

■ Original Article

Pharmaceutical microbiology in pharmacy education: Operational process of an objective structured practical examination (OSPE) in Universiti Teknologi MARA

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ABSTRACT

Objective structured practical examinations (OSPEs) have been implemented as a standard practice in most medical and health science schools worldwide to assess competencies in laboratory skills. A practical examination would improve students' understanding of the experiment they conduct and help build confidence and competency for future application. With the expanding roles of a pharmacist, it is important to strengthen students' skill set during pharmacy education. This article reports the procedures and findings after conducting OSPE for the subject of pharmaceutical microbiology and parasitology in the Faculty of Pharmacy at Universiti Teknologi MARA for three years (2017-2019). There is a significant difference in OSPE performance between the years 2017, 2018, and 2019. The addition of OSPE, while does not significantly change the median marks, is able to better define the students' performance and grade. The conclusion is that the students were able to adapt to the added examination and benefit from the experience.

Keywords: objective structured practical examinations, pharmaceutical microbiology, pharmacy education, students' skills

INTRODUCTION

The pharmaceutical microbiology and parasitology is a subject compulsory for all pharmacy students at Universiti Teknologi MARA (UiTM) and are taught during their first year of enrolment into the program. The subject focuses on building the fundamental understanding on the pathogenesis of diseases caused by microorganism, drug safety, antimicrobial activity, and disinfection. With the current SARS-CoV-2 virus spreading worldwide, there is an importance in making sure that all front-liner healthcare personnel, which include pharmacists are equipped with the proficiency in microbiology and diagnosis, treatment, and

prevention of pathogenic microorganism infection and infestation [1].

The subject is a three-credit hour for 17 weeks course, taught to first year students after they enroll into the pharmacy program. Teaching will be distributed along four activities: lectures, practical classes, problem-based learning (PBL) and tutorial. Assessments will be done to test all three domains according to Bloom's taxonomy (cognitive, affective, and psychomotor) [2]. Throughout the course, continual assessments will be carried out to address the psychomotor and effectiveness domain. Covering laboratory report, OSPE, tutorial, and PBL, the marks from continuous assessment will

Table 1. Course components for pharmaceutical microbiology and parasitology in the Faculty of Pharmacy at UiTM and their specific course learning outcomes target

Learning methods	Cognitive level*	Course learning outcomes
Lecture	C1	Knowledge
Laboratory	P2	Practical skills
Problem-based learning	A2	Social skills, teamwork and responsibilities, & team skills
Tutorial	C1	Knowledge, critical thinking, & problem-solving skills

Note. *Cognitive level is based on Bloom's taxonomy

total to 40% of the overall marks. Final examination will cover the cognitive domain and totaling up to 60% from the overall marks. **Table 1** shows the course summary.

The Faculty of Pharmacy at UiTM has adopted OSPE since 2017 as a tool for practical assessment on students to improve the assessment methods. Practical examination such as OSPE is found to be a core component of evaluation in current medical curriculum [3]. Reports from multiple schools have seen OSPE as an effective tool to improve students' scores in microbiology [4-6]. It is, however, very difficult to achieve criteria of objectivity, uniformity, validity, reliability, and practicability in such examination [7]. It is paramount to have a good, working, and standardized OSPE in a curriculum that at the same time, caters to what is specific to each school it applies to.

OSPEs in pharmacy schools have been reported by multiple schools by now [1, 8]. The initial use of OSPEs is for the assessment of competence in medical schools but has become widespread into many fields [9, 10]. This report aims to share how OSPE is carried out in the Faculty of Pharmacy at UiTM and evaluated students' performance with OSPE's implementation.

METHODS AND SETTINGS

Process

The first step in preparing for OSPE in microbiology is to have the course coordinator to propose the blueprint of the test. The proposal includes the assignment of responsibility of faculty staff members, budget, materials, and equipment, working stations and rooms to be utilized. On top of that, the proposal must contain topics covered during laboratory practical sessions and answers to the course objectives. Once approval was obtained, several meetings will be organized with subject teachers to discuss station to topic distribution and prepare the assessment following the blueprint. During preparations of the questions, consideration on the educational and practical aims of the course including competencies, practical skills and learning outcomes for this course must be observed.

