



# Impact of NBME International Foundations of Medicine “IFOM” Examination on Students’ Academic Achievement

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## Abstract

**Purpose:** To establish whether the inclusion of an external benchmarking examination [NBME’s International Foundations of Medicine (IFOM)] as part of summative assessment in the Bachelor of Medicine and Bachelor of Surgery (MBBS) program at Gulf Medical University produced an impact on teaching and learning for academic achievement.

**Method:** Two cohorts of students (N 120) who appeared for both IFOM Basic Science Exam and IFOM Clinical Science Exam were included in the study. Their IFOM scores were correlated statistically with the university-conducted pre-clerkship and clerkship summative assessment scores. Faculty and students’ evaluation surveys were also conducted to record perceptions of IFOM exams impact on teaching and learning.

**Results:** A strong positive correlation between the IFOM examinations and the university examinations was observed with correlation coefficient between 0.7 and 0.9 and correlation being statistically significant  $p \leq 0.001$ . The faculty and student evaluation survey on the IFOM exams showed that 70% to 92% of respondents perceived that feedback from IFOM exams helped improvement of pedagogical strategies.

**Discussion:** Performance on an external benchmarking examination such as NBME’s IFOM correlated positively with performance on the university assessments following strategic improvements in teaching, learning and assessment methods in the curriculum.

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**Keywords:** External benchmarking examination; International Foundations of Medicine

## 1. Introduction

The National Board of Medical Examiners (NBME) International Foundations of Medicine (IFOM) examinations in basic science and clinical science have been used in many medical schools across the globe as an external benchmark of the curriculum. The formative and summative feedback obtained from these external

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examinations provide valuable information for curriculum improvement. Benchmarking provides external standards for measuring curriculum content, pedagogy and helps to identify opportunities for improvement.<sup>1,2</sup> There are medical schools that have used the NBME Comprehensive Basic Science Examination as a progress test in the pre-clerkship curriculum to provide external validation of internally developed multiple choice assessments in addition to monitoring student improvement over time toward the achievement of competency.<sup>3</sup> In many medical schools in North America, NBME subject examinations are administered as a strategy for students to perform better in the clerkship assessments.<sup>4,5</sup> Studies also show a significant linear correlation with respect to improved performance between NBME subject examinations and USMLE Step 1 and Step 2.<sup>6–8</sup> The NBME's International Foundations of Medicine examinations are used as formative assessments in many medical schools with the sole aim of providing feedback to students to guide future learning, encourage active learning strategies, promote reflection and develop self-evaluation skills<sup>9–11</sup>. The National Board of Examinations (NBME) I, II and III were also used as one of the measurements to predict the future performance of graduates in medical practice.<sup>12</sup>

The IFOM Basic Science Examination (BSE)<sup>13</sup> lays emphasis on the principles and management underlying health, disease and management. The test material is designed to measure application of basic science knowledge in a clinical context. The school report for BSE provides feedback on the performance of students on the total test and content areas namely, discipline and organ systems. The IFOM Clinical Science Examination (CSE)<sup>13</sup> assesses the medical knowledge and understanding of clinical science considered essential for providing safe and effective patient care. The CSE report provides feedback on the clinical disciplines, physician tasks and diseases of the organ systems. The BSE and CSE examinations include MCQ (Multiple Choice Questions) A type questions and administered online. The test consists of 160 items with the time limit of 4 h to complete the test.

The IFOM examination was introduced in 2014 at Gulf Medical University, UAE, for the MBBS program for the purpose of benchmarking the curriculum to international standards. The performance of students on external benchmark examinations has been included as part of a summative assessment to determine promotion and graduation in the pre-clerkship and clerkship training years, respectively, at GMU.

The purpose of the present study is to find out whether the inclusion of the IFOM examination as part of the summative assessment correlates with improved performance on the pre-clerkship and the clerkship assessments conducted internally by the university. The study also examines the impact of an external benchmark examination in enhancing pedagogical strategies for improved performance on the university examination.

