Pharmacy Education (2022) 22(1) 672 - 681
https://doi.org/10.46542/pe.2022.221.672681

RESEARCH ARTICLE

Evaluation of self-reported knowledge and understanding towards a blended research course among pharmacy students: Objective Search Literature Evaluation (OSLE) method validation

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Keywords
Assessment
Curriculum design
OSLE design
Pharmacy education
Research

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Abstract

Background: The objective of the study was to evaluate the impact of classroom versus online Modular object-oriented dynamic learning environment (MOODLE)-based teaching on objective search literature evaluation (OSLE) score, as well as to validate the OSLE method for the assessment of research skills in pharmacy students. **Methods:** The four-station OSLE method was used to assess the performance and self-reflection at the end of each delivery mode. The students were asked to voluntarily vote for the preference of delivery mode in research courses. A hierarchical regression analysis was performed for variables predicting the "*preference*" for class-based teaching and/or MOODLE-based learning. Internal face and content validation were performed with students and faculty members not involved in the course teaching. External validation was performed with three professors working in different colleges in United Arab Emirates (UAE), Saudi Arabia and Qatar. **Results:** Thirty-five students completed the courses and showed significant improvement in self-reported reflection of pre-post knowledge and understanding. Findings suggested that 87.3% (110/126, 95%CI: 75.9 – 89.4, $p < 0.001$) achieved performance indicators and reported the OSLE method as an effective tool for the assessment of knowledge and understanding of research skills in pharmacy education. The predictive model suggested a strong positive effect associated with article appraisal, article application, self-reporting of knowledge and self-reporting of understating (R^2 0.47, F-1.26, $p < 0.001$). **Conclusion:** The findings suggested the OSLE method as an effective tool of assessment in pharmacy education. A negative impact of MOODLE-based learning was found with self-reflection on knowledge.

Introduction

The World Health Organisation announced COVID-19 as a public health emergency of international concern (PHEIC). All countries were advised to initiate strategies such as avoiding travelling, preventing secondary transmissions, promoting early detection etc. (WHO, 2020). The COVID-19 virus spread rapidly, leading to a 13-fold rise in confirmed cases and was characterised as a pandemic (Muro *et al.*, 2020; WHO Covid-19, 2020). To cope and reduce the spread of the virus, precautionary measures have been taken globally. According to the United Nations Educational, Scientific and Cultural Organisation (UNESCO), more than 190 countries have resorted to swift closure of schools and universities, which has affected almost 90% of the student's world population (UNESCO, 2020a; UNESCO, 2020b). The closing of schools and universities has not halted education, with traditional teaching

transformed into innovative online teaching. In United Arab Emirates (UAE), the government announced the closing of schools and universities until the end of the academic year and has instructed them to continue classes through distance mode (MOE UAE, 2020).

Proper planning is required when transforming from traditional style learning, i.e. where the instructor and student are in a classroom, to online teaching. Online teaching or e-learning is defined as delivering a course with the help of the internet using apps, the Learning Management System etc. (Ko & Rossen, 2017). Components which contribute to effective online teaching are cognitive, teaching and social presence, pedagogical practice, online course, design, aid and interaction, collaboration, and e-learning community. It was suggested that both students and the faculty should interact and collaborate in order to carry out effective online learning (Sun & Chen, 2016).

Dziuban and researchers provided theoretical concepts and empirical findings of blended learning and their relationship to the new situation as it evolves. Blended learning allows us to maximise many positive education functions because of its flexibility (Dziuban *et al., 2018*). Harvey also explained that eLearning has evolved towards blended learning (Harvey, 2021). Modern technologies like artificial intelligence and learning models such as microlearning and spaced learning are commonly used in the education industry to improve blended learning.

