

## Impact of Clinical Simulation on the Clinical Competence of Medical Students Clerkship Training

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**Background:** Simulated Patient Case (SPC) software is a powerful educational tool used in several medical colleges to augment the clinical competence of students.

**Objective:** To evaluate the impact of this software on the clinical competence of medical students.

**Design:** A Prospective Pilot Study.

**Setting:** Arabian Gulf University, Bahrain.

**Method:** One hundred five fifth-year medical students attending internal medicine clerkship were divided into two groups: 43 (41%) students used the DXR software (group A) and 62 (59%) students did not use the software (group B). The grades obtained at the end of clerkship examination of the students who used the SPC software (DXR) (group A) was compared to the grades of the students who did not use the software (group B). In addition, we compared the performance of this cohort using DXR in year 4 with their grades at the end of clerkship examination. P-value of < 0.05 was considered statistically significant.

**Result:** Group A students performed better than group B at the end of the clerkship exam, which revealed that the differences in the mean scores were statistically significant (P-value < 0.030). A positive correlation between the students DXR scores in year 4 and their grades in clerkship exam (year 5) was found. The correlations between the DxR (SPC) scores and the student's scores of different exam components (SAQs, OSCE, mid-rotation, bed-side and clinical exams) was statistically significant (P-value=0.01).

**Conclusion:** The beneficial effect of the DXR SPC software on clinical competence was revealed. Therefore, we recommend it for students' clerkship training.

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Effective education in a science discipline is based on teaching and learning strategies that combine acquisition and application of knowledge with practical hands-on training. Learning by examining real patients in the hospitals and clinics is standard practice in all medical curricula since the inception of formal medical education. However, applying this practice is becoming less acceptable to patients and their caregivers and is subject to legal and ethical issues. In addition, the increasing number of medical students make training on real patients not enough to cover the range of pathology and clinical encounters that are expected from medical students.

Simulation software and computer-assisted instruction (CAI) offers an opportunity for professional medical training that is very close to real-life events<sup>1</sup>. Simulation facilitates learning through engagement, feedback, and practice in problem-solving and crisis management skills without taking the risk into a real-life experience<sup>2</sup>. The effectiveness of CAI in medical education proved to be more effective than lectures

in improving student performance<sup>3,4</sup>. The CAI can be referred to as a self-learning simulation system, which can be accessed online and offline, involving the interaction of students with programmed instructional materials, usually about patients' medical problems. The system monitors the responses of the students to the different parts of the instructional scenario and evaluates their problem-solving approaches and skills.

The medical curriculum in Arabian Gulf University (AGU) is centered on problem-based learning (PBL). It is a recognized educational strategy, more frequently used in the pre-clinical phase rather than the clinical phase of medical curricula in several medical schools<sup>5</sup>.

The Diagnostic Clinical Reasoning Program (DxR) is a web-based Simulated Patient Cases (SPC) package that trains students on the clinical reasoning process. It is developed, maintained and upgraded periodically by the DxR Development Group, Inc., Carbondale, IL, USA. Real patient's

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data of 100 interactive virtual encounters with a wide range of clinical problems in adult and pediatric medicine, surgery, and obstetrics and gynecology. Medical students can interview the patient, perform physical exams using instruments and maneuvers from a complete list of modern imaging, request lab tests, and formulate a diagnosis and choose the plan of management. In AGU the DxR software is used in the pre-clinical phase of PBL (mainly for year 4 students) rather than the clinical phase (clerkship years 5 and 6).

The aim of the study is to evaluate the impact of this software on the clinical competence of medical students.

**METHOD**

Included in the study, one hundred five medical students, aged 21-24 years (mean 22 years), 65 were females. The study was piloted during Unit IX (4th year) and Clerkship (5th year) during the academic year 2016-2017.

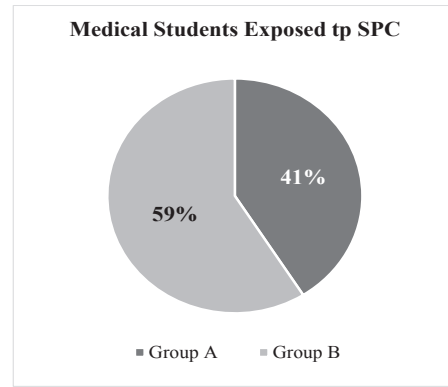
The initial clinical training in phase II achieved with professional skills lab where only manikins and normal subjects are used. This is augmented by using the DxR software in unit IX. In the DxR the students' encountered with an online photo of a real patient presenting with a chief complaint and, when they logged in, they take patient history, perform physical examinations, and request investigations. In addition, they should make a list of working hypotheses before they reach a final diagnosis and select management plan. The students receive immediate feedback. The scoring system is obtained by software "Utility Record", which scores three categories of student performance; clinical reasoning, diagnostic performance and patient management.

During the clerkship phase (20 weeks), the 5th year medical students were requested to use the DxR software (during the first week) as an addition to their clerkship hospital training. Students access the software and the SPC via a local web-server. Group A used the DxR software and group B did not use it. At the end of the clerkship, there was a summative exam that consisted of a written paper (MCQ and SAQ), which is written as case scenario to test not only acquisition of knowledge, but also application, interpretation and synthesis of knowledge. The written exam is followed by an OSCE and a hospital-based clinical encounter (long and short cases) exam.

Two sample t-tests and Pearson correlation coefficient were used to measure the relationship between the students' scores in the different components of the end of clerkship exam in relation to their use of the DxR software. Another comparison was made between the score of the same cohort in the DxR software in year 4 and their performance at the end of clerkship exam in year 5. P-value of < 0.05 was considered statistically significant.