## 2. Method

### 2.1. Overview

The study analyzed the scores of students who were undergoing training for the bachelor of medicine and bachelor of surgery program (MBBS) at the College of Medicine, Gulf Medical University. The degree offered is a five year program, which is an integrated competency based curriculum. The integrated curriculum follows the Accreditation Council for Graduate Medical Education (ACGME) outcomes and competencies. The pre-clerkship and clerkship examinations included the scores of the IFOM and other components of summative assessment.

### 2.2. Participants

The student cohorts admitted in 2011 (cohort 1) and 2012 (cohort 2) to the MBBS program in the College of Medicine, Gulf Medical University were included in the study. The cohort 1 included 55 students of either sex (35 females) with the mean age of  $21.7 \pm 1.5$ . The cohort 2 consisted of 65 students of either sex (42 females) with the mean age of  $22.1 \pm 2.3$ .

The number of faculty who took part in the survey was 27 and they were chosen amongst those who were involved in the teaching, learning and assessment of the cohorts included in the study. The students included in the evaluation survey were from both the cohort of students (N120).

The students were informed at the time of admission to the program, through student catalogue, on the mandatory requirement of appearing for the external benchmark examinations, namely, International Foundations of Medicine, during their period of study. Since the study involved analysis of data of students' performance without the inclusion of examinees' identity, the ethical clearance was not applicable for the study.

### 2.3. Materials

The study included the scores of IFOM BSE, CSE and scores obtained in all other components of summative assessment administered by the university in the two cohorts of students selected for the study.

#### 2.3.1. Summative assessment components

The Pre-clerkship phase of the MBBS program included year 2 and 3 and clerkship phase included year 4 and 5 of the program.

The summative assessment of pre-clerkship phase included continuous assessment and final pre-clerkship examination with a weightage of marks at 60% and 40% respectively. The continuous assessment included course work, portfolio, seminars, end module exams and research work. The pre-clerkship examination included a written component consisting of IFOM BSE and university administered MCQ exam and a practical exam. The practical component included both Objective Structured Practical Examination (OSPE) and Objective Structured Clinical Examination (OSCE). The weightage of marks for the written and practical components was 25% and 15% respectively. The weightage of marks in the written component was equally distributed between the IFOM and university administered MCQ exam.

The summative assessment of clerkship phase included continuous assessment and final clerkship examination with the weightage of marks at 60% and 40% respectively. The continuous assessment included End of Clerkship Assessment, Portfolio and Supervisor Evaluations. The assessment of portfolio was included throughout the 5 year period of study. The weightage of marks in this component was proportionately included in both pre-clerkship and clerkship phases of the curriculum. The final clerkship examination included a written component consisting of IFOM CSE and university administered MCQ exam and clinical exam. The clinical examination was administered as OSCE and DOCEE (Direct Observation of Clinical Encounter Examination), which had a weightage of 25% of the final clerkship examination. The weightage of written component was 15% of the final clerkship exam and equally distributed between IFOM CSE and university administered MCQ exam.

### 2.4. Procedure

At the end of the third year of the program, the IFOM BSE was administered in both the cohorts. The cohort of students who took the IFOM BSE in

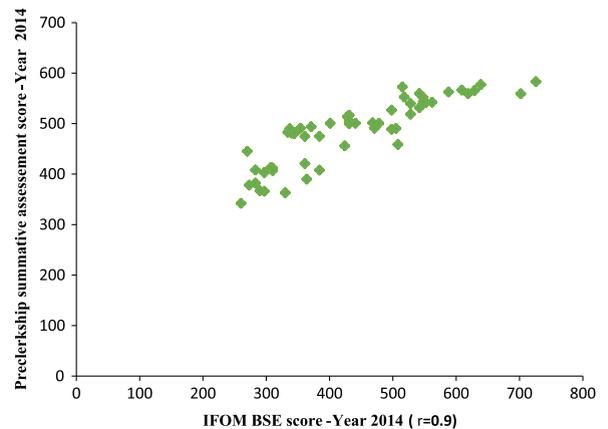


Fig. 1. Correlation of IFOM BSE scores with the pre-clerkship summative scores in cohort 1.

the third year, took the IFOM CSE at the end of their fifth year of study. The IFOM exam administration preceded the University final exams in the pre-clerkship and clerkship phases. The correlation of IFOM scores with the summative assessment scores, which included pre-clerkship and clerkship final exam scores was carried out in both the cohorts. The correlation of the performance between IFOM BSE and IFOM CSE was also carried out to study the strength of relationship between the two examinations in both the cohorts.

