

# Radiological Knowledge of the 4th Year Medical Students before and after the Clinical Rotation in Radiology

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## ABSTRACT

For centuries, basic medical sciences and clinical disciplines have been taught by a traditional method. Recently developed problem-based learning (PBL) method was introduced as an alternative to the traditional teaching. Despite some advantages of the PBL, traditional teaching is still widely used throughout the world. What is more, it was reported that not all subjects in medical education should be taught by the PBL. The hot dispute about the advantages and disadvantages of the two teaching methods, resulted in the introduction of a hybrid method, which was a combination between the traditional and the PBL methods. There were a number of papers that reported about the under-representation of imaging in the medical curricula, which resulted in a low level of knowledge. The aim of the present study was an attempt to establish the level of the theoretical and practical radiological knowledge, by the 4-th year medical students, before and after the clinical rotation in radiology. At the new Medical Faculty, University of Botswana, a PBL curriculum was introduced. The subject of radiology, however, was taught by a traditional method, which was incorporate into the PBL curriculum. The results indicated that at the pre-rotation MCQ test, the class-I (year 2014) and class- II(year 2015) of the 4-th year medical students showed a good level of theoretical radiological, knowledge, by scoring a mean mark of 63% and 64%, respectively. At the post-rotation MCQ test, the same students scored 80% and 73%, respectively. In addition, the class – I students improved their theoretical knowledge by 17%, while class-II did so by 9%. At the end of the year, at the practical examination (OSCE), the two classes of the 4-th year students failed the examination dramatically, since only 5 students (10%) and 4 students (9%), passed the practical examination (OSCE). It was concluded that, during the pre- clinical years(phase-I) the students tend to accumulate theoretical knowledge only, however, the 5 days of radiological clinical rotation appeared insufficient for the students to acquire a bit of clinical knowledge.

**Key words:** radiological, knowledge, 4-th year, medical, students

## INTRUDUCTION

The traditional teaching method, based on didactic lectures, tutorials and practical classes, has been used for centuries, in medical schools. The longevity of this curriculum is due to its educational qualities such as sequential and logical

manner in the teaching of medical subjects. Because of its advantages, the traditional curriculum is still a preferred method of teaching, in the majority of medical schools in North America, Europe and Australia. [1-3] In the second half of the nineteen century, a new teaching method, called the problem-

based learning (PBL) was developed and introduced, in some medical schools around the world, as an alternative to the traditional curriculum. The PBL method quickly gained popularity, because it gives the possibility for an early integration of basic medical and clinical subjects. [4] Because of this and other advantages, the PBL method was introduced in the study of radiology.

Later research on medical education, however, reported that it is neither possible nor desirable to teach all subjects of medical curriculum by the PBL method, only. [5] Because of the contradictory statements on the advantages and disadvantages between the traditional and PBL methods, the so called hybrid method of teaching was introduced, which is a combination between the previous two methods and allows them to be used parallel to each other. [6]

It is generally accepted, among the clinicians, that radiology plays an important role in the health care programs, because imaging is used to detect diseases, direct clinical management, guide procedures and deliver therapies. Despite these important health services, radiology is frequently under-represented in the curricula of medical schools. Recent studies reported that, only 5% of the total teaching time, in medical education, is dedicated to radiology. [7] In addition, the subject is frequently taught by non-professionals, which use educational materials that do not include the latest technological advances or reflect the current role of radiologists in the patient care. [8]

Earlier research reported that, in medical schools of the USA, Europe and Australia there is a lack of standardization of radiological curricula and confusion about the choice of suitable radiology programs [9] A survey, in the USA medical schools, indicated that, most of them do not offer or do not require imaging courses between the 1<sup>st</sup> and 3<sup>rd</sup> years. Instead, radiology course has often been incorporated into the existing pre-clinical subjects, such as anatomy. There are papers

reporting that in many medical schools, around the world, the training of the senior students in imaging occurred during the core clinical rotation in internal medicine, surgery or obstetrics and gynecology, and primarily in the form of electives. [10] In addition, the training in imaging is neglected to such an extent that radiology teaching, in some UK medical schools, is reduced to little or no formal training at all, during the undergraduate curriculum. [7,11]

Studies on the manner, in which radiology is taught, reported a low level of radiological knowledge, a low degree of retention and retrieval of the knowledge and incompetence in the interpretation of radiographs. What is more, they found that the pre-clinical students, performed very well, at the end of the year examination, while the same students, in their 4<sup>th</sup> year, failed the radiology examination. [12] It was also reported that after two weeks of intensive radiology revision, the 4<sup>th</sup> year students re-wrote the examination and scored an excellent mark. [13] Another research studied the ability of the final year medical students to interpret chest x-ray radiographs and found that they also did not perform well. [14]

There is a lack of research on the level of radiological knowledge of the 4<sup>th</sup> year medical students with which they enter the core clinical rotation. In addition, there is no research reporting on the level of knowledge the students acquire during the rotation as well as the extent to which they retain and use it during the end of year OSCE.