**RESULTS**

Figure 1 shows that 43 (41%) students used the DxR software (group A) and 62 (59%) students did not use the software (group B).



**Figure 1: Medical Students and DXR Software Usage**

Table 1 shows the comparison between group A and group B performance at the end of the clerkship (EOC) examination. Two sample t-tests were used to compare the grades of the two groups in the various component of the EOC exam (MCQ, SAQ, OSCE, Clinical encounter). Group A students performed better in all components of the exam except in the MCQ paper. The difference was statistically significant (P-value of < 0.023).

**Table 1: Performance Comparison According to Usage of SPC DXR Software**

Station	Group A n=43		Group B n=62		Mean Difference	P-Value	95% C.I.	
	Mean	SD	Mean	SD			Lower	Upper
DxR	9.29	3.08	10.86	1.99	-1.58	<b>0.005</b>	-2.65	-0.50
WRITTEN	19.80	4.06	21.58	4.09	-1.78	<b>0.031</b>	-3.40	-0.16
SAQ	5.72	1.44	6.39	1.42	-0.68	<b>0.020</b>	-1.24	-0.11
MCQ	14.08	2.84	15.19	2.94	-1.11	<b>0.060</b>	-2.26	0.05
CLINICAL	27.61	5.64	30.47	3.25	-2.85	<b>0.004</b>	-4.78	-0.93
OSCE	6.16	1.46	6.75	0.95	-0.59	<b>0.025</b>	-1.10	-0.08
Bed-side	21.45	4.64	23.72	2.69	-2.26	<b>0.002</b>	-3.69	-0.84
GRADE	69.48	10.15	74.94	7.57	-5.46	<b>0.002</b>	-8.91	-2.01

Group A; Students used the DXR software  
Group B; Students did not use DXR software

Table 2 shows the correlation between the students' scores in the different components of the EOC exam and the score of the DxR software exam for the same cohort when they were in year 4. It was revealed that there was a positive correlation between DxR scores in year 4 and EOC exam scores in year 5.

**Table 2: Pearson Correlation Coefficient between SPC and different Exam Modalities**

	MCQ	WRITTEN	OSCE	Bed-side	CLINICAL	GRADE
SAQ	0.753*	0.885*	0.738*	0.517*	0.621*	0.817*
MCQ		0.973*	0.762*	0.485*	0.602*	0.845*
WRITTEN			0.799*	0.525*	0.644*	0.886*
OSCE				0.580*	0.743*	0.856*
Bed-side					0.976*	0.826*
CLINICAL						0.906*

Table 3 shows no correlation between DxR results in year 4.

**Table 3. Pearson Correlation Coefficient Was Used to Measure the Linear Relationship Between DxR Year 4 and Different Components of the Exams**

	SAQ	MCQ	WRITTEN	OSPE	PHCC	CLINICAL*	GRADE
DxRyr 4	-0.082	0.070	0.021	0.006	0.021	0.019	0.014
**	0.410	.482	0.837	0.954	0.835	0.852	0.886

\* Sum of OSCE and PHCC exams

\*\*Correlation not significant

PHCC (Primary Health Centre Case encounter)

**DISCUSSION**

DxR that incorporates simulated patient cases (SPC) is a well-known reliable educational tool. It has been introduced into the United States medical licensing examination in 2002 and has been implemented in the AGU medical curriculum since 2012<sup>6</sup>. It is used in the pre-clinical phase of the curriculum (year 4), but not in the clinical phase (year 5 and 6).

Our data demonstrated that there were strong correlations between student’s scores of different exam components (SAQs, OSCE, mid-rotation, bed-side and clinical exams) and the DxR (SPC) scores, not the MCQ. Our findings are comparable with a study by Oliven et al; it revealed that both exam modalities (SPCS and OSCE) are well correlated<sup>7</sup>. The correlation between the scores of our two exam modalities, SPC and clinical (OSCE or clinical or OSCE plus clinical), was more significant and with higher internal consistency reliability with the clinical exam. These linear relationships indicate that the SPCS is a reliable educational tool, testing equivalent skills related to what is tested in OSCE and clinical exam and that SPC could be utilized in internal medicine rotation as an additional educational tool as has been suggested previously regarding utilization of the OSCE in internal medicine rotation<sup>8</sup>.

In our study, the SPC (DxR) scores did not significantly predict the students’ scores in the MCQ exam; our data are consistent with the previous study, which identified the lack of correlation between MCQs and clinical exam set-ups<sup>9</sup>. The lack of significant correlations of SPCS with the MCQs exam compared with high reliability with the other different examination formats (SAQs, OSCE, mid-rotation, bed-side and clinical exams) of the unit summative examination could be explained by the fact that the MCQs could measure valuable learning outcomes such as recall, but never the skills, which are typically measured by the OSCE.

The differences in the mean scores between Group A and Group B were statistically significant, which indicates high associations of the DxR scores with all tested exam modalities scores and that students’ performances in the clinical phase were improved compared to the preclinical phase. Our data are consistent with another previous study, which revealed the value of web-based interactive virtual patient case simulation as training or teaching clinical skills and assessment tool for medical and nursing students<sup>7,10</sup>.

In this study, a correlation analysis inside the DxR program with its three main components: diagnostic performance, clinical reasoning, and patient management were not performed compared to a previous study at the preclinical phase<sup>11</sup>.

**CONCLUSION**

**Our study revealed that early exposure of medical students, in their clerkship, to the SPC provided by the DxR program constitutes a valuable and cost-effective educational model not only for evaluation, but also for preparation for the clinical phase. It also highlighted the need for longitudinal studies with large groups to optimize and confirm the efficiency of the DxR as undergraduate assessment tool.**

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**Competing Interest:** None.

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