RESEARCH
Assessment of Learner Metacognition in a Professional Pharmacy Elective Course

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Objective. To investigate the effect of strategic feedback and metacognitive processes on learners’ ability to predict performance and improve self-awareness.

Methods. Strategic faculty and peer feedback, as well as self-assessments, were implemented in a professional pharmacy elective course throughout the semester, focused on three case-based oral presentations. After each presentation, students utilized an objective rubric to determine self-predicted and peer-predicted scores. Actual scores from faculty were compared to students’ predicted scores.

Results. Students’ ability to predict presentation scores did not improve over time; however, students were able to accurately estimate performance in certain rubric sections on individual presentations (depth of problem, presentation). Students were generally overconfident in predicting their performance. When broken down into tertiles, top performing students were more accurate in their self-assessments compared to bottom performing students. Bottom performing students were highly overconfident in their assessment.

Conclusion. Self-awareness is essential for professionals, though difficult to cultivate and improve in one semester. Incorporating longitudinal, continuous feedback and metacognitive skills may help learners become more aware of their own performance and devise a plan for enhancement.

Keywords: metacognition, feedback, self-assessment

INTRODUCTION

Metacognition was originally defined by psychologist John Flavell as “knowledge and cognition about cognitive phenomena as well as monitoring of one’s own memory, comprehension, and cognitive enterprises.” It has since been described in a variety of manners. Metacognition is a higher-order mental process used to plan, monitor, and evaluate one’s awareness of information processing and performance, and denotes critical self-recognition of thinking, learning, and doing. Simply defined, metacognition is thinking about one’s thinking. Instilling metacognitive skills is vital in preparing the next generation of pharmacy students to face challenges after graduation, as the health care field continues to transform at an exceedingly fast pace and the need for continuous relearning and mastery of material is necessary. Not surprisingly, in Standards 2016, the Accreditation Council for Pharmacy Education (ACPE) emphasizes the need to develop independent, lifelong learners. Key Element 4.1 (self-awareness) states, “the graduate is able to examine and reflect on personal knowledge, skills, abilities, beliefs, biases, motivation, and emotions that could enhance or limit personal and professional growth.”

To become experts in their respective fields, students must be presented with metacognitive approaches embedded in the curriculum, which enable them to develop self-assessment strategies in the face of rapidly changing conditions. Overall, pharmacy students tend to lack metacognitive skills and tend to make inaccurate judgements of their performance. Austin and Gregory examined pharmacy students’ ability to assess their clinical knowledge and communication skills in a clinical simulation setting. The investigators found that students overestimated their performance, although those who performed better had...
feedback, written feedback alone, or no feedback would enhance metacognition and achievement in a team-based learning environment. Students provided with both written and verbal feedback on their problem-solving skills and thought process during a case-based assessment improved their scores to a greater extent than students who received written feedback alone or no feedback.

Providing specific feedback and assessment in courses to promote metacognition is an appealing option because of its relative ease of implementation. However, research is controversial and lacking on how the feedback approach improves metacognitive skills over the course of time, an outcome that would demonstrate a more durable skillset. The primary purpose of this study was to investigate how implementation of metacognitive processes affected learners’ ability to predict case-based oral presentation performance and improve self-awareness over the course of a semester in a professional pharmacy elective course.

**METHODS**

Students were eligible for inclusion if enrolled in Drug-Induced Diseases, an elective course available to third-year (P3) students in the professional pharmacy program, in the fall 2015 semester. Throughout the semester, students completed a variety of active learning activities and a total of three case-based oral presentations. A thorough description of the course has been previously published. We sought to employ strategic faculty and peer feedback in the course to enhance learner metacognition. The use of “feedback pearls,” repetition of assessment via student peer- and self-assessment for case-based oral presentations and creation of action plans for future case-based oral presentations were incorporated. Table 1 summarizes the timeline of the fall 2015 semester and implementation of the feedback mechanisms. The study was granted exempt status by the Butler University Institutional Review Board.

