Original Article

Pre/post-testing in evaluation of students' gain of content knowledge from a blood and lymph course

Nazik Elmalaika Obaid Seid A Husain[1] and Ihsan Mohamed Osman Abdelhalim[2]

Abstract

Background: There is an increased interest in programme evaluation, especially the definition of goals and the measurement of educational outcomes.

Objective: To evaluate the student gain of content knowledge in one of phase II modules (blood and lymph) as an institutional self evaluation process.

Method: This descriptive study assessed the students' gain of content knowledge of the blood and lymph course via pre- and post-testing. A sample of 214 second-year pre-clinical medical students comprising 114 males and 110 females of the Faculty of Medicine and Health Sciences, Omdurman Islamic University, Omdurman, Sudan participated in the study. Data were analysed using SPPS, version 15. The *t*-test (unpaired) was used for the difference of means. Pearson's correlation coefficient was used and $P < 0.05$ was considered as statistically significant.

Results: The mean post-test score (7.99/12, SD = 2.17) was significantly higher ($P < 0.0001$) than the mean pre-test score (4.64/12, SD = 1.69). The average normalized gain (gain score) is 0.83. There is no statistically significant difference in the pre- and post-test scores between male and female students (*P*-values: 0.838 and 0.328).

Conclusion: The curriculum content of the blood and lymph course is effective in increasing students' knowledge about the haemopoietic system. Gender difference of students or instructors does not affect students' gain. We believe that other institutions should consider the use of pre- and post-tests as a useful direct method of programme evaluation.

Key words: Educational outcomes, the average normalized gain, hybrid curriculum.

Many medical schools are in the process of curriculum review and revision; while these changes respond to identified problems, they may have implications for the faculty and other resources. The increased interest in programme evaluation, especially the definition of goals and the measurement of educational outcomes to assess their attainment, demonstrates that medical schools are serious about educational accountability[1]. Assessment tools can generally be placed in two categories, direct and indirect measures, as mentioned in the *Handbook of Assessment* by Indiana University South East. Direct measures are those in which the products of student work are evaluated in light of the learning outcomes for the programme. Indirect measures are not based directly on student academic work but rather on the perceptions of students, alumni, employers and other outside agents. While both direct and indirect measures have their place in assessment (together they form an important holistic impression of student learning), it is most useful for programmes to start with the direct measures, and given that it is there that student achievement is directly evaluated. Direct methods include capstone courses, course-embedded assessment, standardized tests, locally developed tests, portfolio evaluation and pre- and post-tests[2].

Harden defined the curriculum as a sophisticated blend of educational strategies, course content, learning outcomes, educational experiences, assessment, the

1. Assistant Professor, Department of Pathology, Faculty of Medicine, Omdurman Islamic University, Omdurman, Sudan
2. Associate Professor, Department of Pathology, Faculty of Medicine, Elzaem Elazhary University, Khartoum North, Sudan
Corresponding :Email: nazic2002sd@yahoo.com
Fax +249183582030 Phone: +249912896888

educational environment and the individual students' learning style, personal timetable and programme of work[3].

The aim of this study was to evaluate a key element of the curriculum – the course content – using pre- and post-testing as a direct method of evaluation. It is an institutional self evaluation process.

Background: The Faculty of Medicine and Health Sciences (F of M&HS) at Omdurman Islamic University is a public teaching institute. It is a member of the Union of Arab Universities and the African Union of Universities. The faculty is also an active member of the League Sudanese Medical Faculties and League of the Arab Faculties of Medicine. The faculty is registered in the WHO 'East Mediterranean'. Alumni of this faculty are either working or getting training in many different countries.

Its vision is to attain international standards and cooperation for the best future and its mission is the graduation of competent, humane, confident doctors. The strategic perspectives of F of M&HS are response to the accreditation needs and continuous evaluation processes, so its strategic themes are an effective curriculum and the educational environment.

The F of M&HS has designed a hybrid curriculum based on integration of basic and clinical medical sciences (integrated modules or courses). Each module in the curriculum is designed and executed by an interdisciplinary group or committee. The faculty adopts problem-based learning to develop observational, thinking and hypothesis capabilities in a completely independent method. The faculty encourages teaching from an Islamic perspective. Male and female students study separately, but they participate actively in all academic, social and cultural activities. Exams are held together.

