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Assessing the impact of reciprocal peer assessment and feedback activities on medical students' confidence in the pharmacology exam

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Abstract:

Medical undergraduates often have a negative perception of pharmacology, and evidence on whether reciprocal peer assessment and feedback (RPAF) improves examination-related confidence is limited. This pre-post interventional study included 97 second-year MBBS students who completed an 8-item, 5-point Likert confidence questionnaire before and after a structured RPAF session conducted following a part completion test. Mean confidence scores increased significantly from 21.68 ± 4.83 to 26.22 ± 4.25 , with a mean change of $+4.54 \pm 5.56$ (Wilcoxon $W = 438.5$, $p < 0.001$, $r = 0.678$), and all 8 items showed significant improvement. Although males had higher baseline confidence, the post-test gender difference was not significant, and no demographic variable significantly predicted the change in confidence. Thus, we show that a single RPAF session can significantly improve pharmacology examination confidence and reduce the baseline gender confidence gap.

Keywords: Reciprocal peer assessment, peer feedback, pharmacology education, examination confidence, self-efficacy, formative assessment

Background:

Pharmacology is a difficult subject to learn for medical students due to its complexity. The subject requires knowledge of pharmacodynamics, the mechanisms of receptor signaling pathways and second messenger systems, knowledge of adverse drug effects, understanding of pharmacokinetic principles, and memorizing a large number of drug classifications [1]. These theoretical areas demand not only a high degree of motivation but also conceptual understanding. The subject is difficult for many students, particularly if it is taught in a rote-learned manner that may make the learning less interesting and more stressful [2, 3]. The study has shown that the confidence level of students has a significant effect on their academic achievement [4, 5], low self-confidence in a subject such as pharmacology can cause anxiety, low motivation, and students may use ineffective study techniques that have a negative impact on the results of examinations [6]. The results of this study underscore the need for teacher-centred learning that is supportive to build students' confidence in order to improve their academic achievements [7]. Peer assessment is widely used and is now known as assessment as learning (AaL), because it allows students to be actively engaged in their own learning process. It helps to build up the knowledge base needed to develop a more complete understanding of the topic [8]. According to Yan and Boud, 'Peer assessment is a form of assessment that will inevitably provide learning opportunities for students when they are actively involved in locating, connecting and employing evidence'. Thus, peer assessment can be considered as an effective approach to promote student self-directed learning (S-D-L) behaviors [9]. Reciprocal peer assessment is a method of assessing students' performance using grades and/or written or oral feedback. Collaborative assessment can also be more effective because peers are in the same learning environment and have similar levels of subject knowledge, which means that they can provide a more relevant and contextualized response [8, 10]. Peer feedback can also foster reflective learning as peers have similar levels of subject knowledge and can provide a more relevant and contextualized response [11]. Giving students the chance to evaluate and give feedback to their classmates helps to foster a spirit of collaboration and constructive criticism, which helps to

build their confidence in the subject matter and enhances the learning outcomes [12]. Therefore, it is of interest to evaluate the effectiveness of the reciprocal peer assessment and feedback activities in enhancing self-reported confidence in the pharmacology examination.

Methodology:

Study design:

The study was a pre and post-test interventional study using questionnaires to assess the impact of the reciprocal peer assessment and feedback activity on medical students' confidence in pharmacology. The study took place in the classroom and lasted for 10 weeks. The study was conducted in the classroom for 10 weeks. This study was carried out in the Department of Pharmacology, All India Institute of Medical Sciences (AIIMS), Raebareli, Uttar Pradesh. The study period was for 1 month from the day of institutional ethical approval. The study population consisted of second year MBBS students who were willing to participate in the study.

Study outcomes:

Primary outcome: Change in baseline confidence scale scores post intervention.

Secondary outcomes: Analysis of how other factors (gender, urban/rural, substance use (if applicable), perceived previous year performance) affect confidence scores.

Detailed study procedure:

The study was carried out in the Department of Pharmacology, following the regular part completion test (PCT) which is conducted for second-year MBBS students. All students were sensitized to the study and its purpose after the PCT. The students who signed informed consent forms were then included in the research. Students were asked to fill a pre-intervention confidence questionnaire on enrolment, which aimed to determine the students' self-perceived confidence in the pharmacology examination. After this initial assessment, model answers to the recently completed part completion test were shared with all participants who were then asked to read and familiarize themselves with the desired answers. Student pairs

were then formed, with no one assessing his/her own answer sheet. Students assessed each other's answer sheets, referring to the model answers given in the pairing. Students gave oral feedback to their peers after the assessment, focusing on specific areas that need improvement and suggestions that will help them understand the material better. Students were then asked to consider the feedback they had received and share a plan for how they would apply these suggestions in the future when preparing for exams. After the peer evaluation and feedback process was complete, the confidence questionnaire was re-administered to all participants. This post intervention measurement allowed the researchers to assess the effect of peer feedback on students' confidence in the pharmacology examination. In addition, all participants were asked to fill out a perception questionnaire to obtain their perceptions of the reciprocal peer assessment and feedback activity and how useful and effective it was to their learning.

