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Original Research Article

Developing a blueprint for summative theory assessment in pharmacology as per the 2024 competency-based medical education (CBME) curriculum

Shailendra Dandge[1]*, M Sneha Manju[1], MD Amirunnisa Begum[1]

[1]Dept. of Pharmacology, MediCiti Institute Medical Sciences, Ghanpur, Telangana, India

Abstract

Background: Blueprinting is designing a structured framework that outlines the assessment content, aligning with learning objectives and assigned weightage. Developing a CBME-based pharmacology blueprint is essential, therefore the present study was conducted.
Objectives: 1. To develop a valid and structured blueprint for the summative written theory examination in pharmacology. 2. To assess the weightage assigned to various topics in 2nd MBBS pharmacology university summative theory examinations. 3. To compare topic weightage in the developed blueprint and weightage assigned to that topic in university theory examination.
Materials and Methods: All competencies outlined in the CBME guidelines, were evaluated for Impact i.e. pharmacological importance (I) and Frequency based on teaching importance (F). The weightage for each competency was calculated by multiplying I X F, summing these values to obtain T, and deriving the Weightage Coefficient (W = I X F/T). The final weightage was estimated by multiplying W with the total marks for each paper (100 marks). Comprehensive analysis of 12 theory question papers was done to calculate weightage for various topics based on their mark's distribution.
Results: Blueprints were developed to guide the design of the Pharmacology Summative Theory Examination for Paper I and Paper II. In Paper I, General Pharmacology received the highest weightage, i.e. 37 marks, followed by the Central Nervous System. In Paper II, Chemotherapy received the greatest weightage of 39 marks, followed by the Cardiovascular System and Blood.
Conclusion: The analysis revealed non-uniform year-to-year distribution of marks across pharmacology topics in summative theory examinations. The developed blueprints were aligned with the 2024 CBME guidelines.

Keywords: Blueprint, Pharmacology, Competency – Based Medical Education, Summative assessment

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1. Introduction

The National Medical Commission (NMC) introduced the Competency-Based Medical Education (CBME) curriculum in 2019. The implementation of CBME marks a significant transformation from a traditional knowledge-based system to an outcome-oriented approach that emphasizes on competency acquisition through integrated learning and assessment.[1] Furthermore, in 2024, the NMC revised the CBME curriculum with several updates to ensure its effective implementation. These revisions are detailed in the Competency-Based Medical Education (CBME) Guidelines, 2024 – National Medical Commission, and are applicable for the MBBS batch of 2024–25 onwards.[2]

The CBME curriculum emphasizes effective learning by specifying the competencies to be achieved for each topic along with the corresponding instructional time. These competencies are further classified into two categories: core competencies and non-core competencies, based on their clinical relevance.[3]

The curriculum further highlights the importance robust assessment systems, given that assessments drives systematic, conceptual and effective learning. Summative assessments conducted at the end of course are therefore considered essential for evaluating student's competence and overall proficiency. In this context, blueprinting serves as a critical tool and vital mechanism for developing structured and evidence-based assessment strategies that ensure

*Corresponding author: Shailendra Dandge
Email: shailendra962@gmail.com

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alignment between learning objectives, instructional methods, and evaluation processes.[4-6]

Blueprinting can be defined as the development of a structured framework or template that determines the content of an assessment. It outlines the number and types of questions distributed across the course content, aligned with specific learning objectives and the relative weightage assigned to each topic.[7,8]

A blueprint provides a systematic, multi-step approach to an assessment design by clearly defining the purpose (e.g., formative or summative; written or practical) and the scope (e.g., undergraduate or postgraduate level) of the examination. This structured process subsequently guides the selection of appropriate content and methods of assessment.[9]

Hence, developing a blueprint for assessment in Pharmacology based on the CBME curriculum 2024 guidelines, will play a pivotal role in strengthening the validity of assessment and ensuring adequate balance over the course content so that there is no over-representation or under-representation of any topics. Additionally, it also serves as a guide for question paper setters and medical undergraduates.[10] In view of the limited published literature and absence of an existing blueprint for summative assessments in pharmacology as per the 2024 CBME Curriculum, the present study was undertaken with the following objectives.

2. Objectives

1. To develop a valid and structured blueprint for the summative written theory examination in pharmacology Paper I and Paper II for 2nd MBBS undergraduates.
2. To assess the weightage assigned to various topics in 2nd MBBS pharmacology university summative theory examinations.
3. To compare topic weightage in the developed blueprint and weightage assigned to that topic in university theory examination.