A draft of the questions and scenario for eight stations will subsequently vetted by a panel in the academic office of the faculty.

Table 2 shows an example of the stations, the topic each station covers, and material needed to be prepared for each station. UiTM enrolls about 160-180 students each year to its pharmacy program, therefore, in order to conduct OSPE, about four laboratories needs to be prepared; each laboratory containing two sets of eight stations, and two holding rooms; one for students being prepared to go into the examination and to avoid from the question being leaked by students who have completed their examination, one room will serve as a holding room for students after the examination. The students will not be allowed to use their mobile phone or computer during their hold. Students in the holding room are allowed to leave after the last batch of students are placed at their stations for the examination.

To keep the process of the examination smooth and in order, each laboratory will have a head invigilator, assessors needed for dedicated stations and another assistant invigilator. Each invigilator will be provided with a set of 'OSPE kit' containing student name list, assessors name list, a guide manual and check list for each station. Prior to the examination, the head invigilator will have to run through the check list.

The invigilators are also responsible to give students their instructions and keep the students moving from station to station according to the time allocation. The holding room will be handled by two staff members, students are free to do their own activity but no communication over any devices are allowed during this time. The staff members in the holding room will be responsible for the student attendance and making sure that the students are ready to move to their dedicated examination laboratories. A flow chart of the examination will be shown in **Figure 1**.

A pilot test of the OSPE stations on roughly 16 volunteers were carried out to understand the feasibility, missing item in checklists, and reliability of the whole course of the examination. For a group of about 180 students, eight

