

Original Research Article

Evaluation of quality of MBBS Biochemistry theory question papers of medical institutions in Maharashtra

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ABSTRACT

Background: In medical curricula, the assessment of cognitive domain of learning is through written theory examination. At present questions are prepared casually just before the examination and are not put through any quality check to assess reliability, validity, educational impact, and acceptability.

Methods: This study was conducted to retrospectively review and evaluate question items in Biochemistry examination question paper, according to specified criteria with the intention to determine its quality and design. A total of 14 preliminary examination question papers were collected by request from medical colleges affiliated to Maharashtra University of Health Sciences, Nashik; to evaluate selection of topics, their weightage, cognitive level, difficulty level and types of MCQ, SAQ and LAQ items, as per prescribed structure and protocol of question setting. The data was compiled in Microsoft excel, and coefficient of variation was calculated for each parameter tested.

Results: There was variation in the topic wise distribution of marks in relation to lecture hours and weightage assigned to each topic. In general, there was inconsistency and nonconformity with respect to the characteristics for maintaining quality. Inadequacy of testing higher cognitive levels and lack of case based and application type of questions was observed.

Conclusions: The quality of question paper setting can be improved by introducing blue print in assessment system. The use of the blue print will ensure consistent high standard of question presentation, which will help students to understand the questions better and to answer them correctly.

Keywords: Biochemistry, Cognitive domain, MBBS, Summative evaluation

INTRODUCTION

Assessment of students is a very important input to judge the value of an educational programme. Assessment in medical education is especially important because we are certifying students as fit to deal with human lives. The means of evaluation of students is based on their performance in examination. A question paper is thus a basic tool used in a written examination. The quality of the question paper that is set assumes special importance because it is related to measurement of the change in the

level of students' knowledge in a subject. Types of question paper differ with types of assessment (Formative or summative) and objectives of examination.

Written assessment methods are used to assess the level of comprehension, ability to analyze, synthesize, and organize information. Unfortunately, assessors end up testing recall abilities and factual knowledge. Bloom's taxonomy of learning defines three domains of learning: cognitive (knowledge), psychomotor (practical skills), and affective (attitudes).¹ But in written format of

question paper mainly cognitive domain can be assessed. The cognitive domain is further subdivided into different hierarchical levels of knowledge that can be tested; viz. knowledge, comprehension, application, analysis, synthesis and evaluation. This is modified into three main subdivisions as shown in Table 1 (knowledge, comprehension, application).

There is no doubt that this taxonomy of learning provides useful insight into the design of assessment and construct questions from higher levels of Bloom's taxonomy, improving the quality of questions.

As per regulations on graduate medical education in phase I of the M.B.B.S. course, every student undergoes a period of study of pre-clinical subjects for two semesters. At the end of second term there is 1st professional university examination. In the curricula prescribed by Maharashtra University of Health Sciences (MUHS) at Nashik, the first two semesters are devoted to introduction to a broader understanding of the perspectives of medical education leading to delivery of health care. Minimum teaching hours are prescribed in various disciplines for two semesters, of which approximately 240 hours are allocated to the subject of Biochemistry. The broad goal of the teaching of undergraduate students in biochemistry with special emphasis on objectives to be attained at the end of the course has been clearly specified in the syllabus. In the syllabus, the topics have been classified into three broad categories. viz. 1) must know (MK) 2) desirable to know (DK) 3) nice to know (NK), which can serve as guidelines to decide weightage to be considered while setting the paper.

The knowledge acquired in biochemistry shall help the students to integrate molecular events with structure and function of the human body in health and disease. Hence it is expected that paper setters should design and implement strategies so that the contents and format of the question paper is appropriately aligned with the objectives. A good question design should have clarity, reliability, validity, authenticity and fairness. As per MUHS guidelines, a Biochemistry question paper should typically include Multiple Choice Questions (MCQs), Short Answer Questions (SAQs) and Long Answer Questions (LAQs). These questions can assess only the cognitive domain in such written examinations.