3. Materials and Methods

After obtaining Institutional Ethics Committee approval (Approval Number: EC/21/III/2K25/9), this study was conducted in the Department of Pharmacology, MediCiti Institute of Medical Sciences. The 2024 revised CBME curriculum, prescribed by the National Medical Commission (NMC) was considered for this study.

After reviewing the published literature on blueprinting in Pharmacology and other medical subjects,[4,6,11] a stepwise process was adapted for developing a blueprint as described below:

All the competencies outlined in the second-year undergraduate CBME curriculum for the Indian Medical Graduate (IMG), were listed initially. The competencies with knows or knows how level of competencies were included in this study. The division of topics for Theory Paper I and Paper II in Pharmacology was considered as per the KNRUHS guidelines.

Each competency or its subdivision was assessed for Impact according to its pharmacological importance (I) and Frequency was assessed based on teaching importance (F).

The Impact (I) i.e. pharmacological importance of each competency was determined and assigned a score 1 or 2 considering the core competencies i.e. must know and non-core competencies i.e. desirable to know or nice to know content as prescribed in CBME curriculum.[4]

1. Score of 1 was allotted to competencies of lesser/moderate pharmacological relevance containing non- core competencies
2. Score of 2 for competencies of high pharmacological relevance representing core competencies.

The Frequency (F) i.e. teaching importance of each competency in pharmacology was calculated by number of teaching hours allocated for the competencies.[11] Competencies with broader objectives or subdivisions were allocated higher instructional hours. Based on the proportion of teaching time for competencies, a score from 1 to 3 was allotted:

1. Score of 1 for competencies with 1 hour of instruction,
2. Score of 2 for competencies with 2 hours, and
3. Score of 3 for competencies with > 2 hours.

After obtaining the Impact (I) and Frequency (F) scores, the weightage of each competency was calculated in the following steps:

1. The product of I × F was computed for each competency.
2. The total sum of all I × F values was denoted as T.
3. The Weightage Coefficient (W) for each competency was derived using the formula: W=I X F /T
4. Finally, the weightage of each competency was estimated by multiplying its Weightage Coefficient (W) with the total marks allotted for each paper. (i.e. 100, this as per the university guidelines, the total marks allotted for Pharmacology summative theory assessment are 200. (Paper I and Paper II carry 100 marks each).

A retrospective analysis was conducted on 2nd MBBS pharmacology theory question papers from KNRUHS, covering the period from April 2022 to July 2024. Yearly, two university examinations are conducted by KNRUHS, each theory examination has two question papers, Paper I & Paper II. A total of 12 theory question papers, each with 100 marks weightage, were included in this study. The weightage

for various topics in Paper I & Paper II, depending on their mark's distribution (expressed as marks %) in the question papers was calculated.

The topic weightage in the developed blueprint and weightage assigned to that topic in university theory examination was compared and analysed.

Statistical analysis: The data was entered and analysed using Microsoft Excel 2019 version. Results were presented in percentages and summarised as tables.

4. Results

As per the methodology mentioned above, two blueprints were developed to guide the design of the Summative Theory Examination for Paper I and Paper II in Pharmacology for second-year MBBS students. Each blueprint was constructed by systematically mapping the prescribed competencies as core/ non-core competencies for Impact (I) and assigning proportional teaching importance as Frequency (F) of each topic based on the allocated instructional hours.

Based on the calculations, the cumulative sum of I × F for all competencies classified as 'T' was 163 for Paper I and 145 for Paper II. In Paper I, General Pharmacology received the highest weightage, accounting for 37 out of 100 marks, followed by the Central Nervous System (CNS) with 20 marks. In Paper II, Chemotherapy received the greatest weightage of 39 marks out of 100, followed by the Cardiovascular System and Blood (CVS & Blood) with 33 marks. The blueprints with detailed distribution of weightage for each competency across individual topics for Paper I and Paper II were calculated and presented as in Tables 1 and 2, respectively.