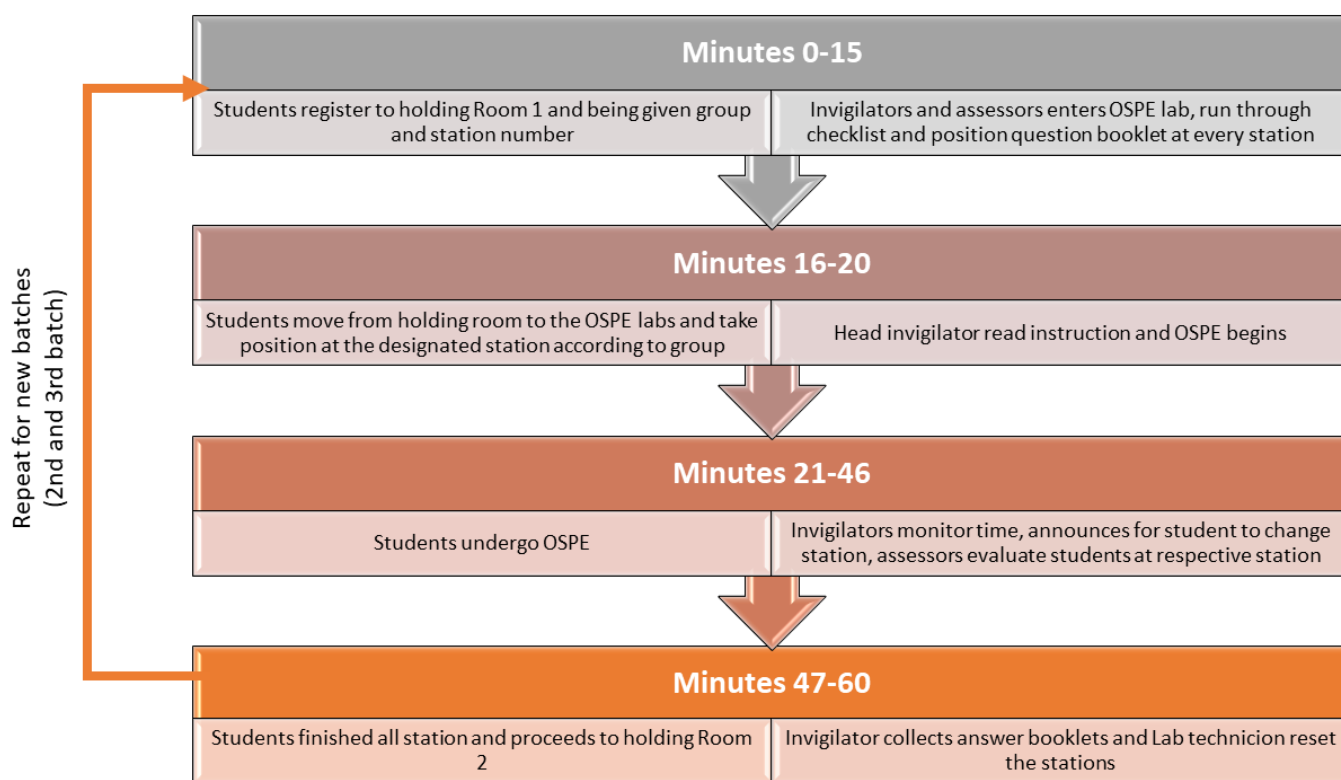


Figure 1. Time flow for a complete OSPE cycle (Source: Authors' own elaboration)

invigilators, one coordinator, and number of assessors depending on the questions' requirement, about three rounds of the examination will be done. The total duration of the session with three rounds was about two hours. The breaks between round were in average 15 minutes and students stop at each station for three minutes. Students were given a feedback form at the end of the OSPE as an assessment of their experience.

Examination Questions, Stations, and Format

For each lab, two set of question book will be prepared, each station will have the same topic but question between the two sets will be slightly different. At any given time, a group of 16 students will be in the examination laboratory, with their beginning station assigned so that each student will start at a different station. Student will be provided with a question booklet that they will use to write down answers, as they move from one station to the next with it.

Figure 2 shows the students station assignments and their movement throughout the examination and **Table 2** is an example of the question for each station and the topic it covers. This subject is given to year one students, so the cognitive domain level of questions is only limited to C1 and C2 of the Bloom's cognitive levels. Marks were totaled up to 100% and will be representing 10% of the final overall marks.

Teachers will be given an answer booklet where they can base their marking on. As for stations with assessors, the

assessment of skills was performed by examiners during the examination using standardized scoring schemes usually in the form of checklists. They will be given a name list and each student was identified by ID card to make sure there will not be a mistake when marks are given.

For the past five years (2016-2020), the students' performances were observed, and their marks are simplified in **Figure 3**, and further broken down in **Figure 4**.

RESULTS

A total of 800 results from students from 2016 to 2020 were analyzed: 2016 (n=158), 2017 (n=168), 2018 (n=185), 2019 (n=160), and 2020 (n=175) (**Table 3**). The median number of students who did not participate in OSPE (years 2016 and 2020) were both B+ (50 and 58, respectively). While when students took part in OSPE, the median numbers of students scores B- for 2017 (47) and 2018 (46) but improved to a B (37) in 2019.

Figure 4 shows the breakdown of students score in a simplified grading groups (A+, A, and A- for example grouped as A, and so on). There is a drop in A scorer after OSPE, but most students maintained the median marks as in the ranges of B grades. There is also an observation of students dropping into the C and D grades after OPSE is implemented.