The faculty and students' evaluation surveys were conducted to obtain their perceptions of the IFOM exams impact on teaching and learning. The faculty survey on IFOM perception consisted of 4 items and each item had 3 response categories as Yes, No and Uncertain. The students' perception of IFOM exam was evaluated by a survey consisting of 7 items. The response to each item was measured on a 5 point likert scale ranging from score 1 as strongly disagree to score 5 as strongly agree.

The test components of summative assessment, pre-clerkship and clerkship final exams were ensured that the items are valid and reliable. The assessment committee ensured that test blue print was developed before any summative exam for content validity and all MCQ written exams had Kuder-Richardson (KR20) reliability coefficient to be within the acceptable range between 0.7 and 0.9. The reliability of OSPE, OSCE and DOCEE, measured by Cronbach alpha was 0.8.

The items included in the survey were developed in-house. A pilot study was conducted by subject experts to validate the items and the reliability was measured by Cronbach alpha, which stood at 0.82.

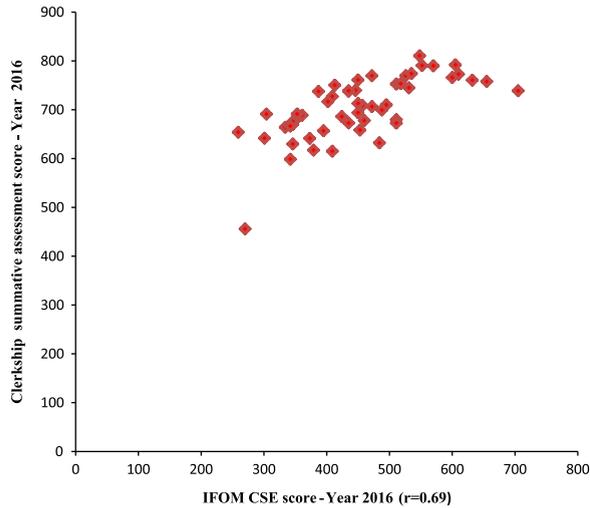


Fig. 2. Correlation of IFOM CSE scores with the clerkship summative scores in cohort 1.

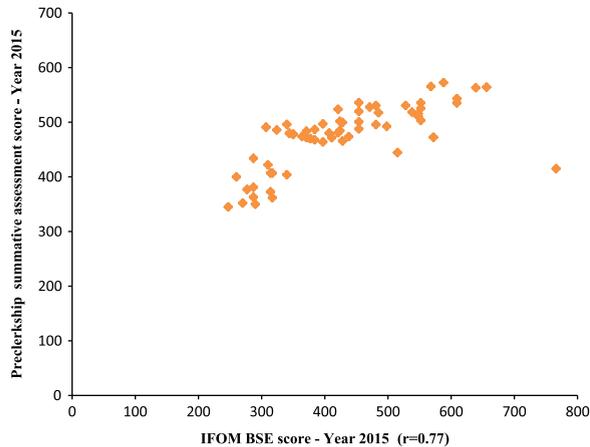


Fig. 3. Correlation of IFOM BSE scores with the pre-clerkship summative scores in cohort 2.

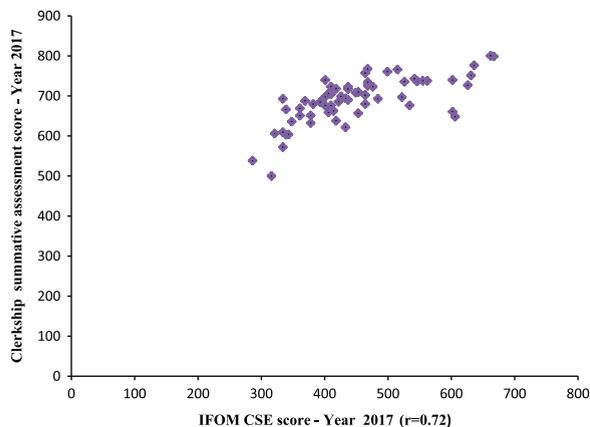


Fig. 4. Correlation of IFOM CSE scores with the clerkship summative scores in cohort 2.