Kirkpatrick's Hierarchy Model is widely used to assess the effectiveness of teaching, which is not only used for traditional mode but also for distance as found in the literature (Cook *et al.*, 2008; Cook *et al.*, 2010; Wong *et al.*, 2010; Yardely, 2012). Salter and researchers combined 17 studies to evaluate e-learning in pharmacy education, classifying them into the four components of the Kirkpatrick model, and concluded that the delivery of knowledge was directly improved (Salter *et al., 2014*). According to a recent research, 90% of promising results were found in the characteristic of student assessments, while social and analytical skills were poorly reported (Lorenzoni *et al.*, 2019).

There is a need to measure the quality of education provided through online teaching mode. The objective of the study was to evaluate the impact of classroom versus online MOODLE-based teaching on objective search literature evaluation (OSLE) scores and to validate the OSLE method for the assessment of research skills in pharmacy students.

Methods

Study design and procedure

A three-year longitudinal quasi-experimental study design with pre-post self-reflection on knowledge and understanding of pharmacy students towards research course contents and OSLE method was applied in this study.

Second professional year pharmacy students attending research course (Scholarly pathway 1) were involved in the study after obtaining written consent. The study was approved by the college of pharmacy curriculum and assessment committee. All students were briefed about the course contents and assessment method. Figure 1 showed the OSLE validation process.

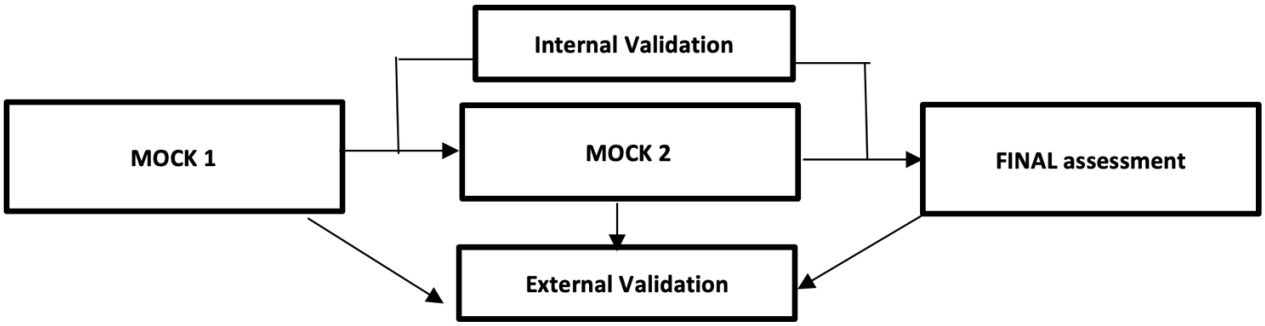

Figure 1: Internal and External Validation sequence

Internal face and content validation were performed with students and faculty members who were not involved in the course teaching. External validation was performed with three professors working in different colleges in UAE, Saudi Arabia, and Qatar.

Ethical approval was obtained from the college IRB committee to conduct this educational intervention and report was generated and submitted to curriculum committee for quality assessment purpose.

Longitudinal OSLE framework

A four-station OSLE design was developed (Figure 2). The station-based contents were specific to course learning outcomes. The research course was delivered in two blended teaching techniques. Following are the details:

1) Classroom teaching: week one to week seven (on-campus class, discussions among students were led by the faculty to perform the activity).

2) Online modular object-oriented dynamic learning environment (MOODLE) based teaching: week eight to week 15 (online discussions to perform the activities using MOODLE platform).

