

### **Evaluation of Students' Performance in Diagnostic Radiology (1988-1992)**

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A retrospective analysis was conducted to evaluate the performance of 249 male (57%) and 187 female (43%) medical students during 37 two-week compulsory rotations in diagnostic radiology between 1988 to 1992. Six percent, 35%, 36% and 20% of students attained grade A (>90% of total marks), grade B (89-90% of total marks), grade C (78-70% of total marks) and grade D (69-60% of total marks), respectively. Low failure rate (<60% of total marks) of only 3% was noted. There was no significant difference in the distribution of various grades according to gender (P = 0.66). In the examination carried out in 1989, more than expected number of students attained grade A or B, while less than expected number obtained grade D or F. Female students achieved significantly higher scores in the practical examination than males (P = 0.01). The latter difference explained the higher mean total scores in 1989 as compared with any other year as in this particular year, female students - with their consistently better performance in practical examination - significantly outnumbered males. There was evidence to suggest that the superior performance of female students in the practical evaluation is attributed to their attendance of the elective departmental activities and procedures more often than males. Correlation analysis had shown that practical examination had the lowest correlation with the multiple-choice questions (MCQs) and the essay components. Furthermore, correlation between scores in each component and the combined scores of the remaining parts showed that MCQs examination had the highest correlation, while the practical examination had the lowest correlation with the other two components. We conclude that the diagnostic radiology course is to be restructured with clearly stated objectives. The course contents and instruction should include self-instruction seminars, attendance of all departmental activities and procedures, problem-solving approach in learning, accessible well prepared teaching kits, and utilisation of newer teaching technology. Attendance and apprenticeship should carry an appropriate weight in the total marks.

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The process of rapid foundation and growth of medical schools in Saudi Arabia have evolved into views and recommendations concerning how to achieve the highest standards in under-graduate curricula and postgraduate training programs<sup>1-3</sup>. One important mean of attaining these standards is to evaluate the outcome of a given system<sup>4</sup>. Equally important is to appraise the reliability, validity and practicality of the various methods used to assess the skills and knowledge of medical students<sup>5-8</sup>.

These objectives have provided an impetus to analyse the performance of undergraduate medical students during rotation in diagnostic radiology over a five-year period. We selected diagnostic radiology as it is commonly perceived as third, behind surgery and medicine, for the required breadth of knowledge, skill and training<sup>9</sup>. We also intended using the results of the present analysis to provide a new perception to the objectives, methods of instruction and evaluation of diagnostic radiology course in the new curriculum.

## METHODS

Rotation in diagnostic radiology at the College of Medicine and Medical Sciences of King Faisal University is offered as a compulsory, dedicated two-week course for all medical students at the 5th level after several clerkship rotations in internal medicine, general surgery and paediatrics. The course objectives are to familiarise the students with the various imaging modalities and their applications to common clinical conditions and to introduce an organised approach to interpretation of conventional radiographs. In this course, the students achieved an understanding of the impact of radiologic findings or clinical situations and of the necessity of designing an orderly radiologic work up tailored to patients' needs and clinical presentation. Students are exposed to various educational activities to allow the large number of students to participate actively in the educational process and to enable them to cope with the unfamiliar vocabulary materials, and modalities. Educational methods during this course include formal tutorials, seminars, attending procedures, reading teaching films and self-study.

Evaluation at the end of the course includes multiple choice questions (MCQs) examination, which represents 50% of the total marks; an essay paper which constitute 20% of the total marks; and a practical examination (viva and film reading), which makes the remaining marks (30%).

An overall score of 60% or more was considered passing, regardless of the scores for the individual components. The grading scheme is as follows: grade A, 90% or more; grade B, 89% to 80%; grade C, 79% to 70%; grade D, 69% to 60%; and grade F, below 60%.

### Data Analysis and Statistical Methods:

Comparisons of proportions of various grades according to sex and year of examination were performed using chi-square analysis<sup>10</sup>. Comparisons of student's mean total score and mean scores of individual examination components according to sex and year of examination were carried out using analysis of variance<sup>11</sup>. Correction for multiple comparisons was done using Scheffe's method<sup>11</sup>. Correlation between different examination components was estimated using Person's product-moment estimate<sup>10</sup>. In all analyses, a two-sided P value of less than 0.05 was considered significant. The BMDP Statistical Software programs (P1D, P2D, P6D, and P4F) were used to analyse the data<sup>12</sup>.