The aim of the present study was, therefore, an attempt to establish the level of radiological knowledge, of the 4<sup>th</sup> year medical students, immediately before they entered the radiological rotation. In addition, we wanted to record whether they change the level of their knowledge after the rotation and the degree to which the students retained and retrieved it at the end of the 4<sup>th</sup> year practical examination (OSCE).

## MATERIALS AND METHODS

At the new Medical Faculty, University of Botswana, a PBL curriculum was introduced. The subject of radiology, however, was taught by the traditional method, which was incorporated into the PBL curriculum. The examination performance of two separate classes, class- I of 43 students, (2014 academic year) and class- II also of 43 students (2015 academic year) was followed up in their 1-st, 2-nd and 4-th academic year. Anon-experimental data collection and analysis method was used. The data were gathered through a “documentary analysis”, which included a survey, tabulation, study and analysis of the examination results.

In the day just before the clinical rotation, the 4<sup>th</sup> students, were given a 30 min. MCQ test, consisting of 15 questions covering the all aspects of radiology. The 5 days long radiological rotation was carried out in a workshop format and each one of them lasted about 2 hours. During the first half of the workshop (1h), a student presented a topic, which was assigned to him, the week before. Each presentation lasted 30-45 min. and was supported by radiographs, on the topic. During the presentation, the lecturer/radiologist and the students of the group discussed and clarified basic radiological signs and patterns, related to the topic. The same procedure, with the same time duration, was repeated with a second student, but with a different topic. For the rest of the morning time left (around 2h), the students reviewed x-ray films, on the topics presented the same morning. In addition, they viewed chest x-ray radiographs containing lung manifestation of HIV/Aids, pulmonary TB, dysphagia, chronic obstructive pulmonary disease (COPD) and pneumothorax.

For one morning only, 2-3 students from the same group were exposed to other fields of radiology, such as Fluoroscopy and CT. Their topics for discussion depended on the diseases of the patient booked for the day. The most common topics, presented to students, were the imaging of the lower

urinary tract, internal female genitalia, perianal fistulae, deep vein thrombosis (DVT), peptic ulcers, brain tumors, cerebrovascular accident (CVA) and liver tumors. Two afternoons from the one week rotation were used for hands-on tutorials with ultrasound. The most common cases, to which the students were exposed, were the following: normal anatomy of the content of the abdominal and pelvic cavities, breast lumps, pregnancy in different duration (PID) and appendicitis.

The level of the radiological knowledge acquired during the rotation week as well as its retention and retrieval, were assessed by another MCQ test, for 30 min., consisting of the same 15 questions, as in the first test. At the end of the 4-th year, the students of class-I (Year 2014) had a radiology practical examination {OSCE}, which was part of the internal medicine general OSCE. During this examination, the acquired over the year’s radiological knowledge and the degree of its retention was assessed on one examination station. The station consisted of two chest x-ray films with pathological changes. On both radiographs were asked a total of 10 questions, which carried 10 marks. The total time given for the one x-ray interpretation was 10 minutes. The students were asked to name the most prominent radiological pattern on a chest x-ray, to localize the pathology by using the appropriate radiological signs and to make a diagnosis and a differential diagnosis.

## RESULTS

The results from the *pre-rotation MCQ test of class-I* of the 4-th year medical students (year 2014), were varying between 57%-69%, mean score 63%, whereas the results from the same *pre-rotation MCQ test of class-II* of the 4-th year students (year 2015), were between 59%-72%, mean score 64%.

The results from the *post-rotation MCQ test*, of class-I was between 73%-92%, mean score 80%, while the score from

the *post-rotation MCQ test* of class-II, were between 68%-80%, mean 73%.

After the post-rotation test, class-I students improved their score by 17 %, in comparison to the pre-rotation one, while class-II students improved their score by 9%, only, with the exception of group VIII, who performed even worse, by decreasing their results from the test-I by 3%.