Each of these methods of evaluation is unique and affords several advantages. It measures the students' knowledge, abilities in written expression, ability of organising and expressing ideas effectively. The examiner is satisfied that a few in-depth questions can provide a sufficient sample of the content to be tested. It permits analysis, synthesis and development of a topic and students reasoning is rewarded

The proper design of the question paper, due weightage to specific contents of the syllabi and appropriate

selection of questions are some of the important points that are usually missed out or overlooked by paper setters. Sometimes paper setters prefer difficult questions and strict evaluation to identify intelligent students and prevent unfair copying practice during examination sessions. But they fail to realize that this might have a negative impact in terms of student learning and also the student should bear consequences for being wrongly failed due to wrong assessment decision.

This happens because, in the traditional assessment system in most medical colleges in India, question paper is set by one teacher/examiner and practical examinations are conducted by some other teacher, without any co-ordination. Papers are set without any consideration to see whether questions are aligned with the objectives.² Often, the content of what to assess is left to the decision of the examiners. The assessment needs to be valid. Validity is a requirement of every assessment and implies that candidates for achieving the minimum performance level the student has acquired the level of competence set out in the learning objectives.³ Content of assessment is said to be valid when it is aligned with the objectives of learning. And this process can be facilitated by using blueprinting in assessment.³ Blueprint is a map and a specification for an assessment program that ensures that all aspects of the curriculum and educational domains are covered by assessment programs. Blueprint links assessment to learning objectives according to the accepted norms and guidelines.⁴⁻⁶

Thus, this study was conducted to retrospectively evaluate the preliminary (summative) question papers of colleges affiliated to MUHS, with a view to know the preferential inclusion/exclusion of selected topics and their weightage, level of cognitive domain being tested, difficulty level of questions; and identify what type of MCQ, SAQ and LAQ that were selected for the question paper design. Most of the time Blue print method is not adopted by examiners prior to paper setting. Usually a blue print is first prepared and then the examiner sets the paper as per the format of the blue print. In the present study, it was presumed that blue print was not prepared prior to setting the question paper. Question papers were analysed to find out whether the quality of questions has met the expected standards that are usually observed by using a blueprint. This study also aims at showing that there is a dire need to implement a routine practice of blue print prior to setting a question paper; to improve validity and reliability of our testing methods.

Preliminary examination conducted at college level was considered because MCQ data of the University final examination question papers is held confidential and not accessible for analysis. Also, preliminary examination is a summative evaluation and hence the pattern of question paper is identical to the final University examination paper. The complete question paper data was voluntarily provided by the colleges on request, for analysis. Moreover, the marks are also computed towards the

internal assessment. However much the prelim exam paper is a sample representative of the final university exam paper, it remains a limitation of the present study.

METHODS

The study was conducted in the Biochemistry Department of HinduHrudaySamrat Balasaheb Thackarey Medical College (HBTMC) and Dr. R.N. Cooper Municipal General Hospital, Mumbai; affiliated to Maharashtra University of Health Sciences, (MUHS) Nashik. There are two separate question papers for the Biochemistry theory written examination: Paper I (50 Marks) and Paper II (50 Marks).

Each paper is of two and half hour duration. In each paper, students are required to attempt 20 Multiple Choice Questions (MCQs), carrying ½ mark each (total 10 marks), any 6 out of 7 short answer questions (SAQs) carrying 4 marks each (total 24 marks) and any 2 out of 3 long answer questions (LAQs) carrying 8 marks each (total 16 marks). A total of 62 marks are assigned for all the questions set for each paper. But considering the options given, the students attempt only 50 marks questions. The entire 1st year MBBS syllabus in Biochemistry has been clubbed into 10 topics for paper I and 12 topics for paper II, with specific number of lecture hours for each topic and division of topics as 1) must know, 2) desirable to know and 3) nice to know (Table 1).

A total of 14 theory Biochemistry question papers (7 of paper 1 and 7 of paper 2) for written preliminary examination conducted in April 2017 were collected by request from seven different colleges affiliated to MUHS. The quality of each paper was analysed and evaluated to determine

- Relative proportions (as percentage) of marks assigned to each topic
- The frequency of must know, desirable to know and nice to know topics expressed as percent marks
- Difficulty level of questions (simple, moderate, difficult)
- Appropriateness of marking scheme, (division of marks provided for structured type of question)
- Level of cognitive domain being tested, by identifying verbs used in the questions as per Bloom’s hierarchy of cognitive learning (recall, comprehension, application).
- Identification of the choice of different types of MCQ, SAQ and LAQ.
- Whether questions are aligned with specific objectives as prescribed in the syllabus.