## 2.5. Analysis

Data analysis was carried out using SPSS software version 24.0 to establish the correlation between IFOM scores and the summative assessment scores. In the study, the summative assessment score excluded the score contributed by the IFOM examination.

The non-parametric method of Spearman's Rank Correlation was used to find the correlation coefficient and test its statistical significance. The level of significance was fixed at 0.05.

## 3. Results

The cohort 1 (N 55), which took IFOM BSE in the year 2014, showed a strong positive correlation ( $r = 0.9$ ) when their scores were compared with pre-clerkship summative assessment scores (Fig. 1). The Spearman's rank correlation showed a significance of  $p \leq 0.001$  when ranks of IFOM BSE scores were compared with the pre-clerkship summative assessment scores. In the same cohort, when the IFOM CSE scores were correlated with clerkship summative assessment scores for the year 2016, a strong positive correlation was observed with Spearman Rank Correlation Coefficient  $r=0.69$  (Fig. 2). A statistical significance of  $p \leq 0.001$  was present in the correlation between IFOM CSE scores and clerkship summative assessment scores.

The cohort 2 (N 65), which took the IFOM BSE in the year 2015, also showed a strong positive correlation with pre-clerkship summative assessment score (Spearman's rank correlation coefficient,  $r = 0.77$ ) (Fig. 3). By Spearman's rank correlation test, a statistically significant correlation  $p \leq 0.001$  was identified between ranks of IFOM BSE scores and pre-clerkship summative assessment scores. When correlation of the same cohort between IFOM CSE scores and the clerkship summative assessment scores was done for the year 2017, a statistically significant strong correlation (Spearman's rank correlation coefficient,  $r = 0.72$ ,  $p \leq 0.001$ ) could be observed between these two variables (Fig. 4).

A positive correlation was identified between BSE and CSE scores with Spearman's correlation coefficient ( $r$ ) 0.25 in the cohort 1. An increase in BSE score of 400 and above resulted in a percentage increase from 55% to 77% for CSE examinees in the same score range.

In the cohort 2, a positive correlation was identified between BSE and CSE scores with Spearman's rank correlation coefficient ( $r$ ) 0.14. An increase in BSE

Table 1  
Faculty perception of IFOM exam.

Item	Yes %	Uncertain %	No %	Total %
IFOM exam provided opportunity to adopt newer teaching and learning methods.	85.18	11.12	3.7	100
IFOM exam provided feedback for improvement of curriculum.	92.59	3.71	3.7	100
Inclusion of IFOM exam as part of summative assessment enhanced curriculum effectiveness.	81.48	14.82	3.7	100
Current teaching & learning strategies followed in the curriculum are enough to achieve international standard of competence in the IFOM exam.	70.38	14.81	14.81	100

\*Faculty N=27

score of 400 and above resulted in a percentage increase from 68% to 79% for CSE examinees in the same score range.

The faculty survey showed that 70% to 92% of them saying “Yes” for the items, “IFOM exam provided opportunity to adopt newer teaching and learning methods”. “IFOM exam provided feedback for improvement of curriculum”. “Inclusion of IFOM exam as part of summative assessment enhanced curriculum effectiveness” (Table 1).

The student evaluation survey showed a median Likert score of 4 on a point scale of 5 for the items, “IFOM exam helped me to improve my performance in all the components of summative assessment”. “IFOM examination helped me to perform better in the final exam”. “The scores of IFOM examination helped me to benchmark myself internationally”. “IFOM exam helped me in self-assessment” (Table 2).

#### 4. Discussion

An external benchmark examination provides international standards for program administrators and faculty for measuring the curriculum, pedagogy and assessment. It also helps to identify opportunities for improvement<sup>1</sup>. The studies conducted by Zahn and colleagues<sup>8</sup> highlighted the relationship between students’ performance on the NBME subject examinations and USMLE Step 1 and Step 2, where it was observed that students were able to perform better in USMLE after taking NBME subject examinations.<sup>14</sup> A pilot study<sup>15</sup> conducted at the University of Queensland benchmarked student learning outcomes by comparing their IFOM CSE scores with scores of the International Comparison Group, which comprise over 8000 IFOM examinees from around the world.