Two tailored instruments were utilized in the study:

The Medical Student Confidence Questionnaire, comprising eight items assessed on a 5-point Likert scale (from "not confident at all" to "very confident"), and The Medical Student Perception of Reciprocal Peer Assessment and Peer Feedback Activity Questionnaire, which included ten items rated from "strongly disagree" to "strongly agree" on a 5-point Likert scale. Both tools were developed in consultation with educational experts to ensure validity and relevance for the target population, thus providing robust data for analysing the effectiveness of the intervention.

Sample size calculation:

Sample size was calculated using the single-proportion formula:

$$\text{Sample size } (n) = \frac{N}{1 + N \times (MOE)^2}$$

Where:

- [1] N = 400 (total number of medical students in the institute)
- [2] MOE = 0.1 (margin of error).

Hence, the calculated sample size was 80. To account for potential dropouts, 90 participants were recruited.

Statistical analysis:

All the study data were entered into a Microsoft Excel spreadsheet and then analyzed using R version 4.2.2 for Windows. For the quantitative results-such as confidence scale scores-values were summarized as mean and standard deviation, while categorical data from the perception surveys were shown as frequencies and percentages. To assess differences in confidence levels between male and female students, the Wilcoxon Signed Rank test was utilized since the data were non-parametric. Relationships between confidence scores and variables like age, gender, or place of residence were further explored with Spearman's rho correlation analysis. To understand which factors most strongly predicted changes in confidence following the intervention, multiple linear regression models were run using the post-intervention score changes as the outcome variable and student demographics as predictors.

Throughout the statistical analysis, a p-value of less than 0.05 was considered statistically significant for all hypothesis tests.

Ethical considerations:

Ethical clearance was obtained from the Institutional Ethics Committee, AIIMS Raebareli. Written informed consent was secured from all participants before enrolment. Participation was voluntary, and confidentiality was maintained throughout the study.

Results:

The total number of students who participated in the study was 97 second-year MBBS students with a mean age of 20.36 ± 1.52 years (range: 18–26 years). Among them, 65 (67.0%) were male and 32 (33.0%) were female. **Table 1** summarizes other demographic characteristics such as place of residence and perceived previous year academic performance. The intervention was associated with a statistically significant increase in total confidence scores. The Wilcoxon signed-rank test yielded $W = 438.5$, approximate $Z = -6.399$, $p < 0.001$, with a large effect size ($r = 0.678$). Seventy-three students (75.3%) improved, 16 (16.5%) declined, and 8 (8.2%) showed no change. The paired t-test was used for sensitivity analysis and yielded the same result ($t = 8.032$, $df = 96$, $p < 0.001$). The total confidence scores showed a statistically significant ($p < 0.001$) improvement with a large effect size ($r = 0.678$) as a result of the intervention. Seventy-three students (75.3%) improved, 16 (16.5%) declined, and 8 (8.2%) showed no change (**Table 2**). Improvements were seen in all eight confidence domains after the intervention, with the largest absolute change in confidence in integration across disciplines ($\Delta = +0.39$) and time management ($\Delta = +0.41$), and the smallest absolute change in confidence in recall of drug classifications ($\Delta = +0.75$) (**Table 3 and Figure 2**). Male students had significantly higher baseline confidence score (**Figure 1**) than female students (22.51 ± 4.54 vs 20.00 ± 5.04 ; $U = 1358.0$, $p = 0.015$). This difference was no longer significant post-intervention (26.45 ± 4.05 vs 25.75 ± 4.68 ; $U = 1126.0$, $p = 0.510$). There were no significant differences between groups at baseline or post-test in terms of residential status or previous academic achievement (all $p > 0.05$). Importantly, there was significant within-group improvement in all subgroups after the intervention. Male gender was only significantly correlated with pre-test confidence ($\rho = 0.250$, $p = 0.014$), but this correlation was not seen after the intervention ($\rho = 0.068$, $p = 0.511$) as assessed by correlation analysis. There were no significant associations between age, residential status or previous performance and confidence at either time point (**Table 4**). Multiple linear regression was conducted according to the study protocol with the dependent variable being the change in confidence score (**Table 5**). The overall model was non-significant ($R^2 = 0.065$, adjusted $R^2 = 0.013$, $F = 1.262$, $p = 0.287$). No predictor was found to significantly account for the magnitude of change in confidence, indicating that the intervention had a similar effect across the various demographic subgroups. The analysis of co-variance (ANCOVA) model was not statistically significant ($R^2 = 0.095$, adjusted $R^2 = 0.034$, $F = 1.567$, $p = 0.166$) (**Table 6**). Baseline pre-