Statistical analysis

The data was compiled in Microsoft excel, presented as tables and graphs and analysed in terms of proportion and

represented in percentages. Coefficient of variation (CV) was calculated for each parameter tested.

RESULTS

Table 1 shows Bloom’s revised taxonomy with levels of cognitive domain and corresponding illustrative verbs.

Table 1: Bloom’s revised taxonomy showing levels of cognitive domain and corresponding illustrative verbs.

Level	Definition	Sample verbs
Knowledge	Student recall or remembers ideas and principles in the approximate form in which they were learned.	Write, list, label, name, state, define
Comprehension	Student explain ideas or concepts, translates, comprehends and interprets information based on prior learning	Explain, summarize, paraphrase, describe, illustrate
Application	Student selects transfer and uses data to complete problem or task	Use, compute, solve, demonstrate, apply, construct

Table 2 illustrates number of hours of lectures for each topic in Paper I and Paper II; including subdivision of topics as 1) must know (MK) 2) desirable to know(DK) and 3) nice to know (NK). The number of hours of lectures are assigned in proportion to the importance of the topic, as indicated under these subdivisions.

Figure 1a and Figure 1b depicts the distribution of marks for each topic of paper I and paper II, respectively, expressed as percentage of the total marks of the paper; and the graphical representation of their coefficient of variation (CV) is also shown.

In general, there was no uniformity observed on comparing the distribution of marks with the lecture hours assigned to each topic. It was observed that the weightage in terms of percentage of marks assigned to some of the topics was either too high (excess) or too low (deficit) in relation to no. of hours of lectures indicated in Table 1. In some question papers, either the question was out of syllabus or selected from topics of paper I instead of paper II and vice versa.

It was observed that in paper I the CV values for different topics ranged from 0.21 to 1.6, and in paper II, CV values ranged from 0.12 to nearly 1.4, indicating marked variation in the frequency of appearance of a topic in the question papers, analysed.

Table 2a: Distribution of lecture hours as per MUHS curriculum (Paper I).

Topics	No. of hours		Percent hours
Cell, subcellular components	1	DK	2%
Enzymes, clinical applications	6	MK	14%
Chemistry and metabolism of proteins	10	MK	23%
Chemistry and metabolism purines and pyrimidines	4	MK	9%
DNA, RNA, genetic code, lac operon	5	MK	12%
Genetic engineering	2	DK	5%
Chemistry and metabolism haemoglobin	3	MK	7%
Biological oxidation	2	MK	5%
Body defence	2	DK	5%
Vitamins nutrition	8	MK	18%
Total	43		100%

MK: must know; DK: desirable to know; NK: nice to know

Table 2b: Distribution of lecture hours as per MUHS curriculum (Paper II).

Topics	No. of hours		Percent hours
Carbohydrate chemistry and metabolism	10	MK	26 %
Lipid chemistry and metabolism	10	MK	26 %
Mineral metabolism and water electrolyte	6	MK	15 %
Acid base balance	2	MK	4 %
Integration of metabolism and starvation	2	DK	4 %
Mechanism of hormones action	1	MK	3 %
Environmental biochemistry	1	NK	3 %
LFT, RFT and TFT	3	MK	7 %
Detoxification	1	MK	3 %
Cancer	1	NK	3 %
Radioisotopes	1	MK	3 %
Lab techniques	1	MK	3 %
Total	39		100 %