The MBBS curriculum at the Gulf Medical University experienced a paradigm shift from teacher-centered learning to student-centered active learning, when the integrated competency based curriculum was introduced in the year 2008. There were a few

challenges in the implementation of the integrated curricula that included the validation of pedagogies to demonstrate active learning process and the development of an assessment system that truly reflected the attainment of learning outcomes and competencies. The challenges were met largely by introducing NBME’s IFOM examinations to benchmark the curriculum according to international standards. Since NBME has developed a blueprint for the IFOM examinations, which could be aligned with the curriculum, we were able to ensure validity of the test and meet the course learning objectives.

The performance of students on the IFOM tests showed improvement over a period of time as the faculty improved their strategies in pedagogy and assessment methods. The problem based learning (PBL) and case based learning (CBL) strategies were given more importance in the curriculum as active learning strategies to improve clinical reasoning and the number of sessions for both was increased in each organ systems after the introduction of IFOM exam. Since the IFOM examination assesses the medical knowledge and clinical reasoning at higher cognitive levels, the exposure to a greater number of PBL and CBL sessions in the curriculum, has made a marked improvement of performance in all the components of the summative assessment.

Team Based Learning (TBL)<sup>16</sup> and Virtual Patient Learning (VPL)<sup>17</sup> were also implemented as active learning strategies. The TBL provided team learning, feedback for improvement and remediation. The VPL provided opportunity for students to improve medical knowledge and clinical reasoning through digital environment.

The present study demonstrated enhancement of the curriculum, which is evident with better student performance on the summative assessment after exposure to the IFOM examinations. Our study showed a strong positive correlation between the IFOM examination and the university administered summative assessments with correlation coefficient between 0.7 and 0.9 and the correlation being statistically significant  $p \leq 0.001$ . The correlation between BSE and CSE

Table 2  
Student perception of IFOM exam.

Item	1.Strongly Disagree	2.Disagree	3.Neutral	4.Agree	5.Strongly Agree	Total Responses	Median Likert Score
IFOM exam helped me to improve my performance in all the components of summative assessment.	7	10	12	82	9	120	4
The content of the IFOM examination matched our curricular content	10	23	27	53	7	120	3.5
Questions in IFOM were similar to those in our tests/exams.	12	28	20	47	13	120	3.5
IFOM exam helped me in self-assessment.	9	15	30	55	11	120	4
IFOM exam helped me to benchmark myself internationally.	5	14	38	52	11	120	4
IFOM examination helped me to perform better in the final exam.	3	3	26	74	14	120	4
IFOM examination helped me to prepare for other licensing examinations	5	3	22	66	24	120	4

\*Student N = 120

performance, though not significant, was positive and tended to show an increase in the percentage of examinees scoring higher in both the exams.

The feedback from faculty and student surveys on the impact of the IFOM exam on teaching and learning also supported the contention that an external benchmark exam definitely helped in enhancing the teaching and learning strategies for improved performance in all the components of summative assessment.

The preparation and training of students to take the IFOM examination had a definite impact on the learning process, which is reflected in the improved performance in all components of the university examination. The students improved their performance on the assessment of course work, graded assignments, end module exams, clerkship rotation tests, OSPE, OSCE and DOCEE. The performance profile reports from NBME provided the opportunity for both the school and the individual student to improve and match international standards. We were able to observe the difference in the learning behavior of students when innovative methods in teaching and learning were introduced. The introduction of external benchmark examination as a part of the summative assessment in the curriculum made a great impact in the adoption of active learning methods to enable students perform better, not only, in the benchmark exam, but also, in all other components of summative assessment. Since the students had exposure to IFOM exam preceding the final university exam, they were able to improve their problem solving skills and clinical reasoning and perform better in the final pre-clerkship and clerkship exams.

