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Metacognitive Awareness among Low-Performing Phase II MBBS Students: A Descriptive Cross-Sectional Study.

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ABSTRACT

Academic difficulty affects approximately one in ten medical students, and metacognition, the awareness and regulation of one's own learning, is associated with academic performance. This descriptive cross-sectional study described metacognitive awareness among low-performing second-year medical students in a government medical college in South India. Twenty-eight students who had passed fewer than three of eight pharmacology theory internal assessments completed the 52-item Metacognitive Awareness Inventory. Subscale scores were normalised to percentages of the maximum attainable score, total scores were categorised into four bands, and items answered unfavourably by more than half of the students were identified. The mean total score was 32.6 ± 7.1 of 52 (62.6%); no student scored very low, whereas 21.4% scored low, 67.9% average and 10.7% high. Knowledge (61.3%) and regulation of cognition (63.3%) were comparable. Debugging (74.3%) and information management strategies (70.4%) were the strongest subscales, whereas planning (56.6%), evaluation (56.6%) and comprehension monitoring (57.7%) were the weakest. Four of the five items most often answered unfavourably concerned declarative knowledge; 71.4% of students did not endorse knowing what information is most important to learn. Most low performers reported average metacognitive awareness with specific weaknesses in planning, evaluation and monitoring, supporting individualised, metacognition-focused remediation early in the curriculum.

Keywords: Metacognition, Self-regulated learning, Academic performance, Medical education, Remedial teaching.

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INTRODUCTION

Medical education is intensive and demands sustained academic performance alongside the acquisition of clinical and professional skills. Despite rigorous selection at entry, a proportion of students find it difficult to keep pace with the curriculum. Approximately one in ten medical students encounters academic difficulty at some stage of training, and some score persistently low in internal assessments [1]. Such difficulty carries consequences that extend beyond a single examination: affected students struggle to meet the requirements for progression and graduation, early academic underperformance has been linked to later concerns regarding professional readiness and conduct, and the experience commonly imposes a psychological burden on the learner [2,3]. Identifying these students early and understanding why they struggle is therefore an important educational priority.

In India, the introduction of the competency-based medical education (CBME) curriculum for the Indian Medical Graduate has reoriented undergraduate training towards defined competencies, self-directed learning and a more learner-centred approach [4]. Within this framework, mentor-mentee programmes, formative assessments, remedial measures and structured feedback are intended to support struggling learners and to help them become self-reliant. Recognising the factors that shape academic performance, and designing interventions to address them, remains challenging, in part because the reasons for underperformance are heterogeneous and not always captured by marks alone. A construct of growing relevance to this problem is metacognition.

Metacognition, a term popularised by Flavell, refers to an individual's awareness of, and reflection upon, their own cognitive processes [5]. It is commonly described in terms of two components. Knowledge of cognition concerns what learners know about themselves as learners, about tasks and about strategies, and is further divided into declarative, procedural and conditional knowledge. Regulation of cognition concerns how learners plan, monitor, manage information, correct errors and evaluate their learning [6,7]. These components underpin self-regulated learning, in which learners move cyclically through phases of forethought, performance and reflection, setting goals, selecting strategies, monitoring progress and adjusting their approach in the light of outcomes [8]. Metacognitive strategies thereby help learners construct efficient study plans and promote deep rather than surface learning.

Effective learners tend to be more metacognitively aware, deploy a wider range of strategies and regulate their learning more actively, and metacognitive awareness has been positively associated with academic achievement in higher and professional education [9-11]. Within medicine specifically, explicit attention to metacognition and self-regulation is increasingly advocated as a means of helping trainees recognise the limits of their own knowledge and direct their learning accordingly [12-14]. Several teaching-learning methods that are already emphasised in CBME, including problem-based learning, the flipped classroom, self-directed learning and structured reflection, are thought to work partly by strengthening these metacognitive skills [13,15].