The curriculum follows the recent advances in medical education. The concept of health for all people is well observed and practised and obeys the needs of the community. Practical training and skill development commence very early. Full implementation of the curriculum takes 204 weeks during which the student studies for 204 credit hours. This period plus the summer community activities and annual vacations make a total of 5 years divided into three phases.

Phase I: In this phase the student studies for 37 weeks in which he/she utilizes 37 credit hours of study. This is followed by a Primary Health Training Course and a Computer Course. The latter activities take 8 weeks followed by the annual vacation.

Phase II (this comprises the second and third years): The study period in this phase is 79 credit hours in 79 weeks in addition to field training. Annual vacation (8 weeks) is at the end of the first year. During the vacation supplementary and substitute exams are held. At the end of this phase training in Primary Health Care is held. Phase II was meant to adopt integrated problem-based teaching of medical sciences supplemented with early exposure to services in the affiliated medical facilities. Problems are designed to be furnished and discussed on a weekly basis.

Phase III (the fourth and fifth years): In this phase the student studies 88 credit hours in 88 weeks' rotational clerkship in hospitals. Examination is held at the end of each rotation. The exams are attended by a number of external examiners for validation.

The blood and lymph course is one of the phase II modules. It is designed to cover all the normal and abnormal aspects of the haematopoietic system including anatomy, physiology, biochemistry, pathology, pharmacology and clinical disorders of blood cells, bone marrow, lymph nodes, spleen and other lymphoid tissues. Transfusion medicine is also covered. The course duration is 5 weeks with 5 credit hours. Basic sciences and a nutrition course are prerequisites. The instructional methods of learning are lectures, laboratory practice, problem-based learning, computer-assisted learning and self-directed learning. Laboratory skills, seminars, assignments, task-based learning demonstrations or simulations, and clinical rounds are also used.

Methods: All pre-clinical medical students (114 males and 100 females) who attended

the introductory session of the blood and lymph course during the second semester of the second academic year 2008–2009, at the F of M&HS were involved in the study. The study used pre-test and post-test with no control group design. The intervening method was the blood and lymph course, conducted in the period from the 4 January to the 12 February 2009. The assessment instrument was a carefully designed test with 12 multiple choice questions selected in single response format. The first two questions were about blood physiology, the third and fourth about biochemistry of blood, while questions 5–8 were about haematopathology. The haematopathology questions covered the main haematology-related problems in the country and included iron deficiency anaemia, sickle cell anaemia, haemophilia and acute leukaemia. Question 9 was about safe blood transfusion. Microbiology related to blood was assessed through questions 10 and 11, whereas blood-related pharmacology was assessed through question 12. Data were analysed using the Statistical Package of Social Sciences (SPSS), version 15. The *t*-test (unpaired) was used for the difference of means. Pearson's correlation coefficient was used and $P < 0.05$ was considered as statistically significant.

Results: Table 1 summarizes the scores of all students in the pre- and post-tests of the blood and lymph course.

Table 1: The scores of all students in the pre- and post-tests of the blood and lymph course (mean score *P*-value < 0.000)

	Pre-test	Post-test
Number of students	214	214
Valid missing	0	0
Mean	4.6495	7.9953
Median	5.0000	8.0000
Mode	5.00	9.00
Std deviation	1.69051	2.17432
Minimum	0.00	1.00
Maximum	9.00	12.00

The mean scores of male and female students in the pre- and post-tests are shown in Table2.

Table 2: The mean scores of male and female students in the pre- and post-tests of the blood and lymph course.

Mean scores	Males	Females	*P*-value
Pre-test	4.7632	4.8100	0.838
Post-test	7.4561	7.7200	0.328

The percentages of students who selected the correct answers in each question are illustrated in Figure 1.

