Original Article

Empowering Competency-Based Pharmacology Education: A Comprehensive Strategy for Enhancing Validity in Summative Theory Assessment within the Evolving Landscape of Medical Education Training

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ABSTRACT

Background: This study enhances the validity of summative theory assessments in pharmacology within competency-based medical education (CBME). Given pharmacological competence's multifaceted nature, this investigation aims to fortify assessment validity comprehensively.

Aim and Objectives: The study formulates test blueprints for 2nd-year medical undergraduate Pharmacology papers – Paper I and Paper II.

Materials and Methods: Competencies outlined in the 2nd-year medical undergraduate curriculum for Indian Medical Graduates are analyzed as per NMC directives. All competencies form the assessment framework, subdivided to ensure comprehensive coverage. Weightage highlights foundational pharmacological concepts.

Results: Blueprints for Papers I and II of the Summative Theory Assessment in Pharmacology for 2nd-year MBBS students are developed. 'T,' the summation of P x C for all competencies, is 190 for Paper I and 220 for Paper II. Paper I prioritizes general pharmacology and the central nervous system; Paper II emphasizes antimicrobial drugs and hormonal drugs.

Conclusion: Blueprints enhance assessment design's excellence and accountability in medical education, guiding educators to create assessments aligning with learning outcomes and preparing students for clinical practice challenges.

Keywords: Competency-Based Pharmacology Education, Summative Theory Assessment, Medical Education Training.

INTRODUCTION

In the dynamic landscape of medical education, the shift towards competency-based frameworks has sparked a paradigmatic evolution in how healthcare professionals are trained and assessed. This transformation, designed to ensure graduates possess the requisite skills, knowledge, and attitudes for safe and effective practice, demands a corresponding evolution in assessment methodologies. Nowhere is this evolution more pertinent than in the field of pharmacology, where competency in medication management is paramount to patient safety and optimal healthcare outcomes.[1]

This study endeavors to explore the imperative of validity enhancement within summative theory assessment in pharmacology, situated within the broader context of competency-based medical education (CBME). Recognizing the multifaceted nature of pharmacological competence, encompassing not only knowledge of drug mechanisms but also the ability to apply this knowledge judiciously and ethically in clinical practice, our investigation seeks to elucidate a comprehensive strategy to fortify the validity of summative theory assessments.[2,3]

The title, "Empowering Competency-Based Pharmacology Education: A Comprehensive Strategy for Enhancing Validity in Summative Theory Assessment within the Evolving Landscape of Medical Education Training," encapsulates the essence of our inquiry. Within this framework, we aim to dissect the complexities of pharmacological education and assessment, identifying key challenges and opportunities for improvement. By grounding our exploration in the evolving landscape of medical training, we underscore the need for adaptability and innovation in assessment practices to align with contemporary educational paradigms.[4,5]

Through this study, we aspire to not only contribute to the theoretical discourse surrounding competency-based assessment but also provide actionable insights and recommendations for educators, curriculum developers, and policymakers. Ultimately, our goal is to empower stakeholders in pharmacological education to design and implement summative theory assessments that authentically reflect the competencies required for modern medical practice, thereby advancing patient care and safety in an ever-evolving healthcare landscape.

MATERIALS AND METHODS

Study Setting and Participants:

This study was conducted at the Department of Pharmacology, GSVM Kanpur, Uttar Pradesh with the participation of faculty members specializing in pharmacology education and assessment. The study involved the analysis of competencies outlined in the 2nd-year medical undergraduate curriculum for Indian Medical

Graduates as per the directives of the National Medical Commission (NMC).

Competency Listing and Division:

All competencies within the knowledge domain of the curriculum were meticulously listed to form the basis of the assessment framework. These competencies were further subdivided into categories to ensure comprehensive coverage of the pharmacology syllabus. Psychomotor and affective domain competencies were excluded from analysis, as they were deemed to be addressed adequately in practical assessments.

Scoring of Pharmacological and Clinical Importance:

Each competency or its subdivision was assessed for both pharmacological and clinical importance. A scoring system ranging from 1 to 3 was employed, with a score of 1 denoting lesser importance, 2 indicating moderate importance, and 3 signifying higher importance. Pharmacological importance scores (P) were assigned based on the relevance of the competency to pharmacological principles and the necessity for foundational knowledge in pharmacotherapy. Similarly, clinical importance scores (C) were allocated based on the anticipated significance of the competency in real-world clinical scenarios.