Metacognition can be measured in various ways, including think-aloud protocols, systematic observation and self-report questionnaires; each has advantages and limitations [16]. Among self-report tools, the Metacognitive Awareness Inventory (MAI) developed by Schraw and Dennison is one of the most widely used, because it is brief, freely available and captures both knowledge and regulation of cognition across eight subscales, including debugging strategies that are seldom assessed by other instruments [6].

Despite this interest, the metacognitive profile of students who consistently underperform has received limited attention, particularly within the Indian CBME setting, and most published work has examined general cohorts rather than identified low performers. Characterising the specific metacognitive strengths and weaknesses of struggling learners could inform targeted, individualised support rather than generic academic help. The aim of this study was to describe the knowledge and regulation of cognition among low-performing Phase II MBBS students using the MAI, and to identify the specific domains and items in which they most often struggled. The findings are intended to serve as a preliminary basis for embedding metacognitive support within the undergraduate curriculum and for planning future interventional work.

MATERIALS AND METHODS

This descriptive, cross-sectional study was conducted in the Department of Pharmacology, Government Theni Medical College and Hospital, Theni, Tamil Nadu, India, a tertiary-care teaching institution, from September 2024 to December 2024 during the 2024–2025 academic session. Identification of eligible students, administration of the inventory and data compilation were completed over approximately two months. The study was approved by the Institutional Ethics Committee (approval number MEII/2024/63) and was conducted in accordance with the Declaration of Helsinki. Reporting follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations [17].

Inclusion and Exclusion Criteria

Phase II (second-year) MBBS students, who study pharmacology as part of the second professional curriculum, formed the sampling frame. Students who had obtained a pass score ($\geq 40\%$) in fewer than three of the eight pharmacology theory internal assessments conducted by the department were included, irrespective of the number of assessments attended, so that repeatedly unsuccessful students were captured. Students who did not provide consent and those who returned incomplete responses were excluded.

Sample Size

No formal sample size calculation was performed. A purposive sampling strategy based on internal assessment performance was used, and all 28 students who met the inclusion criteria were approached; all consented, completed the inventory and were retained in the analysis.

Study Tool

Metacognitive awareness was measured with the Metacognitive Awareness Inventory (MAI) of Schraw and Dennison, a widely used self-report instrument [6]. The MAI comprises 52 statements, each rated as true or false and scored 1 or 0 respectively, with higher scores indicating greater awareness. The items map onto two broad constructs and eight subscales. Knowledge of cognition, assessed by 17 items, comprises declarative knowledge (knowing about oneself as a learner and about what influences performance), procedural knowledge (knowing how to use strategies) and conditional knowledge (knowing when and why to use them). Regulation of cognition, assessed by 35 items, comprises planning (goal setting and resource allocation), comprehension monitoring (assessing one's own understanding), information management strategies (organising and elaborating information), debugging strategies (correcting comprehension and performance errors) and evaluation of learning (appraising performance after a task) [6,7]. The inventory has documented reliability and validity across diverse populations [6].

Study Procedure

A brief demographic sheet recording age, sex and the medium of instruction at school preceded the inventory. The MAI was administered in printed form during a scheduled pharmacology teaching hour, after the head of department had granted formal approval and after the students had received a short orientation on the purpose of the study and on how to respond; guidance was provided during administration when a student required clarification. A dedicated period was allotted so that responses were not rushed. Participation was voluntary and responses were kept confidential; disclosure of name was optional. The scoring key was included in the printout so that students could review their own scores after completion; this feedback was provided for educational reflection and was not part of the study outcome.

Because the study focused on struggling learners, particular care was taken to avoid stigmatising participants: students were approached individually and sensitively, were assured that their scores would not affect their assessment, and were told that participation was entirely voluntary. Written informed consent was obtained from all participants after they had been informed about the purpose, procedures and voluntary nature of the study. Data were anonymised at entry and stored securely.