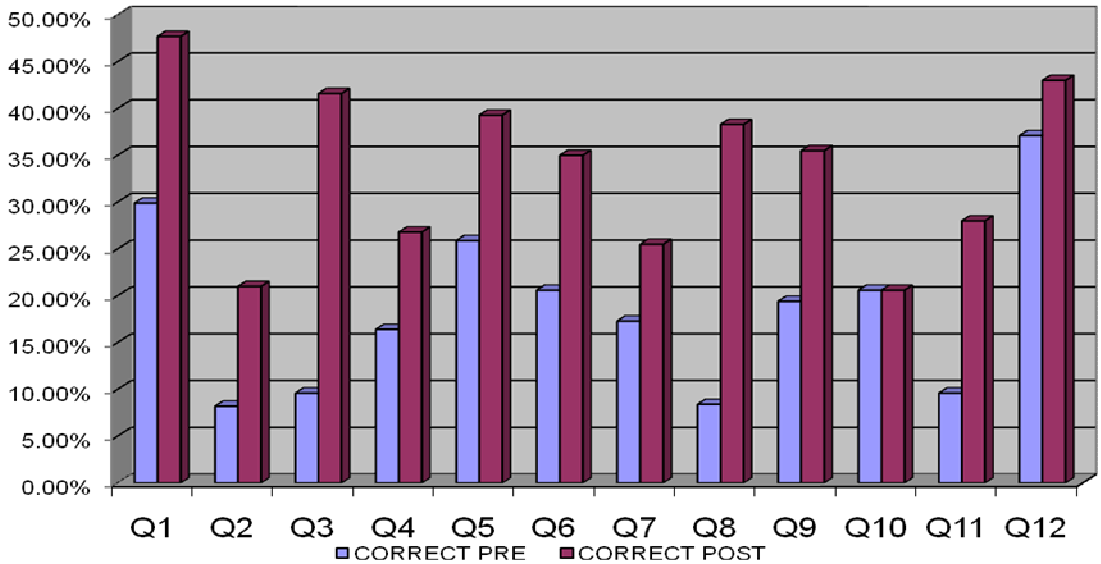

Figure 1. Percentages of students who selected the correct answers in the pre- and post-tests of the blood and lymph course (n = 214).