MK: must know; DK: desirable to know; NK: nice to know

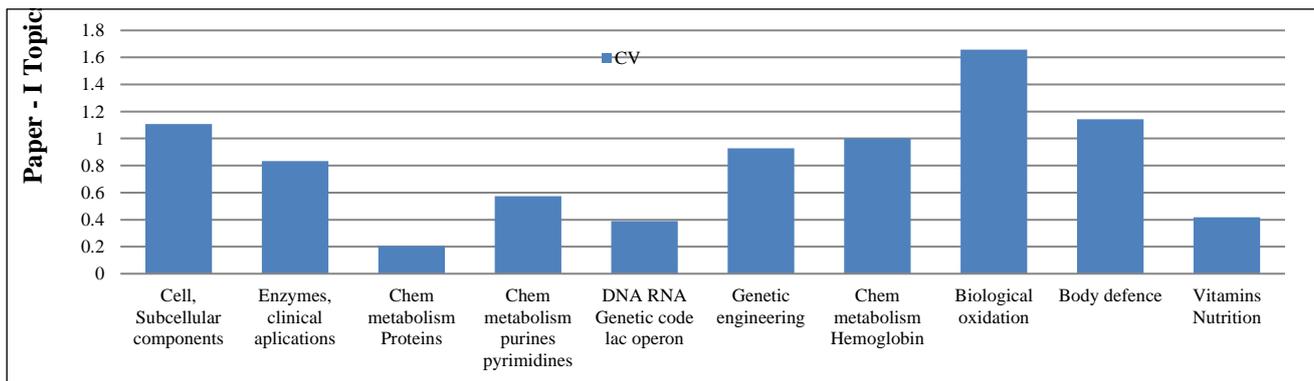


Figure 1a: Topic wise CV of percentage marks of paper I.

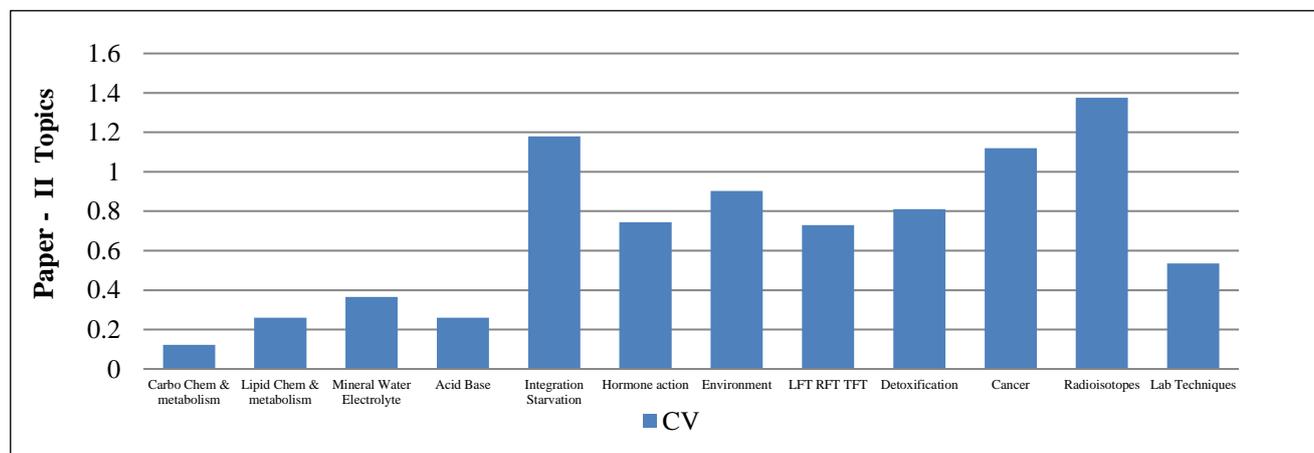


Figure 1b: Topic wise CV of percentage marks of paper-II.

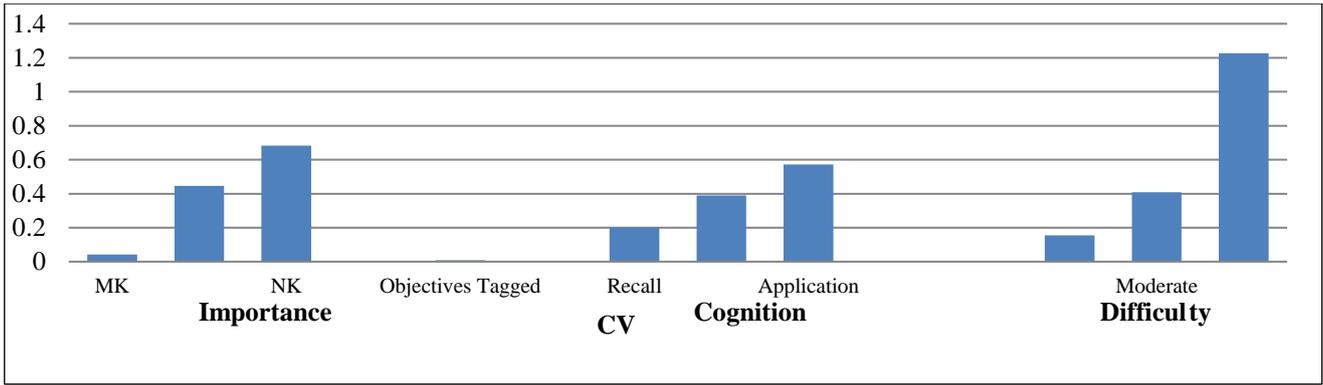


Figure 2a: CV of percentage marks for different levels of importance, cognition, and difficulty for paper-I.