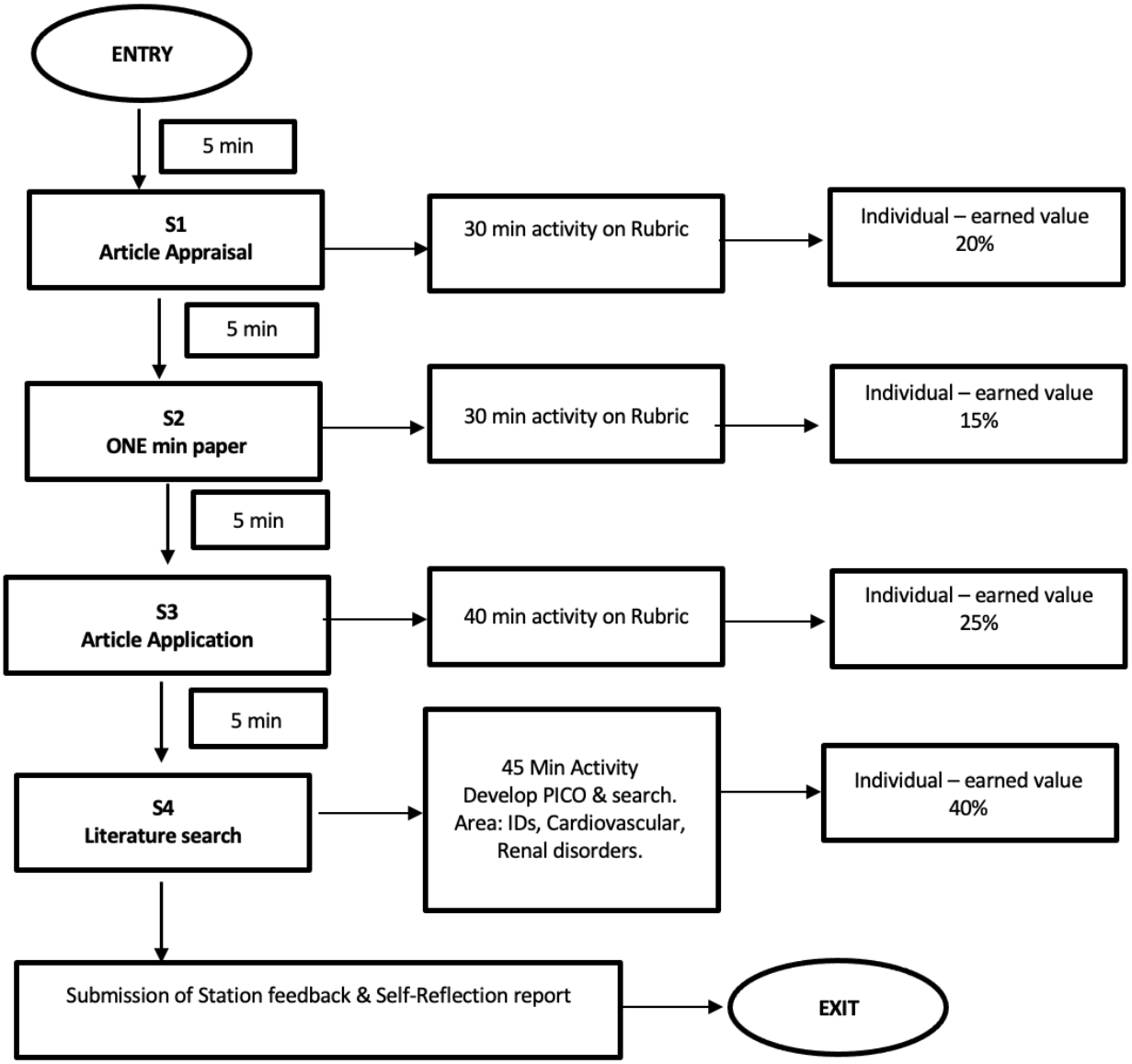

Figure 2: Conceptional Framework of OSLE

The contents and learning outcome mapping are provided in Table I. The internal validation of process was done with three-independent faculty members in college of pharmacy. External validation was done with two independent faculty members from different colleges based on student's self-reflection reports and mean score distribution pattern among all the four stations. The external validation showed significant improvement in knowledge and understanding of students between MOCK and final assessment. The comprehensive feedbacks from students and individual station validation data are provided in the supplementary file (supplementary file 1). During the validation process, several changes were applied in

different stations, for example, contents of station increase in time allocation etc. Similarly, there was no significant difference in %-weightage to the content distribution and CLO mapping of the course (Table I).