## RESULTS

Between 1988 and 1992, a total of 37 two-week courses in diagnostic radiology were offered to 5th year medical students by the Department of Diagnostic Radiology at the College of Medicine and Medical Sciences of King Faisal University, Eastern Province, Saudi Arabia. A total of 249 male (57%) and 187 female (43%) medical students attended the end of rotation examination. These numbers include students who failed one or more times. We determined that the results and conclusions of the analyses would not be significantly influenced by including the test results of those students who failed and retook the examination.

Table 1 shows the distribution of students' grades broken down by sex and year of examination. An almost equal proportion of students attained grade C (36%) and grade B (35%). On the other hand, while 6% of students achieved grade A, only 3% have failed the overall examination. There was no significant

difference in the distribution of various grades according to student's sex (P=0.66). Furthermore, the failures' rates of male and female students were identical (3%). Conversely, the difference in the overall distribution of students' grades in various examination years was statistically significant (P=0.01). The latter difference was primarily related to the results of students' performance in 1989 where more than expected number of students attained grade A or B, while less than expected number obtained grade D or F as shown from comparing the observed versus expected values.

Table 1: Distribution of students' grades according to sex and examination years

	Grades No. (%) <sup>a</sup>					Total (%) <sup>b</sup>
	A	B	C	D	F	
<b>Sex</b>						
Males	12 (5)	86 (35)	95 (38)	48 (19)	8 (3)	249 (57)
Females	15 (8)	64 (35)	63 (34)	38 (20)	6 (3)	187 (43)
<b>Years</b>						
1988	1 (1)	33 (32)	40 (39)	22 (22)	6 (6)	102 (23)
1989	11 (12)	46 (48)	25 (26)	12 (13)	2 (2)	96 (22)
1990	3 (5)	18 (28)	21 (32)	20 (31)	3 (5)	65 (15)
1991	2 (5)	13 (33)	17 (43)	7 (18)	1 (3)	40 (9)
1992	10 (8)	41 (31)	55 (41)	25 (19)	2 (2)	133 (31)
Total	27 (6)	151 (35)	158 (36)	86 (20)	14 (3)	436 (100)

<sup>a</sup>Row percentage, <sup>b</sup>Column percentage

The results of the analysis of students' scores in different parts of the end of rotation examination broken down by sex and year of examination are shown in Table 2. Females had significantly higher scores in the practical examination than males (F value = 6.7, DF = 1,434, P = 0.01). However, no other significant difference was noted for the total scores or other examination components. Table 2 also shows that the attained mean total scores in 1989 was significantly higher than the attained total mean scores in any other year and that was only attributed to higher attainment of scores in the practical component in 1989. Post hoc analysis revealed that in this particular year, female students - with their consistently better performance in practical examination - significantly outnumbered males (69% of students were females in examinations conducted in 1989). This female sex predominance in 1989 is probably the sole explanation of the attained performance in that year as in all other years males to females ratio ranged from 1.2 to 1.4.

Table 2: Mean total scores of students' performance in different examination components according to sex and examination years

	Score (mean <sup>†</sup> SD) <sup>a</sup>			
	MCQs (50%)	Essay (20%)	Practical (30%)	Total (100%)
<b>Sex</b>				
Males	37.98.7 <sup>†</sup> 75.6	3.1 <sup>†</sup> 23.3	2.4 <sup>†</sup> 14.7	5.9 <sup>†</sup>
Females	37.79.0 <sup>†</sup> 76.5	*2.8 <sup>†</sup> 23.2	1.9 <sup>†</sup> 14.9	6.3 <sup>†</sup>

Years							
1988	36.39.5	'74.5	2.8	'23.2	1.9	'14.9	7.1
1989	38.98.1	'79.2	**2.5	'25.2	2.3	'15.1	5.5
1990	37.09.1	'73.2	2.6	'22.6	3.0	'13.5	6.0
1992	38.28.2	'76.2	3.1	'22.9	2.3	'15.1	5.7
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Total	37.88.9	'76.0	2.9	'23.5	2.4	'14.8	6.1
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<sup>a</sup>Percentage in parentheses represents the portion of the total score, \*(analysis of variance), \*\*P<0.0 (Scheffe's multiple-comparison method) in the practical examination between 1989 versus all other years; and in the total score between 1989 versus all other years. MCQs = multiple-choice questions.

The better achievement by female students in practical examination as compared with males was a provocative interesting observation. During 1993 four groups of students (2 male and 2 female groups) attended the diagnostic radiology course. While their results were not included in the current analysis, their performance and attendance were carefully monitored throughout the course. It was clear that female students attended more elective activities than males such as attending the afternoon departmental film reading, observing more invasive procedures, reviewing the teaching files during off working hours, etc.