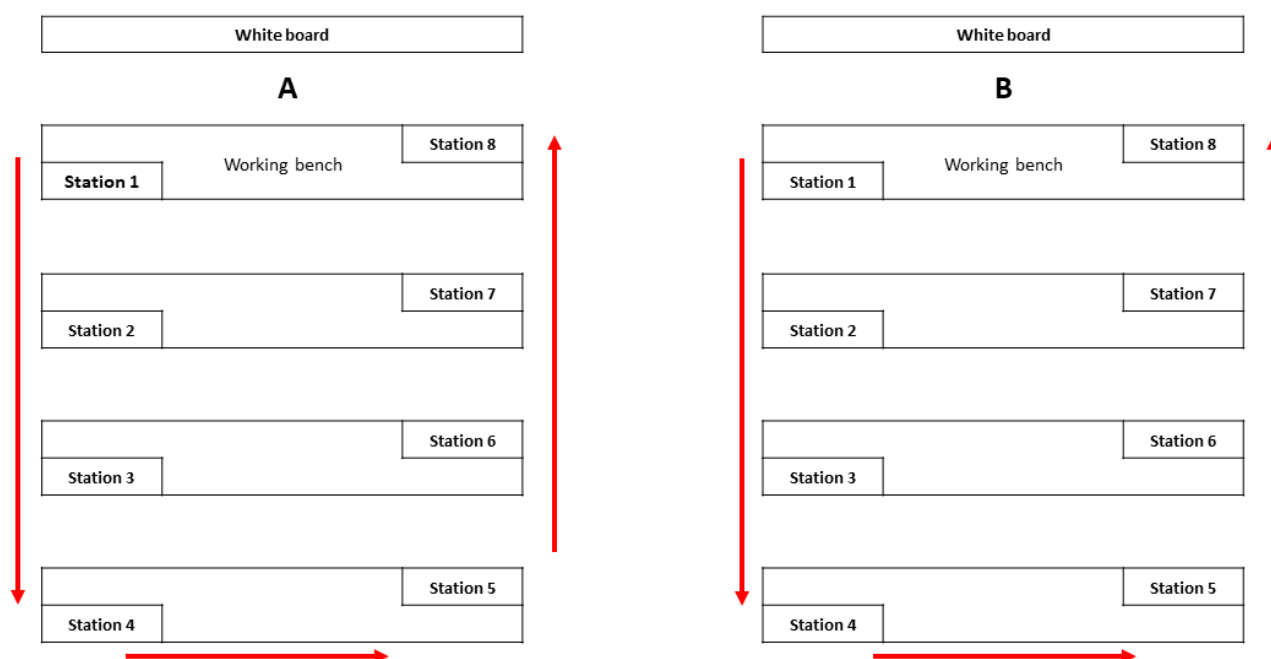
**Floor Plan OSPE
Laboratory**

Figure 2. Student's movement from one station to another (Source: Authors' own elaboration)

Table 2. Stations and their respective topics to be assessed

Station	Topic	Materials provided at station	Assessor present?
1	Introduction to microscope I	1. A compound microscope 2. Prepared slides: <i>Slide 1- Rhizopus sporangia</i>	Yes
2	Introduction to microscope II (reporting observation made at station 1)	1. Picture of blank-labelled microscope	No
3	Aseptic technique: Streak plate method	1. Bacterial broth culture 2. Wire loop 3. Bunsen burner 4. 1 × nutrient agar plate 5. 70% alcohol spray bottle	Yes
4	Gram staining	A pre-set microscope A slide of pre-gram stained <i>E. coli</i> & <i>B. subtilis</i>	No
5	The concept of bacterial selection using selective & differential media	A plate of MacConkey agar with the <i>E. coli</i> & <i>P. aeruginosa</i> growth on it	No
6	Knowledge in antibiotic susceptibility test (AST)	1. A petri dish with MH agar prepared with <i>E. coli</i> 2. Four disks labelled (placed on the plate): A. Ceftriaxone (CRO30) B. Ampicillin (AMP10) C. Gentamicin (CN10)	No
7	Colony morphology on a solid media	Two nutrient agar containing petri dish plate B: <i>Micrococcus luteus</i> colony labelled A & B prepared with: Plate A: <i>Serratia marcescens</i> colony	No
8	Enumeration of bacteria: The plate count (viable count)–To determine the cfu/ml of bacterial culture	1. A dummy NA plate of <i>E.coli</i> at 10 ⁻⁶ dilution with colonies count ranging from 30-300 colonies (<40 colonies) 2. A colony counter.	No