The results from the *OSCE examination* of class-I (2014) and class II (2015) of the 4-th

year students, showed that from class-I only 5 students (10%) pass the examination, while from class-II only 4 students (9%) passed it, with a mean mark of 6.2 and 6, respectively, out of a total of 10 marks. The rest of the students 38(90%), from class-I and 39 (91%), from class-II, failed the examination with a mean score of 2 and 2.5, respectively.

**TABLE I: MCQ RESULTS SCORED BY CLASS-I (YEAR 2014) AND CLASS-II (YEAR 2015) OF THE 4-th YEAR MEDICAL STUDENTS, AT THE BEGINNING AND END OF THE CLINICAL ROTATION**

MCQ RESULTS SCORED BY THE CLASS-I STUDENTS (YEAR 2014), DURING THE PRE- ROTATION TEST				MCQ RESULTS OBTAINED BY THE CLASS-II STUDENTS (YEAR 2015), BEFORE AND AFTER ROTATION.			
Group	Before-rotation	After rotation	Improvement	Group	Before rotation	After rotation	Improvement
I	69 %	92 %	23 %	I	60 %	77 %	17 %
II	66 %	81 %	15 %	II	69 %	70 %	1 %
III	64 %	73 %	9 %	III	65 %	72 %	7 %
IV	56 %	78 %	22 %	IV	59 %	68 %	9 %
V	60 %	75 %	15 %	V	63 %	75 %	12 %
VI	57 %	77 %	20 %	VI	64 %	73 %	9 %
VII	68 %	82 %	14 %	VII	61 %	80 %	19 %
VIII	60 %	85 %	25 %	VIII	72 %	69 %	-3 %
MEAN	63 %	80 %	TOTAL 17 %	MEAN	64 %	73 %	TOTAL 9 %

**TABLE 2: OSCE RESULTS SCORED BY CLASS -I OF THE 4<sup>TH</sup> YEAR MEDICAL STUDENTS, (YEAR 2014),**

Total N	Students passed the examination			Students failed the examination		
	Total number	Breakdown of the N of passed students	Mark scored (out of 10)	Total number	Breakdown of the N of failed students	Mark scored (out of 10)
43(100%)	5 (10%)	2	5.5	38 (90%)	3	0.5
		2	6.5		3	1.0
		1	7		7	1.5
		Total 5	Mean 6.2		4	2
					6	2.5
					3	3
		5	3.5		4	4
		4	4.5		3	4.5
		Total 38	Mean 2			

**TABLE 3: OSCE RESULTS IN RADIOLOGY OF THE CHEST SCORED BY CLASS-II OF THE 4<sup>TH</sup> YEAR MEDICAL STUDENTS, (YEAR 2015).**

Total N	Students passed the examination			Students failed the examination		
	Total number	Breakdown of the N of passed students	Mark scored (out of 10)	Total number	Breakdown of the N of students	Mark scored (out of 10)
43 (100%)	4(9 %)	1	6.5	39 (91 %)	4	0.5
		2	5.5		3	1.0
		1	7		5	1.5
		Total 4	Mean 6		7	2
					8	2.5
					3	3
		4	3.5		4	4
		2	4.5		3	4.5
		Total 39	Mean 2.5			

## DISCUSSION

At the Faculty of Medicine, University of Botswana, a Problem-Based Learning (PBL) curriculum was used. This

teaching method was chosen, because it gives the possibility for an early integration of basic medical and clinical subjects and allows the students to better understand the

role of radiology in diagnosis and patient management. [5-7] However, the authors of more recent papers reported that it is neither possible nor desirable to teach all aspects of medical curriculum through the PBL method. [8]

Over the centuries, basic medical sciences and clinical disciplines, at medical schools, have been thought by a traditional method, which is based on didactic lectures, practical classes and small group's tutorials. Over a long period of time, the latter method established itself as a preferred curriculum, because it is sequential and logical and gives good level of radiological knowledge. [1,2]

Because of these advantages, the subject of radiology was taught by a traditional method, during the first two pre-clinical years or phase- I of the PBL curriculum. To achieve this, we incorporated the *traditional teaching method, into the PBL* curriculum. This became possible because the traditional method closely followed the PBL blocks and clinical cases.