Table 1: Blueprint for pharmacology paper I

Topics	Competency	I	F	I X F	W	W x100	Total marks for topic	Adjusted marks out of 100
General pharmacology (G.P)	PH 1.1	2	2	4	0.0245	2.45	36.81	37
	PH 1.2	2	2	4	0.0245	2.45		
	PH 1.3	2	1	2	0.0122	1.22		
	PH 1.4	2	3	6	0.0368	3.68		
	PH 1.5	2	2	4	0.0245	2.45		
	PH 1.6 (Absorption)	2	2	4	0.0245	2.45		
	PH 1.6 (Distribution)	2	2	4	0.0245	2.45		
	PH 1.6 (Biotransformation)	2	2	4	0.0245	2.45		
	PH 1.6 (Excretion)	2	2	4	0.0245	2.45		
	PH 1.7 & PH 1.8	2	2	4	0.0245	2.45		
	PH 1.9	2	2	4	0.0245	2.45		
	PH 1.10	2	2	4	0.0245	2.45		
	PH 1.11	2	3	6	0.0368	3.68		
	PH 1.12	2	2	4	0.0245	2.45		
	PH 1.13	2	1	2	0.0122	1.22		
Autonomic nervous system (ANS), Peripheral nervous system (PNS), Autacoids	PH 2.1	2	3	6	0.0368	3.68	19.63	20
	PH 2.2	2	3	6	0.0368	3.68		
	PH 2.4	2	2	4	0.0245	2.45		
	PH 2.5	2	1	2	0.0122	1.22		
	PH 2.6	2	1	2	0.0122	1.22		
	PH 2.7	2	3	6	0.0368	3.68		
	PH 2.8	2	3	6	0.0368	3.68		
Central Nervous System (CNS)	PH 3.1	2	3	6	0.0368	3.68	20.85	20
	PH 3.2	2	2	4	0.0245	2.45		
	PH 3.3	2	2	4	0.0245	2.45		
	PH 3.4	2	2	4	0.0245	2.45		
	PH 3.5	2	3	6	0.0368	3.68		
	PH 3.6	2	1	2	0.0122	1.22		
	PH 3.7	2	2	4	0.0245	2.45		
	PH 3.8	2	1	2	0.0122	1.22		
	PH 3.9	2	1	2	0.0122	1.22		
	PH 5.1	2	2	4	0.0245	2.45	3.68	4

Respiratory system (RESP)	PH 5.2	2	1	2	0.0122	1.22		
Gastrointestinal system (GIT)	PH 6.1	2	2	4	0.0245	2.45	7.36	7
	PH 6.2	2	2	4	0.0245	2.45		
	PH 6.3	2	1	2	0.0122	1.22		
	PH 6.4	1	1	1	0.0061	0.61		
	PH 6.5	1	1	1	0.0061	0.61		
Miscellaneous (MISC)	PH 9.2	2	1	2	0.0122	1.22	5.52	6
	PH 9.3	1	1	1	0.0061	0.61		
	PH 9.7	2	1	2	0.0122	1.22		
	PH 10.7	1	1	1	0.0061	0.61		
	PH 10.10	1	1	1	0.0061	0.61		
	PH 10.12	2	1	2	0.0122	1.22		
AETCOM	Module 2.1	2	2	4	0.0245	2.45	6.13	6
	Module 2.2	2	1	2	0.0122	1.22		
	Module 2.3	2	2	4	0.0245	2.45		
Total Sum (T) of IXF = 163, I = Impact , F = Frequency , W = Weightage coefficient, W= I X F / T								