Calculation of Weightage:

To determine the weightage of each competency, the pharmacological importance score (P) was multiplied by the clinical importance score (C) for each competency, with the summation of these products labeled as 'T.' Subsequently, a Weightage coefficient (W) was computed for each competency using the formula P x C / T. The final weightage of each competency was then estimated by multiplying its Weightage coefficient by the total marks allocated for each paper, adhering to the NMC guidelines. Adjustments to the weightage of individual competencies were made to align with the total marks allocated for each paper.

Peer and Expert Validation:

The devised blueprints were subjected to validation by peers and experts in the field of pharmacology through email correspondence. Feedback received from experts regarding the pharmacological and clinical importance of competencies was integrated into the blueprint, and necessary adjustments were made accordingly. Finally, the weightage of individual systems was recalculated to ensure consistency and validity of the assessment framework.

Statistical Analysis:

Descriptive statistics were employed to summarize the distribution of competencies and their respective weightages within the assessment framework. Mean, median, and standard deviation were calculated to provide insights into the overall distribution and variability of weightage across competencies.

Ethical Considerations:

This study was conducted in accordance with ethical principles and guidelines for research after taking due ethical approval from the institute. All data were handled with confidentiality and anonymity, and informed consent was obtained from participants involved in the validation process.

RESULTS

Two final blueprints were developed for Papers I and II of the Summative Theory Assessment in Pharmacology for 2nd year MBBS students. The summation of P x C for all competencies, labeled as 'T,' was found to be 190 for Paper I and 220 for Paper II.

Paper I:

In Paper I, the highest weightage was assigned to General Pharmacology, comprising 30 marks out of 100. This was followed by 16 marks allocated to the Central Nervous System (CNS). Other systems such as Autonomic Nervous System (ANS), Cardiovascular System (CVS), and Respiratory System (RS) also received significant weightage, with 12, 10, and 8 marks respectively. The weightage of individual systems in Paper I is summarized in Table 1.

Paper II:

For Paper II, the highest weightage was assigned to Antimicrobial Drugs, totaling 35 marks out of 100. This was followed by Hormonal and Related Drugs, which received a weightage of 21 marks. Other systems such as Autacoids and Related Drugs (ARD), Chemotherapy, and Drugs Acting on Blood and Blood Forming Organs (DBBF) also received substantial weightage, with 18, 16, and 15 marks respectively. The weightage of individual systems in Paper II is presented in Table 2.

Competencies PH1.3, PH1.6, PH1.7, PH1.8, PH1.9, PH1.10, PH1.11, PH1.12, PH1.63, and PH1.64 were excluded from theory assessment and considered part of practical assessment.

These weightage distributions reflect the emphasis placed on different pharmacological systems and classes within the curriculum, ensuring comprehensive coverage of essential pharmacological knowledge and skills necessary for medical practice. The allocation of weightage underscores the significance of foundational concepts in pharmacology, as well as the clinical relevance of various drug classes and therapeutic interventions

Table 1: Paper I blue print

System	Competency	Subdivisions	P	C	PXC	W= PxC/T	Wx100	Total marks of system	Adjusted marks (out of 100)
General pharmacology	PH1.1		3	1	3	0.016	1.58	29.47	30
	PH1.2		2	2	4	0.021	2.11		
	PH1.4		3	1	3	0.016	1.58		
	PH1.5, PH1.22	Absorption	3	1	3	0.016	1.58		
		Distribution	3	2	6	0.032	3.16		
		Metabolism	3	2	6	0.032	3.16		
		Excretion	3	3	9	0.047	4.74		
	PH1.11	Mechanism of drug action and factors modifying drug action	3	3	9	0.047	4.74		
	PH1.59		2	3	6	0.032	3.16		
	PH1.60		1	1	1	0.005	0.53		
	PH1.56		2	3	6	0.032	3.16		
Autonomic nervous system	PH1.13	Adrenergic drugs	3	2	6	0.032	3.16	13.16	13
		Anti-adrenergic drugs	3	3	9	0.047	4.74		
	PH1.14		2	2	4	0.021	2.11		
			3	2	6	0.032	3.16		
Peripheral nervous system Autacoids	PH1.15	Cholinergic drugs	2	1	2	0.011	1.05	3.16	3
	PH1.17	Anti-cholinergic drugs	2	2	4	0.021	2.11		
	PH1.16		3	3	9	0.047	4.74	13.68	14
		Histamine and antihistaminics	2	2	4	0.021	2.11		
		Serotonin and its Antagonists and Drugs for Migraine	2	1	2	0.011	1.05		
		PGs, Leukotrienes	3	3	9	0.047	4.74		
		(Eicosanoids) and PAF	2	1	2	0.011	1.05		
		NSAIDs							
Central nervous system	PH1.18	Antirheumatic and	2	1	2	0.011	1.05	16.32	16
	PH1.19	Antigout Drugs	2	2	4	0.021	2.11		
		General anesthetics	2	2	4	0.021	2.11		
		Sedative-Hypnotics							
		Antidepressant and	2	2	4	0.021	2.11		
		Antianxiety Drugs							
		Antipsychotic and	2	1	2	0.011	1.05		
		Antimanic Drugs							
		Opioid Analgesics and	2	1	2	0.011	1.05		
		Antagonists	2	1	2	0.011	1.05		
		Antiepileptic Drugs	1	1	1	0.005	0.53		
		Antiparkinsonian Drugs							
Drugs for cough and bronchial asthma	PH1.20,	CNS Stimulants and	2	3	6	0.032	3.16		
	PH1.21	Cognition Enhancers	2	2	4	0.021	2.11		
	PH1.23		3	3	9	0.047	4.74		
Gastrointestinal drugs	PH1.32		2	3	6	0.032	3.16	7.89	8
	PH1.33		3	3	9	0.047	4.74		
	PH1.34	Drugs for peptic ulcer and GERD	2	3	6	0.032	3.16	16.32	16
		Antiemetic and prokinetic	3	3	9	0.047	4.74		
		drugs	2	3	6	0.032	3.16		
		Drugs for diarrhea	1	1	1	0.005	0.53		
		Drugs for constipation Digestants, Gall stone			T= 190				
		dissolving drugs							
P=Pharmacological importance, C= Clinical importance, T= Total of sum of PxC, W= Weightage									

