudes (median = 5 [4–5]) compared to students who sat for the virtual exam (median = 4 [3–5]). Two out of the three statements in the Adequacy and Acceptability domain of the questionnaire were reported with a higher median Likert scale score for the on-campus setting compared to the virtual setting. These statements were: The OSCE stations were interactive (median = 5 (4–5) for the o-campus setting and median = 4 (3–4.5) for the virtual setting), and; The OSCE assessment allowed the student to develop his/her clinical skills (median = 5 (4–5) for the o-campus setting and median = 4 (4–5) for the virtual setting). The lowest scores were reported by the students for statements referring to the stress of the OSCE assessment compared to other types of assessment.

As shown in Table 3., Likert scale of examiners' perception did not differ for OSCE conducted on-campus versus virtual settings for feasibility components including orientation and instructions given, ease of conduction and scoring, time adequacy and management, and overall OSCE setting. Similarly, examiners' perception was equal for OSCE content as well as OSCE ability to assess the students' clinical and communications skills, as well as students' professionalism and attitudes. However, examiners perceived the on-campus (median score = 5 (4–5)) setting as more interactive than the virtual setting (median score = 3.5 (2.75–4.25)). Overall, the examiners were neutral (as Likert median scores were about 3) about the fact that OSCE formats seemed to be less stressful for students than the written exams and other pharmacy practice assessment tools (team-based tutorials, role plays, lab. cases..etc). Examiners agreed that on-campus or virtual OSCEs are a valuable assessment method that allows students to feel more like pharmacists than students. Examiners were also confident that they could do any OSCE format.

4. Discussion

Online teaching was a kind of shift that many pharmacy and medical schools targeted worldwide, especially after the COVID-19 pandemic (Mak et al., 2022, Prettyman et al., 2018, Lim et al., 2020). V-OSCE has been discussed by several studies concerning medical and pharmacy students and was found to be a reasonable solution that relatively retains the same ability to assess various clinical skills and clinical reasoning, history-taking, and formulating management plans and differential diagnoses as compared to the conventional OC-OSCE (Grover et al., 2022, Lim et al., 2020,

Zulkifly et al., 2022). Moreover, few studies discussed the advantages of V-OSCE over the on-campus format that include but are not limited to: reduction in travelling time, undertaking the exam in a comfortable environment, and the potential of scaling-up with smoother logistics (Grover et al., 2022, Dost et al., 2020, Blythe et al., 2021).

Other studies either described how they implemented a V-OSCE assessment (Zulkifly et al., 2022), or measured students' perception and/ or performance on V-OSCE assessment (Grover et al., 2022, Lim et al., 2020, Mak et al., 2022). For example, (Grover et al., 2022) assessed the utility of virtual OSCE sessions as an educational tool in a national pilot study conducted among several universities in the UK. They concluded that V-OSCE workshops could act as a valuable learning resource that has the potential to be used even beyond the pandemic. However, the study also highlighted the importance of future studies to focus on comparing the academic outcomes between the conventional and virtual OSCE teaching sessions.

In Australia, Mak and colleagues (Mak et al., 2022) studied students' and examiners' experiences of V-OSCE during the COVID-19 Pandemic. They found that only a third of students preferred the V-OSCE over the face-to-face OSCE and that "there is a need for remote online delivery of assessments saw innovative ways of undertaking OSCEs and an opportunity to mimic telehealth". The study concluded that the face-to-face OSCE is irreplaceable and recommended OSCEs to be delivered both virtually and face-to-face.

In another study in Australia, Lim et al (Lim et al., 2020) studied pharmacy students' perceptions and performance on the use of V-OSCE. They applied the Monash OSCE Virtual Experience (MOVE) as an online module of case scenarios with virtual patients in a mixed methodology of quantitative and qualitative method. They found that students' perception toward MOVE is promising. However, students still preferred face-to-face OSCE to virtual practice with virtual patients.

Although several studies explored students' perceptions, satisfaction, and performance in either on-campus or virtual OSCE separately, no single study compared both settings head-to head in all the mentioned aspects, which gives a clear scope for our work.