Table I: Teaching method, content and course learning outcome (CLO) mapping

Mode of teaching	Content	CLOs	% Weightage
Classroom Week 1-7	- Introduction to research - Literature search design - Good clinical practice - MeSH term search - Declaration of Helsinki - Essentials of research - Research process - Journal club	Knowledge Skill Competency Role in context Self-development	20% 50% 10% 10% 10%
MOCK 1 – OSLE			
MOODLE based Week 8-15	- Research gap and hypothesis - Research ethics and protocol - Research methods - Selection of research variables - SPSS application - Research Process - Journal club	Knowledge Skill Competency Role in context Self-development	15% 60% 10% 5% 10%
MOCK 2 – OSLE			
Final Assessment – Self-reported Teaching Mode Preference			

% weightage based on number of hours allocated to CLO. There was no significant difference in % weightage to the content distribution of the course

Station 1: Article appraisal

Students were required to do a critical appraisal of the article focusing on clinical pharmacy. Each student had to make open-ended comments for the appraisal and perform the activity within 30 minutes. The station equivalent earned score was 20%.

Station 2: ONE-minute paper

Students were required to review the article by themselves and provide answers to three specific questions on significance, limitations and potential bias. Earned value equivalent to 15%.

Station 3: Article application

A 40-minute rubric-based activity. Students were required to review the practice-based article. The rubric was developed to provide responses based on the application of the article in healthcare practice. Students were expected to understand the concept and results of the article. Earned value equivalent to 25%.

Station 4: Literature search

Individual activity. Two clinical diseases (asthma and acute renal failure) were provided. Each student was required to develop a PICO (topic/objective) with search strategies, limitations of search, database selections, and key terms and provide at least two to three annotated references after search in Vancouver style. The earned value of this station was equivalent to 40%

Task parameters

All the stations had a structured rubric for assessment purpose. Students' performance was assessed based on knowledge and understanding of the contents and skills to perform tasks within the allotted time.

Performance Indicator

Performance is indicated by achieving 60% marks on each OSLE station.

Self-reflection report

The students were asked to grade themselves through the self-reflection of knowledge and understanding of course contents and the OSLE method. Self-reported reflection on knowledge and understanding on the contents (pre-post) based on criteria: 0-20% (poor), 21-40% (moderate), 40-60% (good), 60-80% (application level), 80-100% (expert level). Feedback on the course contents and/or OSLE exam was qualitatively reviewed by faculty members for assessment and suggestions

were reported to the principal investigator (SWG) for approval and to be included in the debriefing list. All the assessments and submission contents were secondarily reviewed by the principal investigator for quality assurance and validation purposes.

All answer and self-reflection reported are verified by the faculty-in-charge and moderated by the subject matter experts from different departments.

Statistical analysis

A statistical package for social sciences 21 windows was used to perform the analysis. The descriptive and inferential statistical methods were used to evaluate the parameters. Data is presented in both tabulated and graphical forms. Logistic regression modelling was performed to predict the factors affecting the outcomes of the OSLE exam. The standard margin of error (5%) with confidence of interval (95%) was used in the test of significance.

Results

A total of 126 students participated in the OSLE validation and teaching-based assessment over three years. Approximately 87.3% of respondents (110/126, 95% CI:75.9–89.4, p<0.001) who achieved performance indicator has reported that the OSLE method is an effective tool for the assessment of knowledge and helped their understanding of research skills in pharmacy education. While the remaining 12.7% (16/126) of the participants who were unable to achieve the performance indicator (score lower than 50% in any station) had also reported a positive response toward the inclusion of the OSLE exam in research course programmes.

Pharmacy students were required to perform several research activities and tasks which included some laboratory-based projects, community-based surveys, focus group interviews, disease-related clinical outcomes, drug-use evaluation, clinical interventions, evidence-based practices etc. Such tasks were re-chartered under the four stations. The study reported significant positive output in station two (p<0.001), self-reported knowledge improvement (p<0.001) and preference for class-based teaching (p<0.001). However, MOODLE-based teaching showed positive output with station three (p<0.001) (Table II).