To highlight important components of effective feedback and assessment and hopefully improve these skills, students were provided with tips (referred to as “feedback pearls”) by course instructors. Feedback pearls included timeliness, domains of feedback, specificity, and constructiveness and were derived from previous literature. A summary of these pearls can be found in Table 2. At the beginning of the four class periods preceding the first case-based oral presentation, five to 10 minutes were dedicated to discussing these feedback pearls. Students engaged in these discussions by providing examples of specific feedback or evaluating the effectiveness of a piece of feedback and suggesting how it could be improved.

Examinations consisted of three separate, case-based oral presentations over the course of the semester. Groups...
of either two or three students each prepared an original clinical case with a drug-induced problem. Required components included a timeline for onset, appropriate laboratory data, mechanism of adverse effect(s), and three viable treatment strategies. Presentations were composed of a description of the case, discussion of viable treatment options, and justification for a preferred treatment plan. Each presentation was 15 minutes in length, with time for questions from faculty and peers. Students were scheduled to present in blocks of two or three groups.

At the completion of each case-based oral presentation, students submitted evaluations via an online survey (SurveyMonkey, San Mateo, CA) for their peers. Peer-prediction scores were based on the aforementioned rubric. The peer-prediction scores were analyzed with the same statistical methods as the self-prediction scores.

Another component of the case-based oral presentation evaluations included supplemental comment fields requesting two things that went well during the presentation and two opportunities for improvement. This was completed for both peer- and self-assessments. On the self-assessment portion of presentations one and two, each student was asked to create an action plan for improvement on future presentations. Specific examples of action plans were also included in the course syllabus for guidance. Detailed written feedback was provided for each student before the next class period, and general comments regarding overall improvement of feedback and action plans were verbally discussed during the next class session. This exercise was completed to reinforce assessment components, apply feedback to an objective rubric during case-based oral presentations, and allow students to improve these skills over time.

Another component this study sought to investigate was differences in self-assessment abilities among levels of performers. Students were stratified into tertiles based on overall course performance to explore differences in presentation score prediction. Tertile 1 consisted of the top five course performers, tertile 2 the middle five, and tertile 3 the bottom five. Overall differences were combined for all rubric sections and comparisons between

Table 1. Timeline of Fall 2015 Semester and Implementation of Strategic Feedback

| Feedback Pearls | Presentations |
|-----------------|---------------|
| Week 1          | Pearl 1       |
| Week 2          | Pearl 2       |
| Week 3          | Pearl 3       |
| Week 4          | Pearl 4       |
| Week 5          | No Class      |
| Week 6          | Presentation 1 |
|                 | Action Plan 1 |
| Week 7          |               |
| Week 8          | No Class      |
| Week 9          |               |
| Week 10         |               |
| Week 11         |               |
| Week 12         | Presentation 2 |
|                 | Action Plan 2 |
| Week 13         |               |
| Week 14         | No Class      |
| Week 15         |               |
| Week 16         | Presentation 3 |

*aStudents completed peer- and self-evaluations after each presentation and received written feedback on each component
self-predicted and actual scores were analyzed among tertiles. A multiple comparisons ANOVA test with Bonferroni correction was utilized to analyze combined overall differences between self-predicted score as it related to varying levels of performers for each section of the rubric and to determine which groups there were differences among if one existed. (SPSS v23.0, IBM, Armonk, NY). A \( p \) value of \(<.05\) was considered significant.

RESULTS

Fifteen P3 students were enrolled in the Drug-Induced Diseases elective course. Demographic characteristics were similar to those of the P3 class overall; 67\% (n=10) were female, average age was 22 years, 87\% (n=13) were Caucasian, average grade point average (GPA) was 3.52 on a four-point scale, and none held a previous degree. All students were present for the four feedback pearl sessions delivered in sequential weeks prior to the first case-based oral presentation. Over the course of the semester, all students completed three self-assessments, two action plans, and up to six peer evaluations (Figure 1).