In our study, there was no significant difference ($p > 0.05$) between the two format settings and the V-OSCE was found to be as satisfactory as the OC-OSCE in most of aspects, which included exam feasibility, exam contents, adequacy and accessibility, and assessment. Also, in terms of satisfaction, there were no differences between both settings in terms of stress level compared to the written exams or other pharmacy practice assessment tools (team-based tutorials, role plays, lab. cases..etc). In fact, this finding is not in line with Mak's findings where 20% of the students felt more anxious while doing the virtual OSCE (Mak et al., 2022). Students agreed that both settings were purposeful assessment methods that allowed them to feel more like a pharmacist than a student.

Table 2
Likert scale scores presented as median (25th–75th percentile) of students' perception of OSCE conducted on-campus versus virtual setting.

Question/Statement	On-campus	Virtual	P-value
Feasibility			
Appropriate instructions were given prior the OSCE exam	5 (4–5)	5 (4–5)	0.327
Appropriate instructions were given during the OSCE exam	5 (4–5)	4 (3–5)	**0.018***
I was fully aware of the nature of the exam process and the skills required	5 (4–5)	4 (3.5–5)	0.08
The allotted time was sufficient for me before entering each OSCE station	5 (3–5)	3 (2.5–4.5)	0.72
The written guide provided was helpful for me to understand how the system will work	5 (3.8–5)	4 (3–5)	0.097
The demo videos provided were helpful for me to understand how the system will work	5 (3–5)	4 (3.5–5)	0.148
The orientation session was helpful for me to understand how the system will work	5 (4–5)	4 (4–5)	**0.003***
During the OSCE exam, the time management system worked well	4.5 (3–5)	3 (2–4)	**0.005***
I am satisfied with the time interval provided to move from station to station during OSCE	5 (3–5)	4 (2–4.5)	0.46
Overall, I am satisfied with the OSCE time management system	4 (1.8–5)	3 (2–4)	0.091
The allotted time was sufficient to complete the tasks at each OSCE station	4.5(2–5)	3 (2.5–4)	0.220
The allotted OSCE setting was neat, well-defined and well-structured	5.0 (4–5)	4 (3–5)	**0.024***
Content			
The OSCE cases are reflecting on what have been previously learned	5 (4–5)	4 (3.5–5)	0.162
The interaction with the simulated patients was realistic	5 (4–5)	4 (3–5)	**0.007***
The interaction with the examiners was realistic	5 (4–5)	4 (3–5)	**0.023***
The difficulty level of the OSCE cases was similar to the in-class case studies	3.5 (2.75–5)	4 (3–4.5)	0.592
Assessment			
The OSCE seem to adequately assess my skills in performing clinical real-case scenarios	5 (3.75–5)	4 (3–5)	0.74
The OSCE seems to adequately assess my communication skills	5 (4–5)	4 (3–5)	**0.025***
The OSCE seems to adequately assess my professionalism and attitudes appropriately	5 (4–5)	4 (3–5)	**0.043***
Adequacy and Acceptability			
The OSCE stations are so engaging	4.5 (3–5)	4 (3–5)	0.371
The OSCE stations are interactive	5 (4–5)	4 (3–4.5)	**0.005***
The OSCE assessment allows me to develop my clinical skills	5 (4–5)	4 (4–5)	**0.043***
Satisfaction			
The OSCE exam was less stressful than the written exams	3 (1–4)	4 (2–5)	0.452
The OSCE exam was less stressful than other pharmacy practice assessment tools (team-based tutorials, role plays, lab. cases..etc)	3 (1–4.3)	3 (2–4)	0.569
The OSCE is a purposeful assessment method	4.5 (3–5)	4 (4–5)	0.785
The OSCE allowed me to feel more like a pharmacist than a student	4.5 (3–5)	4 (4–5)	0.825

Values are shown as median (25th–75th percentile). Five-point Likert scale scoring of the items: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Mann–Whitney U test for comparisons between face-to-face and virtual settings. *statistically significant.

However, some differences do appear to exist between both settings in favor of the on-campus format, which include the appropriateness of instructions given during the OSCE exam, as well as the helpfulness of the orientation session to understand how the system shall work. We believe that students still preferred the conventional OSCE settings parallel to the finding of Lim et al (Lim et al., 2020) which is quite logical given that students do not necessarily need to be concerned about the technicality or logistics of the virtual settings.

Additionally, students significantly preferred the time management system during the on-campus setting, as they believed that it was neat, well-defined, and well-structured compared to the virtual setting. It looks like it is easier for students to be alarmed about the time setting using the bell technique used in OC-OSCE rather than being located in the next breakout room in V-OSCE with self-monitoring timing.