Scoring

Completed inventories were scored and the item responses were entered into a spreadsheet. Each subscale score was obtained by summing the relevant item scores, and, because the subscales contain different numbers of items, each subscale score was normalised as a percentage of the maximum attainable score for that subscale (observed score divided by maximum possible score, multiplied by 100) to allow comparison across domains. Construct-level scores for knowledge of cognition and regulation of cognition were computed in the same way. Total MAI performance was additionally categorised into four bands, namely below 25%, 25% to below 50%, 50% to 80%, and above 80%, corresponding to very low, low, average and high metacognitive awareness respectively.

Statistical Analysis

Data were analysed using descriptive statistics. Continuous variables were summarised as means with standard deviations, medians and ranges, and categorical variables as frequencies and percentages. Given the descriptive design and absence of a comparison group, no inferential testing or adjustment for confounders was undertaken. Percentages were rounded to one decimal place, and normalised subscale scores are reported as percentages of the maximum attainable score. Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics version 24.0 (IBM Corp., Armonk, NY, USA). Between-student variability in subscale scores was expressed as SD in percentage points (SD of the raw subscale score divided by the number of items, multiplied by 100).

RESULTS

Twenty-eight low-performing Phase II MBBS students, aged 19–21 years, participated; all had English as their medium of school instruction. Reflecting the composition of the eligible group, 25 (89.3%) were male and 3 (10.7%) were female. All 28 provided complete responses and were included in the analysis. The participant characteristics and overall metacognitive awareness are summarised in Table 1.

Table 1: Participant characteristics and overall metacognitive awareness (n=28)

Characteristic	Value
Number of participants	28
Age range, years	19–21
English as medium of school instruction, n (%)	28 (100)
Male, n (%)	25 (89.3)
Female, n (%)	3 (10.7)
Total MAI score (maximum 52), mean $\pm$ SD	32.6 $\pm$ 7.1
Total MAI score, % of maximum	62.6
Total MAI score (%), median (range)	64.0 (36–89)
Knowledge of cognition, normalised score (%)	61.3
Regulation of cognition, normalised score (%)	63.3

MAI: Metacognitive Awareness Inventory; SD: standard deviation.

The mean total MAI score was 32.6 of a possible 52 (SD 7.1), corresponding to 62.6% of the maximum attainable score. The median total score was 64.0%, and individual scores ranged widely, from 36% to 89%, indicating considerable variation even within this selected low-performing group. When the two constructs were considered separately, the normalised score for knowledge of cognition was 61.3% and that for regulation of cognition was 63.3%, so that overall awareness of learning and its regulation were broadly comparable and neither construct was globally deficient.

The distribution of total scores across the four bands is shown in Table 2. Notably, no student scored in the very low band (below 25%). Six students (21.4%) scored in the low band, the majority (19; 67.9%) scored in the average band, and 3 (10.7%) achieved a high score. Thus, most low performers reported an average level of metacognitive awareness rather than a conspicuous deficit, while a small minority reported high awareness.

Table 2: Distribution of total MAI scores across performance bands (n=28)

MAI score band (%)	Interpretation	Students, n (%)
<25	Very low	0
25 to <50	Low	6 (21.4)
50 to 80	Average	19 (67.9)
>80	High	3 (10.7)

Higher scores indicate greater metacognitive awareness. MAI: Metacognitive Awareness Inventory.

Subscale-wise normalised scores, together with a measure of their variability, are presented in Table 3. The highest scores were observed for debugging strategies (74.3%) and information management strategies (70.4%), indicating relative strength in recognising and correcting difficulties and in organising information while studying. The three knowledge subscales clustered closely together, at 61.2% for declarative knowledge, 61.6% for procedural knowledge and 61.4% for conditional knowledge, suggesting a fairly uniform, moderate level of knowledge about cognition. The lowest scores were seen for evaluation of learning (56.6%), planning (56.6%) and comprehension monitoring (57.7%), the three regulatory domains most dependent on foresight and reflection. Between-student variability, expressed in percentage points, ranged from 17.5 for information management strategies to 28.3 for procedural knowledge; it was greatest in the procedural and conditional knowledge subscales, which contain the fewest items and in which each item therefore carries a larger share of the subscale score.