Earlier studies on medical education reported that the combination between the two methods resulted into a new method referred to as the hybrid teaching method, which allows parallel use of the two methods. [6] In the teaching of radiology, however, we followed the traditional teaching component of the hybrid method, since previous research indicated that this component gives a good level of radiological knowledge and a better understanding of medical subjects. Besides, the traditional curriculum is still a preferred method of teaching, in the majority of medical schools in North America, Europe and Australia. [3]

The results from our study indicated that at the *pre-rotation MCQ test*, class-I (year 2014) and class-II (year 2015) of the 4-th year medical students, did well and scored a *mean mark of 63% and 64%, respectively*. These results appeared to support the finding reported in an earlier research, which stated that the traditional

teaching method gives a good level of medical knowledge and better understanding of the subjects [1,2] In addition, the latter statement also indicated that the students exhibited a good level of knowledge retention and retrieval, over a long period of time (i.e., between the 2-nd and 4-th year of studies). We, however, strongly believe that the MCQ format of examination does not test the overall radiological knowledge, but reflects the *theoretical component of it, only*. In any case, the good performance, at the pre-rotation MCQ test, makes us assume that the 4-th year medical students entered the clinical rotation theoretically well prepared.

*At the post-rotation MCQ test*, class-I and class-II of the 4-th year students, showed further improvement of their theoretical performance, by scoring a mean mark of 80% and 73%, respectively. We, however, are of the opinion, that the very good theoretical results, scored at the post-rotation MCQ test could be due to the benefit, for the students from the intensive revision of the radiological material and further practical radiological exposure, during the clinical rotation. This assumption was confirmed, by comparison of the results from the pre-rotation MCQ test with those of the post-rotation MCQ test. The results from the comparison indicated that, the class-I students (Year 2014) improved their radiological knowledge by 17%; while the improvement of class-II students (Year 2015) was significantly lower (9%). An exception from this finding was the performance of the group (VIII) students, which decreased their score by 3%. It was assumed that the little improvement of class-II could be attributed to the lack of interest to the subject or simply a dominating laziness.

*The results from the practical examination (OSCE)*, on the chest, at the end of the 4-th year, indicated a very poor radiological knowledge. This statement was based on the extremely bad OSCE results of the students of both class-I and class-II. For example, from class-I, out of a total of 43

students only 5 of them (10%) passed the practical examination OSCE with a mean mark of 6.2, whereas from the same number of students in class-II, only 4 of them (9%), passed the examination, with a mean mark of 6, out of a total of 10 marks.

The poor practical radiological performance of our students appeared not to be a precedent in the radiological education. This is so, because earlier papers reported similar bad performance by both the 4-th and 5-th year medical students. Who have shown incompetence in the interpretation of radiographs. [3,12-14]

On the bases of the results scored at the two MCQ tests and the end of year OSCE, we came to the conclusion that by MCQ tests we tested the level of the accumulated theoretical knowledge, while by OSCE method we test the ability of the students to apply the theoretical knowledge in the clinical practice. The analysis of the results obtained, from the MCQ tests and the OSCE clearly indicated that our students are unable to apply the accumulated, over the years, theoretical knowledge and, therefore, are incompetent in analyzing a chest x-ray with pathological changes.

We, are, therefore, also concerned about the level of clinical performance in imaging. We tend to agree with the findings of previous authors that, despite the important role of radiology in the health care services, the senior students show poor practical radiological knowledge, which is probably due to the under-representation of the subject in the medical curricula. For example, recent studies reported that, only 5% of the total teaching time, in medical education, is dedicated to radiology. In addition, the subject is frequently taught by non-professionals, which use educational materials that do not include the latest technological advances or reflect the current role of radiologists in the patient care. [11]

An analysis of the teaching time allocated to radiology, during the medical education, indicated that, in our faculty, things are not quite different, from those cited above. During the 1-st pre-clinical

year the students were thought radiological anatomy for 7h only, (4h for didactic lectures and 3h for practical classes), while during the 2-nd pre-clinical year, the curriculum allowed a total of 18h (i.e., 10 lectures and 8h practical sessions) for radiological anatomy and clinical patterns. On the other hand, in the 4-th year, our students studied the subject for one rotation week only, consisting 24h (14h lectures and 10h practical sessions). In addition, the rotation week in radiology was informal, since it was a part of the internal medicine rotation. From our calculation it follows that for the total medical course, our students studied radiology for a total of 49h (28 didactic lectures and 21 h practical classes).