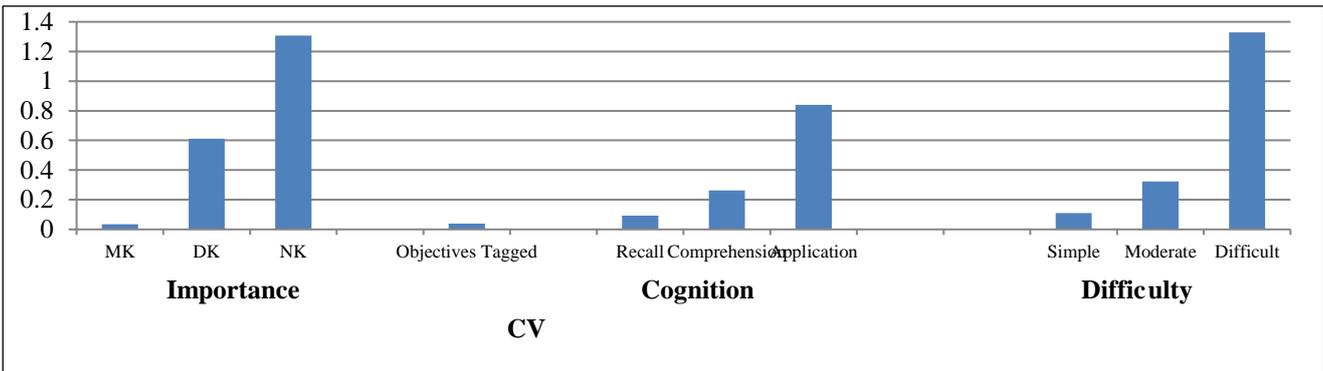


Figure 2b: CV of percentage marks for different levels of importance, cognition, and difficulty for paper-II.

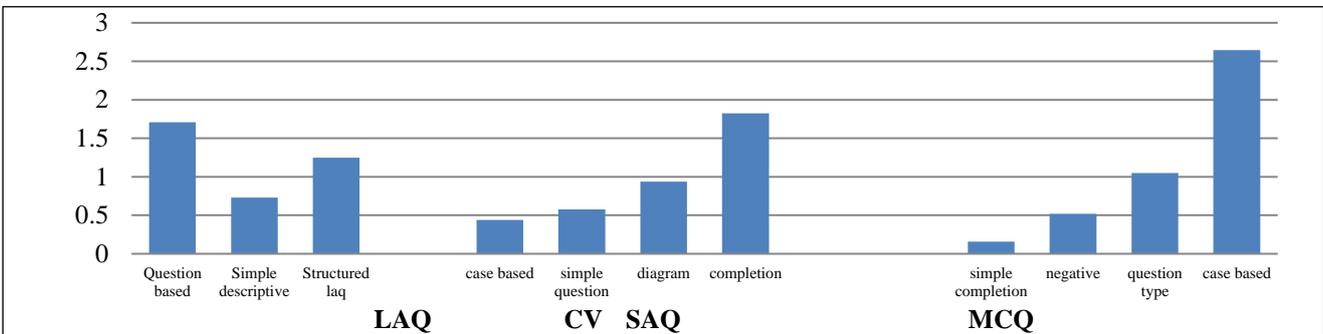


Figure 3a: CV values for different types of LAQ, SAQ and MCQ of paper-I.

The questions of Paper I and Paper II were transposed on excel sheet to analyse

- Must know, desirable to know and nice to know category,
- Level of Cognitive domain i.e. Recall, comprehension & application
- Difficulty Level i.e. simple, moderate, difficult,
- Alignment of questions with objectives of learning.

The content of the question papers in relation to the above four characteristics was further evaluated and expressed as percentage of total marks and coefficient of

variation as shown in (Figure 2a and 2b). The CV values ranged from 0.01 to 1.23 for paper I and from 0.03 to 1.33 for paper II, indicating variability, inconsistency and nonconformity to observance of any standardized norms with respect to the characteristics for maintaining quality.