Overall, students’ ability to self-predict case-based oral presentation performance did not improve over time on any rubric section (Table 3). There was a decreased ability to predict scores on section D (references) noted over time. A post hoc analysis determined that there was a decreased ability to predict section D (references) scores between presentation one and two and between one and three. When section score predictions were evaluated independently with paired \( t \)-tests, sections B (depth of problem) and E (presentation) demonstrated no difference between student self-prediction and faculty score for any individual presentation. The significant differences in student self-prediction and faculty scores seen in sections A (originality and professionalism) and C (solution) for presentations one or two were absent by presentation three. Overconfidence in cumulative oral presentation scores was seen over time. Additionally, sections B (depth of problem) and E (presentation) were the only sections of the rubric that students demonstrated underconfidence at any point during the semester when predicting their own performance. By the third presentation, students were overconfident in their own abilities on all sections and cumulative scores except for section B (depth of problem).

Likewise, students’ ability to predict peer presentation scores did not significantly improve over time on any section (Table 4). There was a decreased ability to predict peer scores on section D (references) noted over time, similar to self-predicted scores. A post hoc analysis determined that there was a decreased ability to predict section D (references) scores between presentation one and two and between one and three, similar to self-predicted scores. When section score predictions were evaluated independently with paired \( t \)-tests, there was no difference between peer-predicted and actual presentation scores for sections B (depth of problem) or E (presentation) on the rubric for any individual presentation. Peer prediction also followed a congruent pattern for sections A (originality and professionalism) and C (solution), closing the gap in prediction by presentation three. Students were also generally overconfident when evaluating their peers’ performance, with sections B (depth of problem) and E (presentation) being the only sections of the rubric that they demonstrated underconfidence at any point in time.

### Table 2. Pearls to Develop Effective Feedback and Assessment Skills

| Feedback Pearl | Faculty Comments |
|----------------|------------------|
| Timeliness of Feedback | Provide feedback right after the class period and before you leave |
| | Informal, immediate feedback during IPPE or APPE |
| | |
| Domains of Feedback | Covers all areas of professional confidence: |
| | Knowledge |
| | Skills |
| | Communication |
| | Attitudes |
| | Creativity |
| Be Specific | Back up data with multiple examples |
| | Document as class/case presentation goes along |
| Be Constructive | Provide solutions/action plan for your area of improvement |
| | Focus on the positive (reinforces this behavior/actions) and areas of improvement (remains uncorrected if not addressed, nobody wins) in your feedback |

Abbreviations: IPPE=introductory pharmacy practice experiences; APPE=advanced pharmacy practice experiences
When comparing overall differences in self-predicted vs actual scores among the three tertiles, there were significant differences noted in the ability to predict scores on multiple sections (Table 5). Tertile 1 more closely estimated their scores compared to Tertile 3 on sections A (originality and professionalism), B (depth of problem), C (solution), and overall scores. Additionally, Tertile 2 more closely estimated their scores compared to Tertile 3 on section B (depth of problem). No other comparisons among tertiles were significant. There were important trends within the separate tertiles for overall score prediction. Tertile 1 only slightly underpredicted their overall scores on presentation one and three but slightly overpredicted their score on presentation two, averaging out to no difference in scores overall for the three presentations. Tertile 2 moderately overpredicted their overall scores (mean 1.4 points) on all presentations. Tertile 3 highly overpredicted their overall scores (mean 3.5 points) and increased in overconfidence with each presentation, overpredicting their score by an average of 10% (5.2 points) on presentation three.

DISCUSSION

To prepare pharmacy students for lifelong learning, it is crucial that faculty incorporate methods that promote learner metacognition and reflective practice. \(^{15}\) Within the traditional pharmacy curriculum, professional students have few opportunities to complete peer- or self-assessments via a standardized rubric. In addition, students do not typically receive training from faculty on how to provide effective feedback or conduct assessments. The teaching methods in our Drug-Induced Diseases elective course sought to
develop student metacognitive processes through initial direct instruction followed by repetitive opportunities for providing and receiving feedback, completing peer- and self-assessments, and developing self-action plans.

Few reports in the literature discuss the integration of repetitive metacognitive processes within a professional pharmacy course. In comparison to previous reports, the course under study featured repetitive processes, which allowed students to become engaged with feedback and replicate similar tasks. Students had multiple opportunities to provide peer feedback and faculty assessed students’ feedback to provide specific suggestions for continual refinement. Students utilized a standardized rubric for peer- and self-evaluations on three case-based oral presentations over the course of the semester. In addition, students critically assessed their own performance to develop a personalized action plan for future modifications and improvements. Constructive review and comments from the course coordinators were important to fully engage the students for ongoing growth and reflective development.