Table 2: Paper II blue print

System	Competency	Subdivisions	P	C	PXC	W= PxC/T	Wx100	Total marks of system	Adjusted marks (out of 100)
Drugs acting on kidney	PH1.24	Thyroid Hormones and Thyroid Inhibitors	3	3	9	0.041	4.09	4.09	**4**
Drugs affecting blood and blood formation	PH1.25	Insulin, Oral Antidiabetic Drugs and Glucagon Drugs affecting Calcium metabolism	2	3	6	0.027	2.73	9.55	**10**
Cardiovascular drugs	PH1.31	Anterior Pituitary Hormones	2	3	6	0.027	2.73		
	PH1.35		3	3	9	0.041	4.09		
	PH1.26	Male sex hormones Female sex hormones	3	3	9	0.041	4.09	15.45	**15**
	PH1.27		3	3	9	0.041	4.09		
	PH1.28		3	3	9	0.041	4.09		
	PH1.29		3	2	6	0.027	2.73		
	PH1.30		1	1	1	0.005	0.45		
Hormones and related drugs	PH1.36		2	2	4	0.018	1.82	20.91	**21**
	PH1.37		3	3	9	0.041	4.09		
			2	2	4	0.018	1.82		
			1	1	1	0.005	0.45		
			1	1	1	0.005	0.45		
			2	2	4	0.018	1.82		
	PH1.40	Antimalarial drugs	2	1	2	0.009	0.91		
	PH1.39	Antiamoebic and antiprotozoal drugs	2	3	6	0.027	2.73		
	PH1.38	Anti-helmintic drugs	3	3	9	0.041	4.09		
	PH1.41	Antiviral drugs	2	3	6	0.027	2.73		
Antimicrobial drugs	PH1.42	Antifungal drugs General antibiotics	3	3	9	0.041	4.09	35	**35**
	PH1.43		3	3	9	0.041	4.09		
	PH1.44		3	3	9	0.041	4.09		
	PH1.45		2	2	4	0.018	1.82		
	PH1.46		1	2	2	0.009	0.91		
	PH1.47		3	3	9	0.041	4.09		
			3	3	9	0.041	4.09		
			3	3	9	0.041	4.09		
	PH1.48		2	1	2	0.009	0.91		
			2	3	6	0.027	2.73		
			3	3	9	0.041	4.09		
Chemotherapy of neoplastic diseases Miscellaneous topics	PH1.49		2	1	2	0.009	0.91	0.91	**1**
	PH1.50		1	1	1	0.005	1.06	14.1	**14**
	PH1.51		2	2	4	0.018	1.82		
	PH1.52		2	2	4	0.018	1.82		
	PH1.53		1	1	1	0.005	0.45		
	PH1.54		1	3	3	0.014	1.36		
	PH1.55		1	3	3	0.014	1.36		
	PH1.57		1	3	3	0.014	1.36		
	PH1.58		1	3	3	0.014	1.36		
	PH1.62		2	3	6	0.027	2.73		
	PH1.61		1	3	3	0.014	1.36		
					T= 220				

P=Pharmacological importance, C= Clinical importance, T= Total of sum of PxC, W=Weightage

DISCUSSION

The process of assessment and evaluation in medical education is pivotal in shaping the learning trajectory of medical undergraduates and ensuring the attainment of requisite knowledge and skills for competent clinical practice. As highlighted in previous literature, assessments serve as a driving force for learning and play a crucial role in educational reform efforts. In the context of medical education, written examinations remain a cornerstone for evaluating theoretical knowledge, which forms the foundation for acquiring clinical skills.