It has been observed that wherever structured questions were asked, separate marking for the subdivisions was not indicated. However, in each paper, it appears that, proper care was taken to prevent repetition of the same topic in two different questions. The results of analysis of different types of MCQs, SAQs and LAQs and their respective CV values are presented in Figure 3a and 3b. The values in the table represent the actual number of the

type of questions. On comparing the CV values of different types of questions, it is observed that in all the

14 papers most of the MCQs were simple completion type.

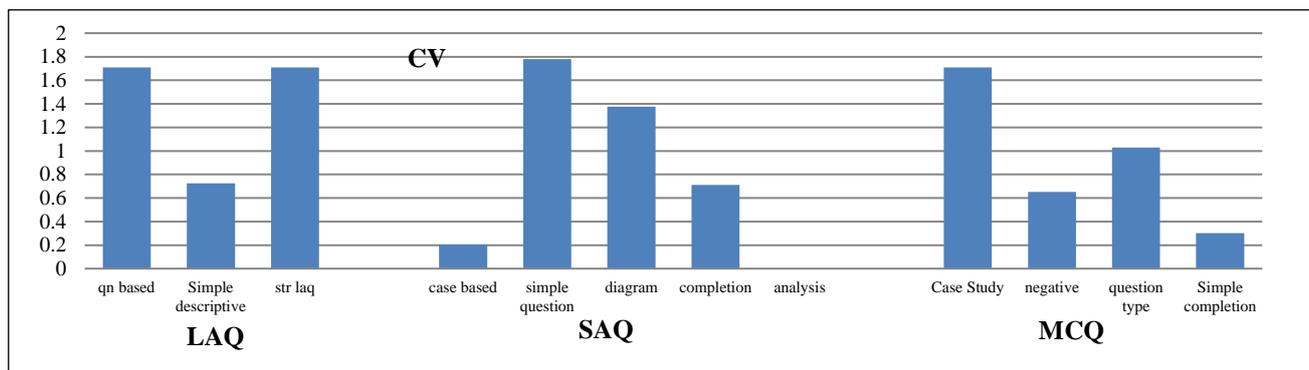


Figure 3b: CV values for different types of LAQ, SAQ and MCQ of paper-II.

Most SAQs were either completion type or simple question type and at least two cases based SAQs appeared in all the papers. Analysis type of SAQ was not observed in any of the papers. Significant variation in the number of different types of LAQs was observed, wherein simple descriptive type was the most preferred choice.

DISCUSSION

Written examination serves an important tool for evaluation of students in summative assessment. MCQ, SAQ and LAQ type of questions can measure the levels of cognitive domains using Bloom’s taxonomy.⁷ Any form of assessment needs to be evaluated considering five criteria: reliability, validity, educational impact, cost effectiveness and acceptability.⁸

In the present study, it is evident that there is no uniformity in the assignment of marks to different subdivisions of the topics. Weightage to the content areas is a delicate issue on which even the experts often differ in opinion. It has also been cited, that the weightage of various topics depended mainly on the examiners own judgment.⁹ Although topics are broadly categorized in the MUHS syllabus as MK, DK and NK, there is yet no official guidelines regarding the weightage to be given to different topics in Biochemistry.

So, teachers select questions based on their own personal judgement. For eg. topic like cancer is either given more weightage than required or it is totally deleted from the content (Figure 1a and 1b). If you arbitrarily take 0.4 as the cut-off CV, then some topics with CV <0.4, show agreement whereas in case of some other topics with CV >0.4 there is no consensus in the topic selection process for setting the question paper.

Maximum weightage was given to must know topics by all colleges and this is evident from CV <0.4 for paper I and Paper II (Figure 2a and 2b). As per CBME system encouraged by MCI, this traditional must know areas of syllabus are actually the core competencies. The competency statements covered under the must know areas in Biochemistry are stated below:

The student must demonstrate an understanding of:

- Biochemical and molecular processes involved in health and disease,
- Importance of nutrition in health and disease,
- Biochemical basis and rationale of clinical laboratory tests and demonstrate ability to interpret these in the clinical context.