Taken in sum, students did not improve their ability to predict their own or their peers’ performance based on a standardized rubric over the course of the semester, demonstrating they are no better at self-assessment vs peer-assessment. To explore this finding, investigators analyzed individual case-based oral presentation performance prediction. On certain sections of the rubric, there were no significant findings when comparing predicted scores to actual scores, indicating that students were not improving at self-assessment vs peer-assessment.

### Table 4. Difference in Peer-predicted vs Actual Presentation Scores

| Section | Predicted Score | Actual Score | Overall Difference | p Value |
|---------|-----------------|--------------|-------------------|---------|
| A. Originality and Professionalism (10 points) | | | | |
| Presentation 1 | 9.8 (0.4) | 9.3 (0.6) | 0.5<sup>d</sup> | .15 |
| Presentation 2 | 9.6 (0.7) | 8.7 (1.5) | 0.9<sup>d</sup> | |
| Presentation 3 | 9.5 (1.1) | 9.1 (0.9) | 0.4 | |
| B. Depth of Problem (10 points) | | | | |
| Presentation 1 | 9.4 (0.4) | 9.3 (0.3) | 0.1 | .27 |
| Presentation 2 | 9.3 (0.8) | 9.4 (0.6) | -0.1 | |
| Presentation 3 | 9.1 (1.2) | 9.5 (0.9) | -0.4<sup>d</sup> | |
| C. Solution (10 points) | | | | |
| Presentation 1 | 9.4 (0.7) | 8.5 (0.6) | 0.9<sup>d</sup> | .14 |
| Presentation 2 | 9.6 (0.8) | 9.4 (0.5) | 0.2 | |
| Presentation 3 | 9.3 (0.8) | 9.0 (1.4) | 0.3 | |
| D. References (10 points) | | | | |
| Presentation 1 | 9.6 (0.4) | 9.4 (0.6) | 0.2 | <.01<sup>e</sup> |
| Presentation 2 | 9.9 (0.2) | 8.9 (0.4) | 1.0<sup>d</sup> | |
| Presentation 3 | 9.7 (0.8) | 9.0 (0.4) | 0.7<sup>d</sup> | |
| E. Presentation (10 points) | | | | |
| Presentation 1 | 9.1 (0.7) | 8.9 (0.9) | 0.2 | .31 |
| Presentation 2 | 9.3 (0.7) | 9.7 (0.5) | -0.4 | |
| Presentation 3 | 9.3 (0.8) | 8.9 (0.8) | 0.3 | |
| Overall Score (50 points) | | | | |
| Presentation 1 | 47.3 (1.6) | 45.3 (1.5) | 2.0<sup>d</sup> | .87 |
| Presentation 2 | 47.8 (1.7) | 46.1 (2.4) | 1.7<sup>d</sup> | |
| Presentation 3 | 47.0 (3.1) | 45.3 (3.9) | 1.7 | |

<sup>a</sup>Predicted scores and actual scores reported as Mean (SD)
<sup>b</sup>Overall difference was calculated by averaging the individual differences between peer predicted and actual scores for each student on each section
<sup>c</sup>P values were calculated using overall difference between peer predicted and actual exam scores using repeated measures ANOVA to test for improvement in presentation score prediction over time
<sup>d</sup>Indicates significant difference in peer predicted vs actual scores for specific presentation utilizing paired t-test
<sup>e</sup>Post-hoc analysis indicated significant differences between presentation 1&2 (p<.01) and presentation 1&3 (p=.01)
accurately predicting their scores (Tables 3 and 4). Part of the reason this effect is difficult to capture when taken in sum is the minimal differences at baseline along with averages potentially negating underprediction and overprediction. It may have been difficult to detect differences in their predictive abilities when their scores and predictions are already close to the maximum. Finally, score predictions were tied to a rubric. This may have allowed students to anchor their judgements on their own and their peers’ performances based on objective criteria and may explain why there were no significant differences between predicted and actual scores for many of the individual presentation section components. Collectively, these points could explain why we did not detect an improvement in students’ ability to predict scores over the course of the semester.