The current study focused on the development of a blueprint for pharmacology summative assessment theory papers, with an emphasis on aligning assessment content with established competencies. Through expert consultation and iterative refinement, the final blueprint was meticulously crafted to ensure validity and comprehensiveness. This iterative process of blueprint development and validation underscores the importance of stakeholder engagement and collaborative efforts in enhancing the quality and relevance of assessment frameworks.

Validity, a fundamental aspect of assessment, encompasses both content and construct validity. Content validity ensures that assessments accurately reflect the intended knowledge content and learning objectives. In contrast, construct validity encompasses the broader domain of subject knowledge and the ability to apply knowledge in clinical contexts.[6] The implementation of a blueprinting approach in assessment design helps mitigate potential sources of construct under-representation and irrelevance variance, thereby enhancing the overall validity of the assessment.

The absence of existing literature directly comparing the results of this study highlights the novelty and significance of our findings. While previous studies have explored blueprinting methodologies in assessment design, few have specifically focused on pharmacology summative assessment theory papers based on competencies.[7] However, parallels can be drawn with a study that examined the impact of blueprinting on formative assessment papers in pharmacology, albeit using a different methodology and curriculum framework.

Content under-representation in a paper result because of improper weightage of marks for clinically important objectives, unequal distribution of course content or examiner bias, such as a tendency to focus on popular topics. Content imbalance may also result in students focusing less on key areas of learning.[7] Hence, a valid assessment paper should be according to content of the course having proportional weightage as per the clinical importance of the competency and balanced questions, that is, not oversimplified or difficult.[8]

The use of a blueprint in assessment design not only ensures the comprehensive coverage of the curriculum but also fosters alignment with educational objectives and domains.[9] Furthermore, authentic assessments, guided by blueprints, serve as a motivational tool for medical students, encouraging deeper engagement with learning materials and ultimately contributing to the development of clinical competence and patient-centered care.

No study was found on literature search to compare our results as so far, no blueprint of pharmacology summative assessment theory papers has been prepared on the basis of competencies except a study which aimed to prepare a blueprint for a written theory paper of pharmacology and later the pharmacology faculty members and students provided feedback after taking the test based on the question paper prepared by the setter using the blueprint.[11]

In conclusion, the development and implementation of a blueprint for pharmacology summative assessment theory papers represent a significant step towards enhancing the validity, reliability, and relevance of assessment practices in medical education. By integrating stakeholder feedback, adhering to established competencies, and promoting alignment with educational objectives, blueprints serve as invaluable tools for promoting effective learning outcomes and preparing medical students for the challenges of clinical practice.

Limitations:

While efforts were made to ensure the comprehensiveness and validity of the assessment framework, it is acknowledged that certain limitations may exist, including subjectivity in assigning importance scores and potential biases in expert feedback.[10] Efforts were made to mitigate these limitations through rigorous validation processes and adherence to established methodologies.

CONCLUSION

The utilization of blueprints in the development of theory papers holds significant value in medical education. By aligning curriculum competencies with assessment domains, blueprints serve as essential tools for crafting assessments that accurately evaluate student knowledge and skills.

This systematic approach ensures the rational judgment of students' performance, fostering fairness and objectivity in evaluation processes.

Moving forward, it is imperative to integrate blueprinting as a standard practice in the preparation of theory papers for all subjects within medical education. Regular review and revision of blueprints by experts in the field are essential to ensure alignment with evolving curricular standards and educational goals. By adapting to changes in the curriculum, blueprints can effectively guide assessment practices, maintaining their relevance and efficacy over time.

In essence, the incorporation of blueprints in assessment design reflects a commitment to excellence and accountability in medical education. By providing a structured framework for assessment development, blueprints empower educators to create assessments that

accurately reflect the intended learning outcomes and prepare students for the challenges of clinical practice. As such, the continued implementation of blueprints represents a fundamental step towards enhancing the quality and validity of assessment practices in medical education.

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