It appears that the training in imaging, in many medical schools around the world, is not only under-represented but neglected as well. This finding is reported by previous papers, which wrote that the training of the senior students in imaging occurred during the clinical rotation in internal medicine, surgery or obstetrics and gynecology, and primarily in the form of electives. [10,11] What is more, the training is neglected to such an extent that radiology teaching, is reduced to little or no formal training at all, during the undergraduate curriculum. [8,12]

In addition, it was also reports that, in medical schools of the USA, Europe and Australia there is a lack of standardization of radiological curricula and confusion about the choice of suitable radiology programs. [3,6,9] A survey, in the USA medical schools, indicated that, most of them do not offer or do not require imaging courses between the 1<sup>st</sup> and 3<sup>rd</sup> years. Instead, radiology course has often been incorporated into the existing pre-clinical subjects, such as anatomy.

We are of the opinion that the 2 main factors for the bad performance of the senior medical students, in radiology, at the OSCE, are: 1) the under-representation of that subject in the medical curriculum (i.e., small number of teaching hours allocated for the subject; 2) neglecting of the

radiology teaching (i.e. lack of individual training in radiology, due to the inclusion of the subject in the other clinical disciplines, such as internal medicine, surgery and obstetrics and gynecology (OG).

In addition, we believe that apart from the two main above-mentioned reasons, for the poor performance of the students in radiology, at our faculty, there are a number of smaller contributors, such as; 1) the acute need for qualified teaching staff, 2. Lack of contemporary teaching resources, such as a digital laboratory with an extensive library of normal and abnormal images. The latter resources should be available to the students continually. 3) The radiology teaching should be closely related to the teaching of anatomy and 4) the Introduction of x-ray films and digital images, should occur during gross anatomy practicals, which should be followed by radiology workshops. In addition, 5) special attention should be paid to the 1-st year students, which should be thought spatial visualization. The OSCE results of our pre-clinical students appeared significantly lower in comparison to the results of the pre-clinical students from the other medical schools, worldwide. We could explain this difference with the fact that, apart from the radiology of the thorax, our students had to be examined on the radiology of the other regions of the human body. <sup>[11]</sup>

We, similarly to the colleagues from the other medical schools, are concerned about the incompetence of the senior students in the interpretation of the x-ray radiographs. We are of the opinion that the poor results of the senior clinical students could significantly be improved after an intensive reviewing of radiological material. <sup>[13,14]</sup> Another reason for the poor radiological knowledge, emanated from the very nature of the PBL curriculum. Because of that, the radiology workshops are sometimes presented with a huge gaps between them, which does not allow a good retention of the previously acquired knowledge. These facts allow us to assume that the poor OSCE performance of our

senior students is a result of the low level of gross anatomy knowledge and the insufficient and insequentially distributed teaching time, provided by the PBL curriculum.

During the 4-th year, the students were not exposed to formal radiology training, because the subject was incorporated in the department of internal medicine. The only formal training was during the week of radiology rotation, which took place at the end of the academic year and was part of the rotation block of the internal medicine.

## CONCLUSIONS

The subject of radiology is significantly under-represented in the medical curriculum, throughout the world. From the results of our study, we came to a number of conclusions, which, if implemented may result to a significant improvement of the practical knowledge in radiology. In the first place, radiology should be regarded as a clinical subject equal to the rest of the subjects in the rest of medical curriculum and should be allocated enough teaching time, which is crucial for the understanding the three dimensional shape of the anatomical organs and systems, in the body.

We believe that the low level of practical radiological knowledge, of the chest, of the 4-th year medical students is due to the factors mentioned above, namely, the under-representation of the subject in the medical curriculum, and the insufficient and irregularly distributed teaching time, provided by the PBL clinical curriculum. We found it difficult to imagine that the clinical radiology will be adequately covered in the 5 days of intensive practical radiological rotation. In that respect, we share the opinion of the other authors that the low level of radiological knowledge in imaging, could be explained with the poor retention of acquired, in the pre-clinical years, radiological knowledge. Another factor is the interruption of the logical teaching in radiology, during the 3-rd year

of their education. It appears that the clinical lecturers completely ignore the radiology teaching or reviewing, because they probably believe that this is not part of their job or simply avoid the explanation, because of lack of radiological knowledge. It appears that our results are in agreement with the reports of earlier authors, that approximately 2/3 to 3/4 of the acquired knowledge will be retained after one year, with a further decrease up to 50%, in the next year.

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