Students also think that the interaction with the simulated patients was more realistic in the OC-OSCE. Our finding confirmed the conclusion found in the MOVE study, as students did not prefer the simulated patients to the real patients in the face-to-face settings (Lim et al., 2020). Additionally, our study found that OC-OSCE appropriately assessed communication skills, professional-

Table 3
Likert scale scores presented as median (25th–75th percentile) of examiners' perception of OSCE conducted on-campus versus virtual setting.

Question/Statement	On-campus	Virtual	P-value
Feasibility			
OSCE orientation were given smoothly and effortlessly before the exam.	4 (3.75–4.25)	4 (2.75–5)	0.785
OSCE instructions were given smoothly and effortlessly during the exam.	4 (3–4.25)	4 (3.5–4)	0.705
OSCE conduction was easy	4.5 (4–5)	3 (2.75–4.25)	0.066
OSCE scoring was easy	3 (2.5–4.25)	4 (4–4.25)	0.059
The allotted time was sufficient to complete the assessment process at each OSCE station.	4.5 (2.75–5)	3.5 (2.75–4)	0.317
During the OSCE exam, the Time Management System worked well overall. The allotted setting was neat, well-defined and well-structured.	5 (4–5)	4 (3.5–4)	0.059
The allotted setting was neat, well-defined and well-structured. The allotted setting was easy to conduct	5 (4.5–5)	3.5 (2.75–4.25)	0.102
The allotted setting helped you to easily conduct the OSCE assessment During the OSCE exam, the Time Management System worked well.	5 (4.7–5)	4 (2.75–4.25)	0.066
Content			
The interaction with the simulated patients was realistic.	4 (2.75–5)	3.5 (2–4.25)	0.257
The interaction with the students was realistic.	4 (4–5)	4 (1.75–4.25)	0.180
Assessment			
The OSCE assessed student's ability to perform clinical skills correctly.	4 (2.75–4)	3.5 (2–4)	0.157
The OSCE assessed student's clinical knowledge correctly.	4 (3.5–5)	3.5 (2.75–4.25)	0.317
The OSCE appropriately assessed student's communication skills.	4 (3.25–4.25)	4 (2.75–4.25)	1.000
The OSCE properly assessed the student's professionalism and attitudes.	4 (3.5–5)	3.5 (2.75–5)	0.577
Adequacy and Acceptability			
The OSCE stations are very engaging.	5 (4–5)	4 (2.75–4.25)	0.059
The OSCE stations are interactive.	5 (4–5)	3.5 (2.75–4.25)	0.034*
The OSCE assessment allows students to develop clinical skills.	4.5 (4–5)	4 (3.5–4.25)	0.102
Satisfaction			
The OSCE exam was seems to be less stressful for students than the written exams.	2.5 (1.75–3)	3.5 (2–4)	0.197
The OSCE exam seems to be less stressful for students was less stressful than other pharmacy practice assessment tools (team-based tutorials, role plays, lab. cases..etc).	3 (2–3.25)	3 (2.75–4.25)	0.257
OSCE is a purposeful assessment method.	3.5 (3–4)	4 (3.75–4)	0.157
OSCE allowed students to feel more like a pharmacist than a student.	4 (3.75–5)	4 (3.75–5)	1.000
I am very confident to do this type of assessment again	4.5 (3.75–5)	4 (3.75–4.25)	0.414

Values are shown as median (25th–75th percentile). Five-point Likert scale scoring of the items: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Mann–Whitney U test for comparisons between face-to-face and virtual settings. *statistically significant.

ism, and attitudes compared to the V-OSCE. This finding is in parallel with the findings of other studies (Branch, 2014, Zulkifly et al., 2022, Ganesananthan et al., 2021). In all these studies, students preferred the OC-OSCE as a better communication tool with the patient as well as the examiner. This could be explained by the non-verbal communication, body language, and eye-to-eye contacts that are more explicit in the OC-OSCE than in the virtual format (Wang and Ruiz, 2021).

Furthermore, students think that the OSCE stations are more interactive in the on-campus setting, which also allows them to develop their clinical skills significantly more than in the virtual OSCE. The interaction with patients and examiners is the point that needs to be developed in the future studies of V-OSCE.