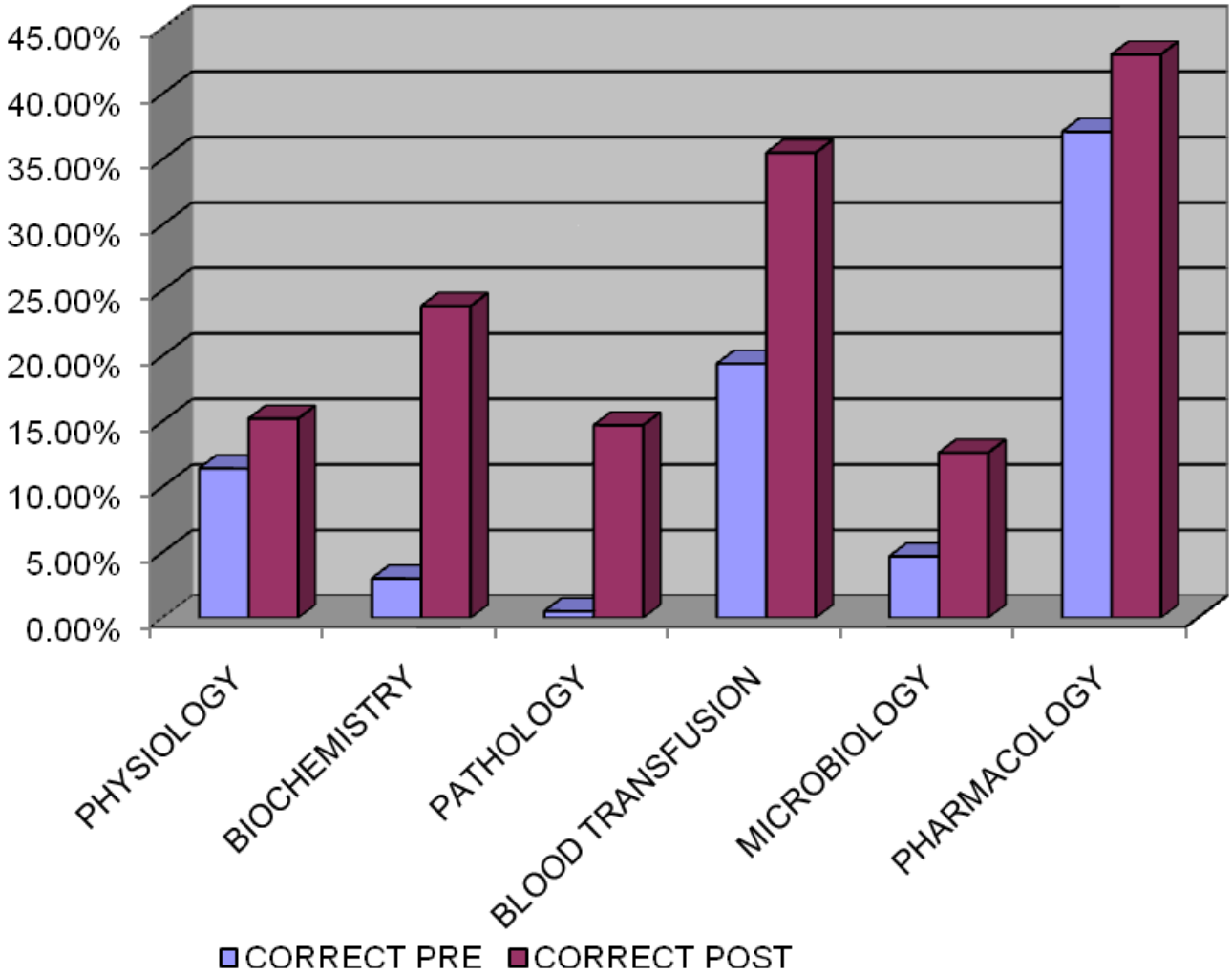

Figure 2 shows the percentages of students who selected the correct answers when the questions were grouped for the different participating disciplines.

Discussion

Pre/post-testing as a method of evaluation has been widely used to assess knowledge gain of programmes and curricula in a variety of sciences, including culture, computers, library and genetic counselling, as well as in different disciplines within the medical field, such as nutrition counselling for cancer patients and geriatric medicine[4-8]. In continuing medical education, Botash et al. used pre- and post-testing to assess knowledge changes in specific content areas and described a post-intervention competency assessment among practising medical providers and paediatric residents.[9] Moreover, pre- and post-testing can be used to test skills[10, 11].

One of the questions that came up in assessment is not only whether students can demonstrate the learning outcomes when they graduate, but how much of what they can demonstrate was actually gained during their time in the programme. This suggests the need to assess the students' knowledge and skills at the point of entry into the programme and, later, at the point of exiting the programme. In pre/post-testing assessment, student work is assessed both early and late in the academic career, from which the growth and development of the students can be deduced[12].

The pre- and post-tests are sometimes reported as the average normalized gain (g).

The latter is defined by Hake as the ratio of the actual average gain (%[post] – %[pre]) to the maximum possible average (100 – %[pre])[13]. The average normalized gain (g) of a course as the ratio of the actual average gain G to the maximum possible average gain $G_{)max}$ is calculated as follows:

$(g) \equiv \% G / \% G_{) max} = (\% [S_f] - \%[S_i])/(100 - \%[S_i])$

where S_f and S_i are the final (post) and initial (pre) class averages. 'High-g' courses are those with $g \geq 0.7$; 'medium-g' courses are those with $0.7 > g \leq 0.3$; 'low-g' courses are those with $g < 0.3$[13].

Hake, in his survey of pre/post-test data reported for 62 introductory physics courses, found that g is a valid measure of course effectiveness in promoting conceptual understanding, and that the interactive engagement courses are, on average, more than twice as effective in building basic concepts as traditional courses. He also concluded that the average normalized gain eliminates factors such as the initial knowledge level of the students or the popularity of the instructor and thus clearly assesses the teaching effectiveness of an individual instructor using a given pedagogical method[13]. Thus, pre/post-testing is a useful method of evaluation, not only for programme evaluation, but also for instructional methods and teaching effectiveness.

In this study, the mean post-test score was significantly higher ($P < 0.0001$) than the mean pre-test score (Table 1), and the average normalized gain of the blood and lymph course was 0.83, putting it in the 'high-g' group. This indicates the effectiveness of the curriculum.

In spite of the different course instructors for male and female students, there was no statistically significant difference in the scores of pre- and post-tests gained by male and female students (P-values 0.838 and 0.328) (Table 2). This indicates that gender difference does not affect gain of content knowledge. It also indicates that difference of instructors does not affect student gain of content knowledge.

The percentages of students who selected the correct answers for each question in the post-test are higher than those in the pre-test (Figure 1). When the questions are grouped for the different participating disciplines, the study reveals that the percentages of students who selected the correct answers in the post-test exceed those in the pre-test (Figure 2). This finding indicates that integration of the different basic and clinical disciplines related to haematological diseases resulted in a highly effective course for second-year medical students. The same conclusion was reached by Saleh et al. in a different study for a musculoskeletal disease course[14].