Table II: Distribution of assessment marks on course delivery method

Characteristics (n=126)	Class-based	MOODLE-based	*p*–value‡
OSLE score (mean±S.D)	77.5±5.36	74.9±6.11	0.611
Station 1 score (mean±S.D)	18.3±4.12	17.2±6.18	0.742
Station 2 score (mean±S.D)	13.4±3.44	10.1±2.94	0.001
Station 3 score (mean±S.D)	20.5±5.43	23.2±4.18	0.001
Station 4 score (mean±S.D)	38.1±6.93	36.4±7.44	0.378
S-R Knowledge† (mean±S.D)	83.6±8.51	61.9±6.42	0.001
S-R Understanding† (mean±S.D)	84.1±6.12	70.5±9.17	0.044
S-R Preference N(%)	82 (65.08%)	44 (34.9%)	0.001§

†S-R- Self-reported in % value, p < 0.05 considered significant. ‡ Student t-Test, § Chi-Square, 2018 Cohort = 35, 2019 Cohort = 46, 2020 Cohort = 45 (N=126)

At this point, regression analyses were required to predict the factors affecting the preference for "*class-based teaching*" among pharmacy students (n=82). Multi-variable hierarchical regression analyses were applied (Table III). The predictive model suggested a strong positive effect associated with article appraisal, article application, ONE-minute paper, literature search, self-reporting of knowledge and self-reporting of understating (R^2=0.47, F=1.26, p<0.001). The factor with negative effects related to the class-based teaching was article application.

Similar regression multivariate hierarchical regression analyses modelling was used to predict the factors affecting the preference of "*MOODLE-based teaching*" among pharmacy students (n=44) (Table IV). The predictive model suggested a strong positive effect associated with article application, appraisal, literature search, and self-reporting of understating (R^2=0.55, F=1.49, p<0.001). Factors with negative effects related to the MOODLE-based teaching were self-reporting of knowledge and ONE-minute paper.

Table III: Summary of Hierarchical Regression analysis for variables predicting preference to 'Class-based Teaching' (N= 82)

Variables	Model 1			Model 2			Model 3			Model 4		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Article appraisal	0.25	0.04	0.15‡	0.37	0.06	0.16‡	0.24	0.05	0.17†	0.25	0.04	0.15‡
ONE-min paper	0.77	0.61	0.21‡	0.79	0.59	0.19‡	0.75	0.07	0.19‡	0.69	0.61	0.21‡
Journal Application	-0.14	0.23	-.24†	-0.30	0.26	-0.20†	-0.31	0.24	-0.22			
Literature Search				0.21	0.11	0.12†	0.21	0.12	0.15†	0.25	0.13	0.16†
Self-reported Understanding							0.67	0.58	0.24†	0.67	0.39	0.23‡
Self-reported Knowledge							0.11	0.08	0.27†	0.16	0.09	0.22†
R^2		0.23			0.28			0.36			**0.47**	
F for change in R^2		4.21†			5.64**			2.11†			**1.26‡**	

†$p < 0.05$, ‡$p < 0.01$

Table IV: Summary of Hierarchical Regression analysis for variables predicting preference to 'MOODLE-based teaching' (N= 44)

Variables	Model 1			Model 2			Model 3			Model 4		
	B	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Article Appraisal	0.20	0.08	0.13‡	0.23	0.07	0.14‡	0.22	0.08	0.15†	0.21	0.09	0.16‡
ONE-min paper	-0.45	0.20	0.11‡	-0.48	0.30	-0.13‡						
Journal Application	0.32	0.28	0.29†	0.32	0.27	0.29†	0.33	0.27	0.25‡	0.31	0.25	0.28‡
Literature Search				0.19	0.11	0.13†	0.22	0.10	0.19†	0.21	0.09	0.19†
Self-reported Understanding							0.24	0.09	0.21†	0.22	0.11	0.20‡
Self-reported Knowledge							-0.42	-0.05	-0.39†			
R^2		0.27			0.31			0.33			**0.55**	
F for change in R^2		3.07†			4.61‡			4.73†			**1.49‡**	