Few studies looked at the examiners' perceptions on virtual or on-line OSCE (Mak et al., 2022, Grover et al., 2022). In the current study, the same examiners evaluated students in the two OSCE formats that could minimize influences and differences arising as a result of examiner experience and clinical seniority (Chong et al., 2018, Stroud et al., 2011, Schleicher et al., 2017). In fact, many studies discussed many aspects of bias arising from examiners' evaluation of students, including examiner seniority and experience (Chong et al., 2018, Yeates et al., 2015, Chesser et al., 2009), examiner familiarity with residents (Stroud et al., 2011), examiner's level of experience and gender bias (Schleicher et al., 2017) and contrast effects and examiner behavior and training (Yeates et al., 2015, Chesser et al., 2009).

To the best of our knowledge, this is the first comparative study between both virtual and on campus OSCE settings, which hinders our ability to directly compare our findings with other studies. Nevertheless, our study highlighted some aspects that could be improved when conducting a virtual OSCE assessment. It was clear in our study that students preferred the conventional on-campus setting in terms of the times and logistics, interaction with simulated patients and examiners, communication skills and professionalism, and development of clinical skills. The V-OSCE can be developed to cover all these aspects in the new era of digital transformation. So far, all the research that studied the V-OSCE maximized the use of many developed options in the virtual platforms that could mimic the conventional OSCE, such as the breakout rooms in MS-teams as virtual stations that mimic the OSCE conventional stations, the lock-down browser use for the integrity of the virtual setting, mimicking the invigilators in the conventional OSCE, and the Google-Meet used as a waiting room, mimicking the class room as a waiting room in the conventional setting (Grover et al., 2022, Lim et al., 2020, Prettyman et al., 2018, Mak et al., 2022, Zulkifly et al., 2022). All these digital platforms aid in the conduction of virtual OSCE. Though they have many cons, including the limitation of interaction and communication between patient and student, student and examiner, as well as students' understanding of the logistics and time management. There is a need for a specialized platform to conduct the virtual OSCE from A to Z rather than combining two or three platforms as those employed in this work and many other studies.

The MOVE study (Lim et al., 2020) introduced by Monash University is a good example of that, but it is still a simulated patient platform and not a complete virtual OSCE.

4.1. Strengths and weaknesses

In our study, we used OSCE naïve students rather than students who had experienced OSCE before, which gives a strength to this study as per (Mak et al., 2022). In addition, other studies assessed students' comparison between both OSCE settings by asking students who experienced the conventional OSCE to compare it to the virtual OSCE, which might contain a sort of bias in remembering a historical experience (Zulkifly et al., 2022).

Another point of strength in our study is that the study design was crystalized in a way that avoided biases such as selection bias. Indeed, the study was conducted on the same batch of students (fourth year pharmacy students) who were taught by the same course instructors and examined by the same examiners for both settings, which minimized bias in assessing the students' performance. Students' distribution was randomized according to their cGPA to avoid selection bias in the level of students that might be reflected in their assessments. All students attended a MOCK OSCE and workshops for both settings; all examiners were trained on both settings.

However, this study is not without limitations. First, our sample size is (n = 51) students only. It could be that other findings will be different with a larger sample size. Second, we used different case studies that were validated and revised by the course instructors to maintain a relatively comparable level of information and to maintain the integrity of the virtual OSCE. However, this will not guarantee that differences in the level of difficulty of the case studies might exist between the two settings. Third point is that we trained our students and examiners for the use of virtual platforms (MS-Teams, Google-Meet, and Lockdown browser). Nevertheless, it is logic that their knowledge and practice of the conventional methods is much easier.

5. Conclusion

Although students were not ready for digital transformation as they still preferred the on-campus OSCE over the virtual OSCE format in many aspects, including the clinical and communication skills, interaction with patients and examiners, and time management system, the virtual OSCE is still a feasible and satisfactory method of assessment when OC-OSCS is not possible. The feasibility, exam contents, adequacy and accessibility, satisfaction, and students' assessment were the same in both OSCE settings. While the examiners' perceptions for both settings were the same, with the exception of interaction with students, future studies should focus on establishing more Regus instructions for V-OSCE and developing specific programs that capture the wider views of patients and examiners to evaluate nonverbal communication skills.

Data Availability

All data will be available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authors' contribution

SA and AE analyzed and interpreted the collected data from study participants. ZK, MA and MG contributed to idea conceptualization, study design, and interpretation of data. ZK, MA. AE. AA, SA and MG were major contributors in writing the manuscript. The authors read and approved the final manuscript.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jsps.2023.01.004.

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