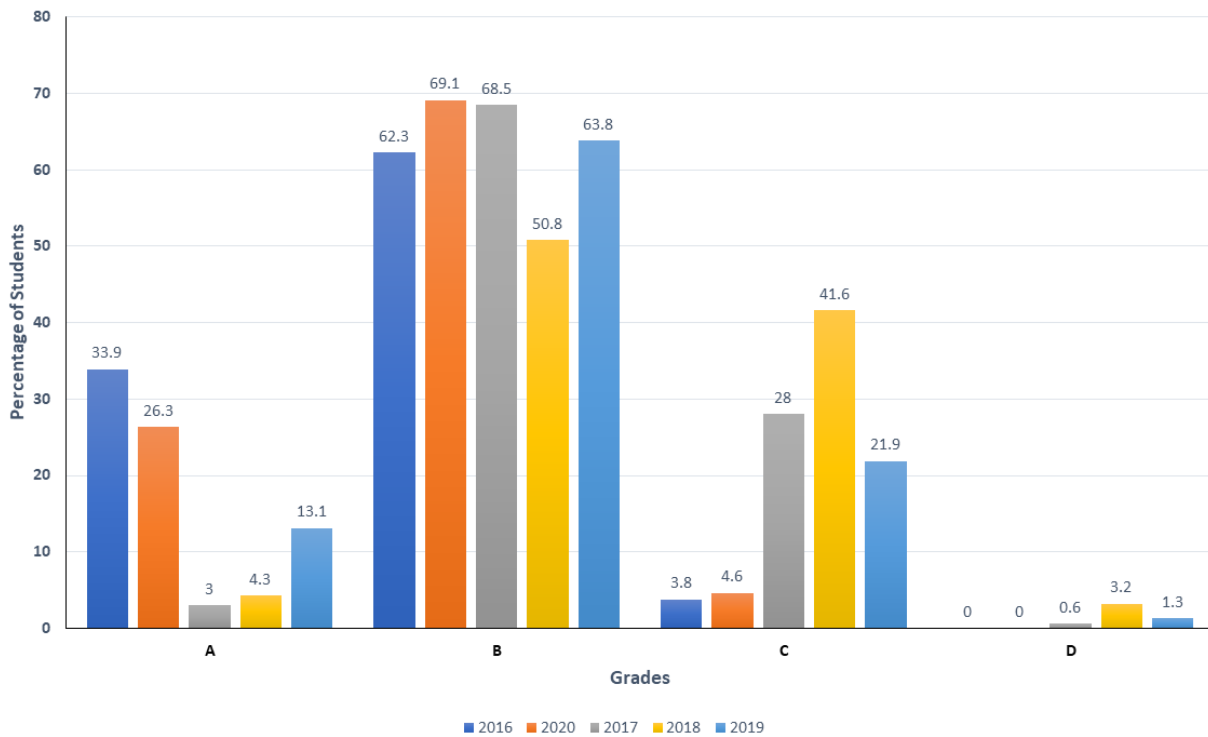


Figure 3. Students’ overall performance for the course with OSPE (year 2017 to 2019) and without OSPE (year 2016 and 2020) (Source: Authors’ own elaboration)



Figure 4. Overall performance of students before (red background) & after OSPE was implemented (blue background) (Source: Authors’ own elaboration)

Table 3. The number of students involved in the study

Year	OSPE	Number of students (n)
2016	Not included	158
2017	Included	168
2018	Included	185
2019	Included	160
2020	Not included	175
Total		800

With regards to OSPE, 528 students were participated in the examination in the Faculty of Pharmacy at UiTM from the years of 2017 until 2019. For comparison, data from 2016 and 2020 where OSPE was not part of the syllabus were included. Quantitative features that were assessed in the study were simplified marks, for example A+, A, and A-grades are marked as simply grade A. To characterize the structure of the variables, basic descriptive statistics were