The IFOM CSE included categories that cover clinical disciplines, diseases of the organ systems and physician tasks. The training of students on these categories provided ample opportunity for students to apply the clinical reasoning in the university assessments, including the OSCE and DOCEE. The faculty had the flexibility to change teaching strategies and make curriculum adjustments based on how students performed. The questions that were constructed by the faculty for the end-of-course and end-of-clerkship rotation assessments showed marked improvement, because, the faculty constructed the test items to match external benchmark examination. The training given to faculty as part of faculty development program on item construction provided the needed skills to improve the standard of test items constructed in the summative assessment. It was observed that the introduction of external benchmark examination in the curriculum had improved the performance in all the components of summative assessment, due to the improvement in the teaching, learning and assessment methods.

## 5. Limitations

The observation was based on a pilot study conducted in two cohorts of students and carried out in one institution. A larger study of this nature from other institutions is needed to support the observations presented in the study.

## 6. Conclusion

In the present study, we found a positive and statistically significant correlation between an external benchmark examination (NBME's IFOM examination) and a university examination. The introduction of external benchmark examination in the curriculum can promote adoption of newer teaching and learning strategies for improvement of curriculum effectiveness.

## Ethical approval

Not applicable.

## Funding

None.

## Other disclosure

None.

## References

- McNair CJ, Kathleen HJL. *Benchmarking: A Tool for Continuous Improvement*. New York, NY: Harper Business; 1992. MLH citation.
- Robert N, Robin R. Benchmarking for continuous quality improvement. *Curriculum inventory in context*. *AAMC* 2015;12.
- Teresa RJ, Mohammed KH, Richard DP, Diane DD, Jonathan DK. Use of the NBME comprehensive basic science examination as a progress test in the pre clerkship curriculum of a new medical school. *Adv Physiol Educ* 2014;38:315–320.
- Magarian GJ, Mazur DJ. Does performance on the NBME part II medicine examination when used as a clerkship examination reflect knowledge acquired during medicine clerkship?. *J Gen Intern Med* 1991;6:145–149.
- Elnicki DM, Lescisin DA, Case S. Improving the national board of medical examiners internal medicine subject exam for use in clerkship evaluation. *J Gen Intern Med* 2002;17:435–440.
- Ripley DR, Case SM, Swanson DB. Predicting performance on the NBME surgery subject test and USMLE step 2: the effects of surgery clerkship timing and length. *Acad Med* 1997;72:S31–S33.
- Armstrong A, Dahl C, Haffner W. Predictors of performance on the national board of medical examiners obstetrics and gynecology subject examination. *Obstet Gynecol* 1998;91:1021–1022.
- Zahn CM, Saguil A, Artino Jr AR, Dong T, Ming G, Servey JT, Balog E, Goldenberg M, Durning SJ. Correlation of National Board of Medical Examiners scores with United States medical licensing examination step 1 and step 2 score. *Acad Med* 2012;87:1348–1354.
- York M. Formative assessment in higher education: moves towards theory and the enhancement of pedagogic practice. *High Educ* 2003;45:477–501.
- Nicol DJ, Macfarlane- Dick D. Formative assessment and self-regulated learning: a model and seven principles of good feedback practice. *Stud High Educ* 2006;31:199–218.
- Black P, William D. Developing the theory of formative assessment. *Educ Assess Eval Account* 2009;21:5–31.
- Hamdy H, Prasad K, Anderson MB, Schreiber A, Williams R, Zwierstra R, Cudahy H. BEME systematic review: predictive values of measurements obtained in medical schools and future performance in medical practice. *Med Teach* 2006;28:103–116.
- International Foundations of Medicine (IFOM)-NBME. (<http://www.nbme.org/ifom/>); 2017 (Accessed 29 September 2017).
- Glew Rh, Ripkey DR, Swanson DB. Relationship between students' performance on the NBME comprehensive basic science examination and the USMLE step1: a longitudinal investigation at one school. *Acad Med* 1997;72:1097–1102.
- David W, Jennifer S, David H, Diann E, Dave S. Global benchmarking of medical student learning outcomes? Implementation and pilot results of the international foundation of medicine clinical sciences exam at the University of Queensland, Australia. *Med Teach* 2014;36:62–67.
- Abdelkhalek N, Hussein A, Gibbs T, Hamdy H. Using team based learning to prepare medical students for future problem based learning. *Med Teach* 2010;32:123–129.
- Robison Don G, Catalano Bridges-, Matson Christine Julie. The role for virtual patients in the future of medical education. *Acad Med* 2017;92:9.

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