Table 3: Subscale-wise normalised metacognitive scores and between-student variability (n=28)

Subscale	Construct	Items (n)	Normalised score* (%)	SD [†] (percentage points)
Declarative knowledge	Knowledge of cognition	8	61.2	19.6
Procedural knowledge	Knowledge of cognition	4	61.6	28.3
Conditional knowledge	Knowledge of cognition	5	61.4	28.2
Planning	Regulation of cognition	7	56.6	22.4
Comprehension monitoring	Regulation of cognition	7	57.7	17.6
Information management strategies	Regulation of cognition	10	70.4	17.5
Debugging strategies	Regulation of cognition	5	74.3	22.2
Evaluation of learning	Regulation of cognition	6	56.6	21.3

*Normalised score = (observed score / maximum possible score) × 100. †SD of the raw subscale score divided by the number of items in the subscale, × 100. SD: standard deviation.

An item-level analysis was undertaken to identify the specific statements to which more than half of the students gave an unfavourable ('false') response, since these represent concrete, addressable weaknesses (Table 4). Four of the five most frequently unfavourable items belonged to the declarative-knowledge subscale. Two of them, 'I know what information is most important to learn' and 'I am good at remembering information', were each answered unfavourably by 20 students (71.4%), and a further two, concerning organising information and having control over one's own learning, by 15 students (53.6%) each. One comprehension-monitoring item, 'I find myself analysing the usefulness of strategies while I study', was answered unfavourably by 16 students (57.1%). In addition, one evaluation-domain item was answered unfavourably by 15 students (53.6%). Taken together, these responses indicate that difficulty in recognising, organising and prioritising key information, rather than in correcting errors once identified, was especially common in this group.

Table 4: MAI items answered unfavourably ('false') by more than 50% of students (n=28)

MAI item	Domain	'False' responses, n (%)
I know what information is most important to learn	Declarative knowledge	20 (71.4)
I am good at remembering information	Declarative knowledge	20 (71.4)
I find myself analysing the usefulness of strategies while I study	Comprehension monitoring	16 (57.1)
I am good at organising information	Declarative knowledge	15 (53.6)
I have control over how well I learn	Declarative knowledge	15 (53.6)

A 'false' response scores 0 and reflects the less metacognitively favourable answer. In addition, one evaluation-domain item was answered unfavourably by 15 (53.6%) students. MAI: Metacognitive Awareness Inventory.

DISCUSSION

This study set out to describe the metacognitive awareness of a group of consistently low-performing Phase II MBBS students and to locate their specific areas of difficulty. The central finding was that most of these students possessed an average level of overall metacognitive awareness, with a small proportion scoring high and none scoring very low. Metacognitive awareness, at least as captured by self-report, therefore did not appear to be uniformly deficient in this group. This suggests that persistent low academic performance in these students is unlikely to be explained by a global absence of metacognition alone, and that a more granular, subscale- and item-level view is needed to understand where support should be directed.

The near-parity between knowledge of cognition (61.3%) and regulation of cognition (63.3%) indicates that these learners are, on average, neither markedly better at knowing about learning than at regulating it, nor the reverse. The more informative signal lay within the subscales. Students were relatively strong in debugging strategies and information management, meaning that they could recognise when something had gone wrong and attempt to correct it, and could organise material while studying. In contrast, planning, evaluation of learning and comprehension monitoring were the weakest domains. These weaker domains are precisely the ones that require anticipation and reflection: within the self-regulated learning cycle of forethought, performance and reflection, planning belongs to the forethought phase and evaluation to the reflection phase, while comprehension monitoring is the ongoing self-assessment that links the two [8,18]. A profile of relatively intact reactive strategies but weaker proactive planning and reflective self-evaluation is consistent with learners who work hard yet fail to set clear goals, gauge their own understanding accurately, or learn systematically from feedback, a combination that can plausibly sustain underperformance.