test score was the only factor that was significantly associated with post-test confidence ($\beta = 0.222$, $p = 0.020$) suggesting that students with higher initial confidence had higher post-intervention confidence, and that demographic factors were not independently associated with the magnitude of change. The internal consistency of the summed total score was good at both test and retest (Cronbach's $\alpha = 0.800$ at pre-test and 0.793 at post-test), which indicates that the summed total score is a reliable composite measure of examination confidence in pharmacology. The Medical Student Perception of Reciprocal Peer Assessment and Peer Feedback Activity Questionnaire were answered positively by the students (Table 7). Most students were comfortable with giving feedback (28.13% agreed, 17.71% strongly agreed), felt able to identify areas for improvement

(42.71% agreed, 23.95% strongly agreed), and felt that the criteria for evaluation were clear and understandable (40.62% agreed, 15.63% strongly agreed).

Table 1: Demographic characteristics of the group

Subgroups	Categories	N	%
Residential status	Rural	34	35.4%
	Urban	63	64.6%
Previous year performance	Non satisfactory	38	38.5%
	Satisfactory	59	60.8%

Table 2: Primary Outcome: Confidence Scores

	Pre-test	Post-test	Change
Mean $\pm$ SD	21.68 $\pm$ 4.83	26.22 $\pm$ 4.25	+4.54 $\pm$ 5.56
Median (IQR)	21.0 (18–25)	26.0 (24–29)	4.0 (1–8)
Range	9–32	16–35	–10 to +18

Table 3: Item-wise analysis of pre and post-test confidence scale scores.

Item	Pre-Test Score (Mean $\pm$ SD)	Post-Test Score (Mean $\pm$ SD)	W (Test Statistic)	p
1. Preparedness for examination	2.59 $\pm$ 0.93	3.12 $\pm$ 0.77	613.0	<0.001
2. Understanding of key concepts	2.81 $\pm$ 0.89	3.38 $\pm$ 0.80	421.0	<0.001
3. Application to complex scenarios	2.63 $\pm$ 0.91	3.26 $\pm$ 0.75	464.0	<0.001
4. Recall of drug classifications	2.48 $\pm$ 0.97	3.23 $\pm$ 0.84	462.0	<0.001
5. Optimism about performance	2.54 $\pm$ 0.88	3.35 $\pm$ 0.75	291.0	<0.001
6. Integration across disciplines	2.81 $\pm$ 0.89	3.20 $\pm$ 0.87	460.5	<0.001
7. Utilization of study resources	2.93 $\pm$ 1.03	3.38 $\pm$ 0.89	729.0	0.001
8. Time management during examination	2.89 $\pm$ 0.97	3.30 $\pm$ 0.96	739.0	0.002

Table 4: Spearman Correlation Analysis

Variable	vs Pre-test (rho, p)	vs Post-test (rho, p)
Age	0.089, p = 0.388	–0.062, p = 0.547
Gender (Male=1)	0.250, p = 0.014	0.068, p = 0.511
Residence (Urban=1)	–0.143, p = 0.163	–0.115, p = 0.260
Previous Performance	0.083, p = 0.418	0.120, p = 0.242

Spearman's Correlation coefficient: rho

Table 5: Multiple Linear Regression: Change Score (Post-Pre) Model

Predictor	β	SE	t	p	95% CI
Intercept	20.709	7.958	2.602	0.011	[4.90, 36.52]
Gender (Male vs Female)	–1.587	1.214	–1.307	0.195	[–4.00, 0.83]
Residence (Urban vs Rural)	0.059	1.227	0.048	0.962	[–2.38, 2.50]
Previous Performance (Sat.)	0.017	1.192	0.014	0.989	[–2.35, 2.39]
Age	–0.744	0.382	–1.945	0.055	[–1.50, 0.02]

Estimated Coefficient (β), Standard Error (SE), t-statistic (t), and 95% Confidence Interval (95% CI).