Table 2: Blueprint for pharmacology paper II

Topics	**Competency**	**I**	**F**	**I x F**	**W**	**W x 100**	**Total marks for topic**	**Adjusted marks out of 100**
Cardiovascular system (CVS) & blood	PH 4.1	2	3	6	0.0413	4.13	33.1	33
	PH 4.2	2	3	6	0.0413	4.13		
	PH 4.3	2	1	2	0.0137	1.37		
	PH 4.4	2	1	2	0.0137	1.37		
	PH 4.5	2	3	6	0.0413	4.13		
	PH 4.6	2	2	4	0.0275	2.75		
	PH 4.7	2	2	4	0.0275	2.75		
	PH 4.8	2	3	6	0.0413	4.13		
	PH 4.9	2	3	6	0.0413	4.13		
	PH 4.10	2	1	2	0.0137	1.37		
	PH 4.11	2	2	4	0.0275	2.75		
Endocrinology	PH 7.1	2	3	6	0.0413	4.13	23.44	23
	PH 7.2	2	2	4	0.0275	2.75		
	PH 7.3	2	2	4	0.0275	2.75		
	PH 7.4	1	2	2	0.0137	1.37		
	PH 7.5	2	3	6	0.0413	4.13		
	PH 7.6	1	2	2	0.0137	1.37		
	PH 7.7	2	3	6	0.0413	4.13		
	PH 7.8	2	1	2	0.0137	1.37		
	PH 7.9	2	1	2	0.0137	1.37		
Chemotherapy	PH 8.1	2	2	4	0.0275	2.75	38.62	39
	PH 8.2	2	1	2	0.0137	1.37		
	PH 8.3 Sulphonamides	2	1	2	0.0137	1.37		
	PH 8.3 Penicillins	2	2	4	0.0275	2.75		
	PH 8.3 Cephalosporins	2	1	2	0.0137	1.37		
	PH 8.3 Quinolones	2	1	2	0.0137	1.37		
	PH 8.3 Macrolides	2	1	2	0.0137	1.37		
	PH 8.3 Tetracyclines	2	1	2	0.0137	1.37		
	PH 8.3 Aminoglycosides	2	1	2	0.0137	1.37		

	PH 8.3 Misc. Antibiotics	2	3	6	0.0413	4.13		
	PH 8.4	2	1	2	0.0137	1.37		
	PH 8.5	2	3	6	0.0413	4.13		
	PH 8.6	2	1	2	0.0137	1.37		
	PH 8.7	2	3	6	0.0413	4.13		
	PH 8.8	2	1	2	0.0137	1.37		
	PH 8.9	2	1	2	0.0137	1.37		
	PH 8.10	2	3	6	0.0413	4.13		
	PH 8.11	1	2	2	0.0137	1.37		
Miscellaneous (MISC)	PH 9.1	1	1	1	0.0068	0.68	4.82	5
	PH 9.4	2	1	2	0.0137	1.37		
	PH 9.5	2	1	2	0.0137	1.37		
	PH 9.6	1	1	1	0.0068	0.68		
	PH 9.7	1	1	1	0.0068	0.68		
Total Sum (T) of IXF = 145 , I = Impact , F = Frequency , W = Weightage coefficient, W= I X F / T								

A total of 12 theory question papers (6 Paper I and 6 Paper II) were analysed in this study. The results obtained after comprehensive analysis, are as follows - In Paper I: highest weightage was given for ANS, PNS and Autacoids with 36.5% (219 marks) followed by CNS with 22.67% (136 marks). In Paper II: highest weightage was for Chemotherapy with 42.5% (255 marks), followed by CVS & blood with 32.30% (194 marks), as shown in the table 3 and table 4 respectively.

Table 3: Showing topic wise weightage in summative university examinations for pharmacology paper I question papers from April 2022 to July 2024

Topic	Jul-24	Feb-24	Aug-23	Mar-23	Sep-22	Apr-22	Marks	Marks %
G. P	24	27	23	19	19	21	133	22.17
ANS, PNS & Autacoids	36	32	32	33	39	47	219	36.5
CNS	25	25	26	15	24	21	136	22.67
Resp	3	6	3	15	3	0	30	5
GIT	5	4	5	10	5	3	32	5.33
Aetcom	6	6	5	5	5	5	32	5.33
Misc	1	0	6	3	5	3	18	3

Table 4: Showing topic wise weightage in summative university examinations for pharmacology paper II question papers from April 2022 to July 2024

Topic	Jul-24	Feb-24	Aug-23	Mar-23	Sep-22	Apr-22	Marks	Marks %
Cardiovascular system (CVS) & blood	29	28	33	37	31	36	194	32.33
Endocrinology	19	23	11	13	16	16	98	16.34
Chemotherapy	37	38	47	44	44	45	255	42.5
MISC	15	11	9	6	9	3	53	8.83

On analysis, the topic weightage in the developed blueprint was compared with the weightage assigned to that topic in Summative university theory examinations for Paper I and Paper II, and was summarised in the tables 5 & 6 respectively.