†$p < 0.05$, ‡$p < 0.01$

Discussion

Most pharmacy graduates believe that the benefits of online learning are increased peer support, shared learning, and immediate feedback on their performance in a different online pre-registration course. (Elliott *et al.*, 2009; Alkatheri *et al.*, 2019; Lunn *et al.*, 2020) According to research developed at the University of Louisiana, researchers found out that students had achieved 90% in the majority of modules in an online elective course on current topics in pharmacy (Pate *et al.*, 2017). In a study on the effects of online lectures in an introductory drug information course, more than 47% of students reported that their learning was better with online lectures. The study also showed a significant difference in knowledge, understanding and research skills between class-based content and online MOODLE-based teaching (Freeman *et al.*, 2006).

Another study reported that online delivery methods provide students with the flexibility to complete assignments at their convenience, with greater participation of students, and fortifying self-directed learning (King & Egras, 2015). The University of Houston College of Pharmacy, Texas conducted a critical care hybrid online elective course for third-year pharmacy students and compared their performance on an online course with traditional courses. The authors reported that the overall examination score was significantly better in the hybrid course (87.7%) compared to traditional courses (82.6%). However, the study also showed low mean value in self-reported knowledge improvement, one-minute paper (station two) and article application skills with online MOODLE-based delivery contents compared to class-based teaching (Wanat *et al.*, 2016).

In pharmacy education, giving feedback helps to improve clinical judgments (Grover *et al.*, 2014). Constructive feedback aids learning, knowledge consolidation and reflection. Simulation-based educational research proved the relevance of feedback or 'debriefing' on student performance (Tait *et al.*, 2018). Students' performance in preparing care plans for patients in OSCE is improved with debriefing

sessions (Takeda *et al.*, 2017). The Concordia University Wisconsin School of Pharmacy evaluated the implementation of multiple content-integrated journal club activities in a two-term medical literature evaluation (MLE) course series using near-peer student facilitators (Brown & Kostrzewa, 2018). Another part of pharmacy training which also requires structured feedback and debriefing is in the ambulatory care setting, to identify gaps in care and formulate strategies to change behaviours to improve care in the future (Robinson *et al.*, 2011). In this study, students were asked to do self-reflection on knowledge improvement and to gain an understanding of the contents of a different mode of delivery. There is good evidence of the positive relationship between feedback as a mode of teaching with the learners' performance (Alammary, 2019). The study reported a significant increase in the mean score of self-reported knowledge and understanding compared to online MOODLE-based content delivery.

Australian researchers conducted a mixed-methods study in which pharmacy student participants completed case-based scenarios within different simulation modalities, with feedback provided to them after each scenario (Tait *et al.*, 2018). The participants reported that feedback allowed knowledge consolidation and facilitated reflective learning with high interactivity (Takeda *et al.*, 2017). Pharmacy students from Jordan were assessed by role-playing on their ability to conduct a simulated patient medication interview. During the learning activity, each student received immediate feedback (debriefing) based on the marking criteria to ensure that they received tailored feedback which lead to positive outcomes in student learning (Bajis *et al.*, 2019). Similarly, another study investigated students' views on faculty feedback and their satisfaction with faculty feedback on their academic performance (Hall *et al.*, 2012).

It is important to have both qualitative and quantitative feedback on teaching methods. Overall participants of this study showed no significant difference in the mean score of OSLE (including values from all four stations), article appraisal station and literature search station. However, some participants reported technical difficulties and time requirements. Online learning contributes positively to the knowledge of pharmacists (Nesterowicz *et al.*, 2014; Elnaem *et al.*, 2018; Sakeena *et al.*, 2018). In contrast, this study reported improvements in knowledge, understanding, teaching mode preference and article application station mean scores with class-based teaching compared to online teaching.