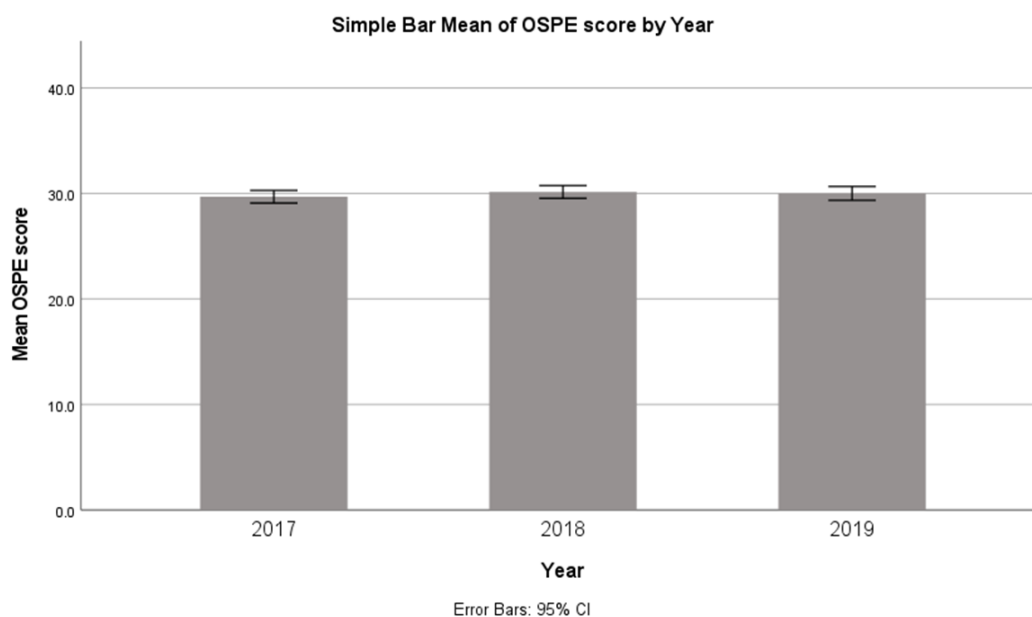


Figure 5. Mean students' OSPE score from year 2017 to 2019. Error bar at 95% confidence interval (Source: Authors' own elaboration)

calculated in the form of location measures (arithmetic means and medians) and variability (standard deviation). **Figure 4** shows the overall performance of students before and after OSPE is introduced.

A one-way between group analysis of variance (ANOVA) was used to know difference of OSPE score between year 2017, 2018 and 2019. The ANOVA was not statistically significant, indicating that the OSPE score were not different between years, $F(2, 510)=0.55$, $p=0.58$ (**Figure 5**). Thus, performance of students in OSPE between different batches were similar.

DISCUSSION

This is the first experience of conducting an OSPE for the Faculty of Pharmacy at UiTM. This current OSPE is a result from comparing and taking inspiration from OSPEs conducted by other schools and combining it with the resources and facility that the Faculty of Pharmacy at UiTM own, the curriculum, and the number of students. Based on the observation, OSPE does increase the students' practical skills and confidence in carrying future laboratory work. The addition of 10% marking weightage from OSCE did not cause any difference in the overall performance of the students over the years.

While there is a decline in students grades after taking OSPE, the results were able to better discriminate the grading of students where a better distribution of marks was observed for years 2017 to 2019. The scores for after OSPE were seen to be in an improving trend, as the curriculum continues to improve, and students were able to be prepared for the coming OPSE. It is important to declare to take note on the

score trends and continuedly working on improving the curriculum and students learning experience.

Overall, OSPE is a great tool to improve students' psychomotor and confidence in laboratory skills. After three years of running the examinations, there is confidence to conclude that OSPE will be a fixed assessment method for microbiology in the Faculty of Pharmacy at UiTM's curriculum.

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Ethical statement: The authors stated that ethical approval is not applicable as the data was obtained from student results and no survey was conducted on students. It was a retrospective study where students details were also kept anonymous. This data is also preliminary and based on data from faculty. Percentages of grades are also not a confidentiality issue (as it is anonymous). Therefore, no implications for students.

Declaration of interest: Authors declare no competing interest.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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