According to the Indiana University *Handbook of Assessment*, standardized or locally developed tests can be administered twice in a student's career to assess learning. However, if the test is exactly duplicated each time, then students may improve simply by having seen it twice. On the other hand, if different tests are administered on the two occasions, it can be difficult to ensure that both tests are of the same nature and difficulty, so the reliability of this method becomes questionable[2]. Therefore, it is preferred to use different evaluation methods.

Although locally developed pre- and post-tests require work by the programme's faculty in development and scoring, they are less costly than standardized tests and are often more meaningful in that they focus more clearly on the intended learning outcomes[2].

Evaluation of the course content helps in mapping the curriculum, which can help both staff and students by displaying the key elements of the curriculum mentioned above, and the relationships between them. Students can identify what, when, where and how they can learn. Staff can be clear about their role in the big picture. The scope and sequence of student learning is made explicit, links with assessment are clarified and curriculum planning becomes more effective and efficient. In this way the curriculum is more transparent to all the stakeholders including

teachers, students, the curriculum developer, the manager, the public and the researcher[3].

The present study is a step in the right direction and we agree with Hake that improvements in future assessments might be achieved through standardization of test-administration practices; use of a survey questionnaire refined and sharpened in light of the present experience; observation and analysis of classroom activities by independent evaluators; and use of questionnaires which assess student views on science and learning[13].

Conclusion

This study concluded that the curriculum content of the blood and lymph course is effective in increasing students' knowledge about the haemopoietic system and that the difference of instructors or gender does not affect student gain when the objectives and instructional methods of teaching are well designed. Evaluation of the course content makes curriculum mapping more effective and efficient. We believe other institutions should consider the use of pre- and post-tests as a useful direct method of programme evaluation.

Acknowledgement

We are extremely grateful to Mrs. Christin Sharrock and Mr. Gavin Sharrock (WILEY-BLACKWELL, Oxford, UK) for correcting the English language of this paper, putting fine touch, besides their support and encouragement.

References:

1. Jonas HS, Etzel SI, Barzansky B. Educational programs in US medical schools. JAMA 1992; 268(9):1083-90.
2. Dobbie A, Rhodes M, Tysinger JW, Freeman J. Using a modified nominal group technique as a curriculum evaluation tool. Fam Med. 2004; 36(6):402-6.
3. Harden RM. AMEE Guide No. 21: Curriculum mapping: a tool for transparent and authentic teaching and learning. Med Teach 2001; 23(2): 123-137.
4. Pilcher ES, Charles LT, Lancaster CJ. Development and assessment of a cultural competency curriculum. J Dent Educ 2008; 72(9): 1020-8.
5. Devitt P, Palmer E. Computers in medical education 1: evaluation of a problem-orientated learning package. Aust N Z J Surg 1998; 68(4): 284-7.
6. Dunn K, Crow S J, Van Moorsel T G, et al. Mini-Medical School for Librarians": from needs assessment to educational outcomes. J Med Libr Assoc 2006; 94(2): 166-73.
7. Kolasa KM, Jobe AC, Miller MG, et al. Teaching medical students cancer risk reduction nutrition counseling using a multimedia program. Fam Med 1999; 31(3): 200-4.
8. Swagerty D Jr, Studenski S, Laird R, et al. A case-oriented web-based curriculum in geriatrics for third-year medical students. J Am Geriatr Soc 2000; 48(11): 1507-12.
9. Botash AS, Galloway AE, Booth T, et al. Continuing medical education in child sexual abuse: cognitive gains but not expertise. Arch Pediatr Adolesc Med 2005; 159(6): 561-6.
10. Carr SE, Carmody D. Outcomes of teaching medical students core skills for women's health: the pelvic examination educational program. Am J Obstet Gynecol. 2004; 190(5):1382-7.
11. Kromann CB, Jensen ML, Ringsted C. The effect of testing on skills learning. Med Educ 2009; 43(1): 21-7.
12. Sobhy SI, Shoeib FM, Zaki NH. Assessment and upgrading of Alexandria University nursing students' knowledge and attitudes about genetic counseling. J Egypt Public Health Assoc 2001; 76(3-4): 205-22.
13. Hake RR. Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. Am J Phys. 1998; 66 (1): 64-74.
14. Saleh K, Messner R, Axtell S, et al. Development and evaluation of an integrated musculoskeletal disease course for medical students. J Bone Joint Surg Am. 2004 Aug; 86-A(8):1653-8.