Table 5: Showing Comparison of topic wise weightage % assigned in the university summative examination with weightage allotted in the developed blueprint for Paper I

Topic	Weightage (marks %) assigned in university summative examinations	Weightage in developed blueprint
General Pharmacology	22.17	37
Autonomic Nervous System (ANS), Peripheral Nervous System (PNS),Autacoids and related drugs	36.5	20
Central Nervous System (CNS)	22.67	20
Respiratory system	5	4
Gastrointestinal System(GIT)	5	7
AETCOM	5.33	6
Miscellaneous (MISC) topics	3	6

Table 6: Showing Comparison of topic wise weightage % assigned in the university summative examination with weightage allotted in the developed blueprint for Paper II

Topic	Weightage (marks %) assigned in summative theory examination	Weightage in developed blueprint
Cardiovascular drugs and Blood	32.33	33
Endocrinology	16.34	23
Chemotherapy	42.5	39
Miscellaneous (MISC) topics	8.83	5

5. Discussion

Written theory examinations play a crucial role in summative assessment as they provide an objective and standardized method to evaluate a student's comprehension, analytical abilities, and integration of core concepts. It serves as a tool for facilitating competency-based evaluation. Thus, the theory question papers should be valid, i.e. aligning with CBME competencies and balanced representation of the curriculum content.

A comprehensive structured Blueprint will serve as a guide to design valid theory question papers for summative assessments. Based on an extensive review of the available literature, it was observed that there is a relative paucity of peer-reviewed publications specifically addressing the blueprinting of summative theory assessments in Pharmacology. A study done by Pichholiya M et al.[10] was published in 2021, so the competencies were not aligned with the revised CBME 2024 guidelines. Consequently, the published work regarding blueprinting in Pharmacology for summative assessments aligned with the revised CBME 2024 guidelines remains limited.

In this context, the present study was aimed to develop a detailed, systematic and structured blueprint for summative theory assessment in Pharmacology incorporating the revised CBME 2024 guidelines.

In the study done by Pichholiya M et al,[10] the weightage was calculated by assigning scores based on Impact i.e. pharmacological importance considering must know, desirable to know and nice to know competencies and Frequency based on clinical importance based on lesser/moderate/higher clinically important content areas which may lead to subjective interpretation.

In the present study we have calculated weightage by considering Impact i.e. pharmacological importance based on core and non-core competencies as prescribed in CBME 2024 guidelines. Instead of using clinical importance, which may introduce subjective bias—we considered Frequency i.e. teaching importance based on the allocated instructional hours, as the distribution of teaching hours itself reflects the clinical relevance and importance of each competency in that topic.

After calculating the relative weightage and developing a structured blueprint, it was observed that: In Paper I, General Pharmacology had the highest weightage, which is similar to the study done by Pichholiya M et al.[10] In our study, the topics ANS, PNS, and Autacoids collectively received a weightage equal to that of the CNS. Where as in the previous study by Pichholiya M et al,[10] it was noted that the weightage to CNS was much less than the collective weightage for ANS, PNS and Autacoids. In Paper II, Chemotherapy carried highest calculated weightage followed by Cardiovascular system & Blood. This was in congruence to the study done by Pichholiya M et al.[10] This difference may be attributed to the updates in the CBME 2024 guidelines.

On comprehensive analysis of university summative theory examination question papers, it was observed that there was relative variation in the weightage assigned to the topics across different years. There was under-representation for few topics, while others received disproportionately higher weightage. The weightage assigned to the topics were relatively incongruent with weightage allotted in the developed blueprints. Thus, the analysis further re-emphasized the need for a structured blueprint.

Furthermore, previous published studies on comprehensive analysis of summative theory question papers in Pharmacology, by Sai NP 12 and Khuteta NK13, also concluded that there was under- representation of certain topics as per the CBME guidelines and there is a need for development of structured blueprint. Thus, the designed blueprint in this study will ensure adequate distribution of questions across the course content, aligned with specific learning objectives and the relative weightage assigned to each topic, as per the CBME 2024 guidelines.

6. Conclusion

The analysis revealed non-uniform year-to-year distribution of marks across pharmacology topics in summative theory examinations. The study enabled the development of a systematic and structured blueprint for the summative written theory examinations in Pharmacology Papers I and II for 2nd MBBS undergraduates. These blueprints were aligned with the CBME competencies outlined in the 2024 CBME guidelines, and the distribution of topics was carried out in accordance with the respective university regulations.

7. Limitations

This study was confined to the development of a structured blueprint for summative written theory examinations and did not evaluate its implementation or effect on student learning outcomes. Furthermore, the blueprint was developed in alignment with specific university regulations, which may limit its generalizability to other universities.

8. Source of Funding

None.

9. Conflicts of Interest

None declared.

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