In this study, OSLE method was found effective to evaluate pharmacy students on various aspects of research skills and competencies. OSLE should furnish additional benefits including better understating of clinical research methodologies and search strategies (Hall *et al.*, 2012; Sakeena *et al.*, 2018; Alammary, 2019). In this study, the variables affecting preference for class-based teaching were significantly different from factors influencing the preference for MOODLE-based learning. It is important to explore and understand student behaviour in online learning. Students showed improved knowledge and understanding of the contents of class-based teaching than MOODLE-based pharmacy education. Further exploration of attitude and practices are required to design or plan an online learning forum. Offering pharmacy students research experience, which includes data analysis and discussing research projects is important to inculcate their confidence to establish links to conduct further research (Ramsauer, 2011). Anxiety among students is a crucial variable when teaching research methods course online where students have less direct contact with the faculty and have to perform activities independently.

The instructors' ability to involve and connect with students is important during online activities (Rapp-McCall & Anyikwa, 2016). Student participation in online sessions of research has been suggested to be less intimidating, thereby enhancing the quality and quantity of interaction during online classes (Ni, 2013). Another comparative study reported that online discussion performance was significantly correlated with the number of discussion messages read and posted (Alammary, 2019). Enhanced training in research methods, biostatistics and literature evaluation has been suggested to be incorporated in Pharm.D. programmes as poor understanding was found among pharmacy students in biostatistics and research study design. There were significant mean differences in knowledge scores by attitude and confidence (Bookstaver *et al.*, 2012). This study is the benchmark for evaluating research contents in both quantitative and qualitative ways and determining the comparative effectiveness between class-based teaching and MOODLE-based research course in pharmacy education.

It was reported that positive attitudes and perspectives towards research were strongly influenced by exposure to the research process through projects, friends or mentors, previous degrees or having future intentions to pursue a research degree (Kritikos *et al.*, 2015). Adopting a culture of research among students can improve their engagement in research (Harirforoosh & Stewart, 2016). In this study, the class-based teaching strongly improved self-reported research knowledge and understanding. This also showed better understanding in other research skills development

(including article appraisal, application, literature search, PICO design etc..) compared to online teaching.

The noted barrier in the study is the lack of literature evidence on the subjective topic. It was limited to research course and literature which were mostly associated with clinical-based training module assessment. Pharmacy students often complain the lack of time to do research activities or learning assignments. Moreover, research training in pharmacy students has became madatory in recent review of the pharmacy education curriculum. There was no skill assessment validated tool for research courses in pharmacy education while the development and validation of OSLE require extensive internal and external review process, more exploration of the inter-content variability analysis is required. The research was first exposed to pharmacy students so some results might be limited to attitude difference. Further inter-college application of OSLE will provide generalised results to content and response analysis.

Conclusion

The study validated the use of OSLE as an assessment tool for research course in pharmacy programmes. It concluded the preference of "*class-based teaching*" among pharmacy students. The self-reporting percentage (%) of knowledge and understanding showed strong positive effect to mode of teaching preferences. Online MOODLE-based teaching showed negative impact to self-reported knowledge development or improvement to specific course contents.

Acknowledgement

The authors would like to express their gratitude to second professional year pharmacy students (Cohort 2018, 2019 & 2020) of Gulf Medical University for their participation and providing effective feedback in the validation of OSLE method.

Ethical and consent to participate

The Gulf Medical University Ethical Committee ruled that no formal ethical approval was required in this particular case. The College of Pharmacy Assessment and Curriculum Development committee has been informed and consented before the design of the MOODLE-based lesson. Written informed consent was taken from all participants.

Consent for publication

Written consent was taken from all participants for publication. Anonymity and privacy were maintained throughout the process of analysis and draft writing.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declared that they have no competing interests.

Source of funding

The authors declared that no funding was received.

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