The correlation matrix of various examination components is shown in Table 3 where the highest correlation was noted between MCQs and essay. On the other hand, low; albeit, significant correlation was seen between the practical examination and the MCQs and the essay components. Also examined was the correlation between scores in each component and the combined scores of the remaining parts. While MCQs examination showed the highest correlation, the practical examination had the lowest correlation with the other two components.

Table 3: The correlation between students' scores in different examination components

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A. Correlation matrix (correlation coefficients) of students' scores in individual examination components

	MCQs	Essay
Practical		
MCQs	1.00	0.4184
	0.3078	
	(P<0.0001)	(P<0.0001)
Essay		1.00
	0.2523	
	(P<0.0001)	

B. Correlation between students' scores of each examination component and the combined scores of the other two

MCQs	vs.	Essay + Practical
		0.4500 (P<0.0001)

Essay	vs.	MCQs + Practical 0.4365 (P<0.0001)
Practical	vs.	MCQs + Essay 0.3342 (P<0.0001)

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MCQs = Multiple-choice questions

## DISCUSSION

Diagnostic radiology is commonly perceived as third subject, behind surgery and medicine, for the required breath of knowledge, skill, and training<sup>9</sup>. Therefore, it was rational to appraise the rotation offered to undergraduate medical students in this important discipline to provide new conviction as to the objectives, methods of instruction and evaluation of the course.

Analysis of distribution of grades of all students has shown that the course has a limited discriminated power as it has resulted in a relative low failure rate of only 3%. The latter figure is lower than the failure rates in chemistry (29.5%), pathology (4.4%), and internal medicine (14.2%) previously reported from our own college<sup>4</sup>. On the other hand, grade A was achieved by 6% of students. The latter figure is comparable to that achieved by our own medical students in chemistry (6.5%), but higher than the percentage of the A grade in pathology or internal medicine<sup>4</sup>. Conversely, higher honor's rate has been attained in a similar course offered to senior medical students at Northwestern University Medical School<sup>13</sup>.

While there was no significant difference in the distribution of final grades between male and female students, grades attained in examinations conducted in 1989 showed a trend that was conspicuously different from that of other years. In that year, there was more than expected number of students attained grade A or B, while less than expected number obtained grade D or F.

It was interesting to see that, on the whole, female students scored better than males in the practical component of the final evaluation. That trend explained the relatively better overall score in 1989 compared with all other years as in this particular year the proportion of female students significantly outnumbered the proportion of males. Post hock analysis suggested that the superior performance of female students in the practical evaluation could be attributed to the fact that females attend elective departmental activities and procedures more often than males. In previously published data about students' performance in different examinations at our college, female students generally performed on a par with male students<sup>4,6</sup>.

The performance of the female students in practical examination and its apparent relation to active participation during the course suggest that the instruction and assessment of the course ought to be modified. Students should be encouraged or mandatory requested to attend all departmental activities and procedures. Attendance and apprenticeship should have its own weight in the mark distribution and perhaps it can be assigned the marks currently designated to the essay examination. It was recently shown that engagement of medical students in various services offered by radiology department enhances the students' advancement in practical and functional knowledge of decision-making process involved in radiology as well as clinical medicine<sup>14</sup>.

Correlation analysis has shown that despite that significant correlation was noted between examination components, the lowest correlation was observed between practical exam and each of the MCQs and essay component. Furthermore, correlation between scores in each component and the combined scores of the

remaining parts showed that MCQs examination had the highest correlation, and the practical examination had the lowest correlation with the other two components.

The relatively low correlation of the practical component as compared with the other two parts of the examination may dictate tangible modifications in the instruction methods. Problem-solving approach should be adopted where small groups (10-15 students) with faculty guidance discuss 5-6 common patient problems to develop an investigative plan in imaging<sup>15</sup>. Prepared teaching kits should be made available using duplicate films and a syllabus to ensure that all students cover the same material. The kits are also to be available to students to review alone and can be readily updated as required. Besides, to minimize the view box monotony, traditional teaching methods may be sublimated by newer teaching technology such as computer-based learning using hypermedia application<sup>16</sup>.

#### CONCLUSION

The result of the analysis of the performance of medical students in diagnostic radiation rotation indicates that future courses should be structured with clearly stated objectives. The course contents and instruction should include self-instruction seminars, attendance of all departmental activities and procedures, problem - solving approach in learning, accessible well prepared teaching kits, and utilization of newer teaching technology. Attendance and apprenticeship should be assigned an appropriate weight in the total marks.

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