Table 6: ANCOVA: Post-test Score Adjusted for Baseline

Predictor	β	SE	t	p	95% CI
Intercept	29.394	6.111	4.810	<0.001	[17.25, 41.53]
Baseline Pre-test Score	0.222	0.094	2.366	0.020	[0.036, 0.408]
Gender (Male vs Female)	0.190	0.943	0.201	0.841	[–1.68, 2.06]
Residence (Urban vs Rural)	–0.863	0.935	–0.923	0.359	[–2.72, 0.99]
Previous Performance (Sat.)	0.809	0.907	0.893	0.374	[–0.99, 2.61]
Substance Abuse (Yes vs No)	–0.359	2.572	–0.140	0.889	[–5.47, 4.75]
Age	–0.394	0.292	–1.349	0.181	[–0.98, 0.19]

ANCOVA: Analysis of Covariance; Estimated Coefficient (β), Standard Error (SE), t-statistic (t), and 95% Confidence Interval (95% CI).

Table 7: Medical Student's responses to "Perception of Reciprocal Peer Assessment & Feedback (RPAF) activity Questionnaire"

Questions	SD	D	N	A	SA
1. Feedback was constructive & helpful	3 (3.13)	6 (6.25)	27 (28.14)	42 (43.75)	18 (18.75)
2. I was prompted to reflect my own by the RPAF activity	2 (2.08)	10 (10.41)	25 (26.04)	41 (42.70)	18 (18.75)
3. Peer Assessment criteria were clear & easy to understand	1 (1.04)	10 (10.41)	31 (32.29)	39 (40.82)	15 (15.83)
4. I had no problem offering feedback to my users.	3 (3.13)	17 (17.70)	32 (33.33)	27 (28.13)	17 (17.71)
5. I was able to pinpoint my areas of improvement following the activity	3. (3.13)	10 (10.41)	19 (19.79)	41 (42.71)	23 (23.95)
6. RPAF should be used in other subjects as well	1 (1.04)	7 (7.29)	17 (17.70)	40 (41.68)	31 (32.20)

Values in parentheses indicate percentage responses. Total N=96; Likert Scale: SD- strongly disagree, D- Disagree, N- Neutral, A-agree, SA- Strongly Agree.

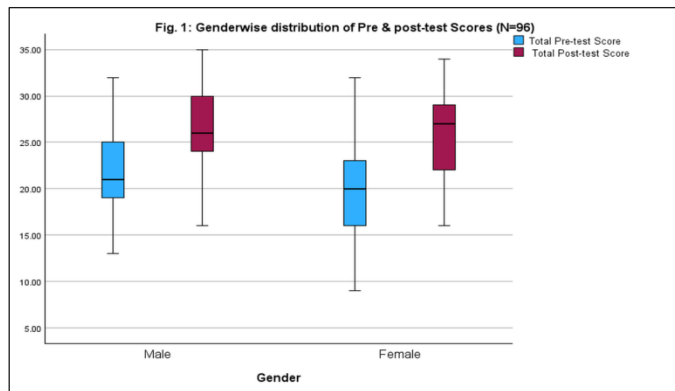


Figure 1: Gender wise distribution of Pre & post-test Scores (n =96)

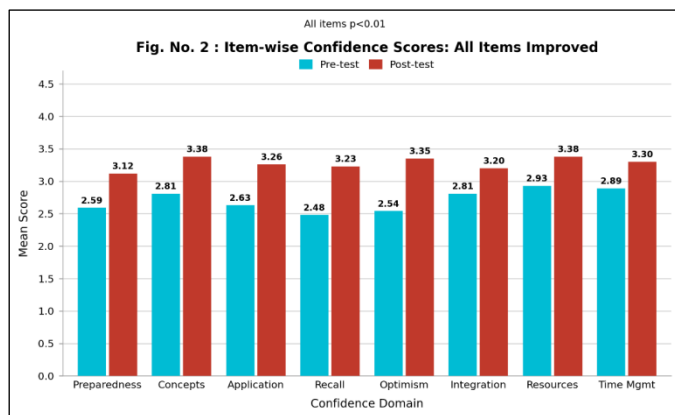


Figure 2: Item-wise Confidence Scores: All Items Improved

Discussion:

The aim of the present study was to evaluate the effect of reciprocal peer assessment and peer feedback on the examination confidence of second year MBBS students in pharmacology. The analysis showed that the mean confidence in pharmacology examination increased by $+4.54 \pm 5.56$ points ($p < 0.001$, effect size $r = 0.678$) after a single session of reciprocal peer assessment, with 75.3% of the participants achieving an increase. There were marked gains in all eight areas of confidence, particularly in performance optimism and drug classification recall. The baseline confidence level was higher for males than for females ($p = 0.015$), but this difference was not found after the intervention ($p = 0.510$). Demographic factors did not predict the size of improvement as revealed by regression analysis, and the findings of this study are similar to those reported in the literature which demonstrates that peer-based learning is a source of academic self-efficacy in health professions education. Specifically, our results validate the qualitative results of Seneviratne *et al.* who observed that peer assessment creates a conducive atmosphere for comparing knowledge and refining answers [13]. This study has shown a large effect size, which further supports the use of reciprocal peer assessment as a powerful pedagogical tool to help develop student confidence in the pharmacology curriculum. Overall, Abraham *et al.* found

that when students had clear learning goals and received feedback from peers, they were able to take ownership of their learning and growth, both for high and low achievers. The process of peer assessment that creates confidence seems to be multi-layered in that the comparison of one's responses with model answers clarifies what is expected of them, the process of evaluating a peer's work develops evaluative judgment, and the oral feedback received gives verbal persuasion, all of which have been identified as sources of self-efficacy in Bandura's social cognitive theory. Our overall improvement for each of the eight confidence domains is in line with this theoretical framework, and offers the rationale that a single, well-designed RPAF session could address multiple dimensions of examination readiness. Abraham *et al.* found that the peer feedback combined with the specific learning objectives can be used to empower both high and low achievers to take responsibility for their own learning, which results in meaningful engagement and self-regulatory learning [14]. The positive results found in this study can be well explained by Bandura's social cognitive theory, which includes comparing responses with model answers that clarify performance expectations, evaluating peer work that develops evaluative judgment and oral feedback that offers verbal persuasion [15]. The marked gains in each of the eight confidence domains support this theoretical perspective, showing that one, carefully designed session can have a positive impact on several aspects of examination readiness. Largest gains were observed at the item level for performance optimism and drug classification recall. These domains react quickly to immediate feedback that identifies gaps in knowledge, whereas higher order cognitive skills such as interdisciplinary integration and time management do not. Post-PCT, model-answer guided peer feedback session, as used in this study, has been found to be most effective when it is specific, timely and actionable [16, 17]. Which are all characteristics of formative assessment and feedback in medical education. The large difference in baseline confidence between the male and female students, despite no formal difference in academic selection criteria, is in line with previous research on gender and academic self-confidence in medicine [18]. Interestingly, this difference was not significant after the intervention, which could indicate that peer-based formative strategies can help to close the gap in self-confidence within the class. A non-significant regression model indicates that the benefits of the intervention were consistent across all demographic and academic subgroups, consistent with previous research that suggests well-structured peer learning is widely available [19]. Although all students made progress, the finding that is consistent with modern social efficacy research, prior performance was the only significant predictor of post-test scores, higher starting students showing a higher absolute ceiling [20]. Reciprocal peer assessment is highly accepted by students based on their answers to the perception questionnaire, and the majority of students strongly support its implementation in the wider medical curriculum. This positive view is consistent with the findings of previous pharmacology education research, in which students have always expressed their positive attitude toward the use of peer-based methods to develop personal and

professional skills [13]. This study has some limitations, however, in spite of the important findings. The single group pre-post design does not include a control arm, which makes it difficult to determine if the confidence gain is due to the RPAF intervention alone. This assessment was conducted in a single session, with no longitudinal follow-up, and the self-reported confidence may not be a true reflection of competency but rather a social desirability bias. The single centre study limit statistical reliability and generalizability. Lastly, secondary analyses are at risk of Type I error due to the lack of formal correction for multiple comparisons. Randomized controlled trials (RCTs) comparing RPAF with traditional post-test debriefing should be used in future research to establish causality. Longitudinal designs are required to evaluate the long-term effect of the confidence gained across cycles. In addition, there would be a benefit in correlating self-reported confidence with objective examination marks to determine whether there is a link between the two. Finally, qualitative exploration using focus group discussions or reflective journals would complement the quantitative results by clarifying the processes that students go through when they feel a change in their level of confidence during and after receiving peer feedback.

Conclusion:

We shows that one structured RPAF session can provide large scale improvements in the confidence of second year MBBS students in pharmacology examination. These improvements were seen in all confidence domains and across all demographic groups. In particular, the intervention reduced the gender confidence gap that already existed, indicating that RPAF is a pedagogical instrument that is not biased against women. Reciprocal peer assessment is an effective, low resource and feasible approach to improving student readiness and supporting active learning in medical education that can be integrated into formative schedules.

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