The problem is mainly centered around the “nice to know” and “desirable to know” areas, which are the noncore competencies. To what extent should we test or assess the non-core competencies at the UG level is still a debatable issue, and is often tainted by personal subjective bias by most paper setters. In the present study, for DK and NK topics the CV is greater than 0.4, indicating variation in the inclusion or exclusion of these subdivisions of subject topics and their weightage. As illustrated in Figure 2a and 2b, it is evident that examiners rely mainly on simple recall type of questions. (CV <0.4). The reason being, such type of questions is easy to set and less time consuming. But, disappointingly they fail to assess the higher cognitive level of student learning. At the expense of some time and effort along with training, examiners can be sensitized and trained in utilizing resources to frame MCQs, SAQs and LAQs that can test higher cognitive domains of learning (Table 1).

The suggested distribution of the cognitive level of questions is recall type-50%, comprehension-25% and application-25% for preclinical subjects like

Biochemistry. However, in the present study several deviations from this standard were observed. The proportion of recall type questions was much higher than 50%, and application types questions amounted to less than 10%.

Most of the LAQs were either simple descriptive type or question based. There was hardly any structured type of LAQs (Figure 3a and 3b). While testing, using essay type questions, the level (UG/PG) of students should be kept in mind. Secondly, the objectives should be clear and precise. And thirdly, construction must include different domains to be tested. In traditional essay type questions, phrases used such as: what do you think? what do you know? what is your opinion? write all about, describe and discuss; has the limitations of very low reliability, validity and objectivity. Instead use of words like define, enlist, name, enumerate, compare, explain, outline, state pros and cons, state reasons and summarise; can be used to overcome these limitations. Further one can frame structured questions, include checklists and make problem based LAQS, to allow the student a more in-depth exploration of subject material and to build and structure an argument.

As shown in Figure 3a and 3b, the SAQs were mostly simple question type or completion type. SAQs can be used best for lower to middle part of the cognitive domain - testing knowledge, comprehension, application and analysis. It cannot test non-cognitive skills such as communication skills, interpersonal and psychomotor skills. It has the advantage of covering a large topic area and there is consensus amongst examiners on expected answers.

Objectivity and reliability is enhanced and moreover it focuses on testing attainment and application of knowledge. Two cases based SAQs were included in all the papers. This was probably noticeable due to strict adherence to MUHS guidelines for setting of question papers, wherein examiners are instructed to frame at least two cases based SAQs.

MCQs were mainly simple completion and negative statements. Only in paper II few case based MCQs were included. Cognitive domains can be evaluated at different levels including knowledge, comprehension, application, analysis, synthesis and evaluation.

Modified Bloom's taxonomy identifies three levels of cognitive domain.¹⁰ With some time, effort and training it is possible to develop MCQs that will evaluate the level III or problem-solving skills, as most of the physician's time is spent in analyzing patient's problems.¹¹ A valid MCQ question should be able to measure achievement of the intended learning outcomes of the module/unit and not just what is easy to measure.

In deciding the importance, weightage, cognitive level, difficulty level and selection of different types of LAQ,

SAQ and MCQ questions it becomes imperative to develop some standard, may be in the form of a blue print plan. In the Biochemistry syllabus prescribed by MUHS, the desirable to know topics and nice to know topics are very broadly cutoff from the main stream of important topics. Instead, it would be more advisable to label all topics as MK; and within some of the topics there should be further demarcation of MK, DK and NK subdivisions.

CONCLUSION

All in all, the evaluation of question papers revealed no uniformity in the assignment of marks to different subdivisions of the topics, variation in the inclusion or exclusion of MK, DK, NK subdivisions of subject topics and their weightage. Moreover, higher cognitive domains of learning were not tested, reflecting low reliability, validity and objectivity; without any indication of markers to discriminate between different levels of performance.

This lack of quality of the marking guidance and clarity of the assessment criteria can be overcome by use of a blue print plan. Blue print ensures that the test has been developed and mapped carefully against the educational objectives of the course. It also indicates the marks carried by each question, maintaining consistency and reproducibility in grading. It is useful to prepare a blueprint so that the faculty who sets question paper knows which question will test which objective, which content unit and how many marks it would carry.¹² Blueprinting helps to match various competencies with the course content and the appropriate modality of assessment.¹³ Teachers' paper setting skills can be improved through training and opportunities to learn from more experienced assessors. Lastly, one must ensure fairness in assessment so that students get a fair chance to demonstrate what they know and can do and to be able to succeed in examinations.

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