The item-level findings sharpened this picture. The statements most often endorsed unfavourably were predominantly declarative-knowledge items concerned with knowing what is most important to learn, and with organising and remembering information. Difficulty in identifying and structuring high-yield content is a plausible and direct contributor to poor assessment performance, and it points to concrete, teachable strategies. Explicit sharing of learning objectives and assessment blueprints can help students distinguish core from peripheral material; concept mapping and other organisational techniques can support the structuring of information; and spaced retrieval practice and interleaving can address the difficulty with remembering that these students reported [13,15]. Because the failing items were specific and consistent, they translate readily into a focused remediation checklist rather than a diffuse instruction to 'study harder'.

These results are broadly consistent with the wider literature linking metacognitive awareness to academic achievement in higher and medical education, in which more metacognitively aware students tend to perform better [9,11]. At the same time, the apparent mismatch between an average level of self-reported metacognition and demonstrably poor academic performance deserves careful comment. Because the MAI is a self-report instrument, it reflects students' beliefs about their own learning rather than their observed regulatory behaviour, and it is therefore susceptible to inaccurate self-appraisal. Weaker learners in particular tend to have poorly calibrated self-assessment and may over-estimate their own competence, so that reported awareness exceeds the skill they actually deploy [19,20]. The average

scores observed here should be interpreted in this light, and they strengthen rather than weaken the case for objective, behavioural measures of regulation alongside self-report.

The findings carry several practical implications for a competency-based curriculum. First, the MAI, being brief and free, could be used as an early screening tool to generate an individual metacognitive profile for students identified as at risk, which could then guide mentoring. Second, the domains found to be weakest here, namely planning and self-evaluation, are amenable to direct instruction: teaching learners to set specific goals before study, to monitor understanding during study, and to appraise performance afterwards, ideally scaffolded through formative assessment with structured feedback, addresses exactly the phases in which these students appeared least skilled [8,15]. Third, the teaching-learning methods already promoted within CBME, including problem-based learning, the flipped classroom, self-directed learning and structured reflection, can be deployed deliberately to strengthen metacognition, and are likely to be most effective when introduced early and applied consistently rather than reserved for remediation after failure [4,13].

The strengths of this study include its focus on genuinely low-performing students rather than a general cohort, the use of a validated and widely comparable instrument, and the combination of construct-, subscale- and item-level analyses, which yielded specific and actionable targets for support.

Limitations

The cross-sectional design captures a single time point and precludes any inference about change or causation. The sample was small, drawn from a single institution and predominantly male, all of which limit the generalisability of the estimates. Reliance on a self-report instrument introduces the possibility of social-desirability and self-appraisal bias, and no qualitative component, such as interviews or think-aloud tasks, was included to triangulate the quantitative findings. Metacognitive subscale performance was not compared with students' actual topic-wise assessment scores, so the alignment between reported awareness and objective performance in corresponding areas could not be examined. Finally, there was no intervention and no longitudinal follow-up, so the study cannot speak to whether the observed profile changes over time or responds to teaching.

Future work should address these limitations: Larger, multi-centre samples would improve precision and generalisability; correlating metacognitive profiles with objective assessment performance would test whether the self-reported weaknesses map onto measurable deficits; and triangulating the MAI with think-aloud or observational methods would help separate genuine regulatory skill from self-belief. Above all, interventional and longitudinal studies are needed to determine whether explicitly strengthening planning, monitoring and evaluation improves academic outcomes in low-performing learners.

CONCLUSION

In summary, most low performers in this study showed average—not deficient—metacognitive awareness, with relative strengths in debugging and information management but consistent weaknesses in planning, evaluation, comprehension monitoring and declarative knowledge. This variability argues against a one-size-fits-all response and supports an individualised, metacognition-focused approach to remediation, embedded early in the competency-based curriculum and guided by an individual metacognitive profile; larger, longitudinal and interventional studies are needed to confirm these patterns and to test whether strengthening metacognition improves academic performance.

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