Interestingly, students worsened in their ability to predict their own and peers’ performance on section D (references) over time. It may have been expected that students would perform better on section D (references), as this was the least subjective part of the rubric by nature of the content; however, training on citations occurred during first-year (P1) of the professional pharmacy program and accuracy of citations is not regularly assessed throughout the curriculum. Pharmacy students have a guide available to standardize citation formats; however, students may have not consistently used this guide during development of the presentation and did not have access to reference this guide when completing the rubric assessment. A continued focus on appropriate referencing is a target for the course moving forward.

When evaluated in aggregate, students were overconfident in their abilities, though overconfidence did not necessarily result in significant differences between predicted and actual scores. This is likely because of several factors. One large outlier for presentation three overestimated the cumulative score by nearly 11 points. With this outlier eliminated, overconfidence stabilized for aggregate scores between presentations two and three. For the final presentation, 43% (n = 6) of students anticipated a perfect score. This could demonstrate either a high level of confidence in their performance or, more likely, assessment fatigue within the course. Previous studies have noted difficulty in reducing overconfidence in students, even with feedback. We attempted to negate this effect by providing a detailed rubric with objective criteria as well as rubric training; however, we still noted an overall trend of overconfidence. Future efforts may target employing incentives, such as extra credit or participation points; though success using incentives is inconsistent. Reduction in the number of peer- and self-assessments completed throughout the semester may alleviate assessment fatigue and increase thoughtful participation. Faculty may also consider promoting self-awareness of metacognition through teaching the purpose and usefulness of necessary skills as well as having students complete the “Metacognition Awareness Inventory”

Table 5. Overall Differences in Self-predicted vs Actual Presentation Scores Among Top, Middle, and Bottom Performers

| Section A. Originality and Professionalism | Tertile 1 | Tertile 2 | Tertile 3 | p Value |
|-------------------------------------------|----------|----------|----------|---------|
| Presentation 1                            | 0        | 0.8      | 0.5      | .049c   |
| Presentation 2                            | 0.8      | 0.8      | 2.0      |         |
| Presentation 3                            | 0        | 0.2      | 1.0      |         |
| Combined                                  | 0.3      | 0.6      | 1.2      |         |

| Section B. Depth of Problem               | Tertile 1 | Tertile 2 | Tertile 3 | p Value |
|-------------------------------------------|----------|----------|----------|---------|
| Presentation 1                            | 0.3      | -0.7     | 0.2      | .03d    |
| Presentation 2                            | -0.2     | 0        | 0.7      |         |
| Presentation 3                            | -0.8     | 0        | 0.8      |         |
| Combined                                  | -0.2     | -0.2     | 0.6      |         |

| Section C. Solution                        | Tertile 1 | Tertile 2 | Tertile 3 | p Value |
|-------------------------------------------|----------|----------|----------|---------|
| Presentation 1                            | 0.2      | 0.5      | 1.5      | .01c    |
| Presentation 2                            | -0.3     | 0.2      | 1.0      |         |
| Presentation 3                            | -0.2     | 0.5      | 1.2      |         |
| Combined                                  | -0.1     | 0.4      | 1.2      |         |

| Section D. References                      | Tertile 1 | Tertile 2 | Tertile 3 | p Value |
|-------------------------------------------|----------|----------|----------|---------|
| Presentation 1                            | 0.2      | 0.8      | 0.2      | NS      |
| Presentation 2                            | 0.8      | 1.5      | 1.0      |         |
| Presentation 3                            | 1.0      | 1.0      | 1.2      |         |
| Combined                                  | 0.7      | 1.1      | 0.8      |         |

| Section E. Presentation                    | Tertile 1 | Tertile 2 | Tertile 3 | p Value |
|-------------------------------------------|----------|----------|----------|---------|
| Presentation 1                            | -0.8     | -0.2     | -0.5     | NS      |
| Presentation 2                            | -0.8     | -0.3     | 0.3      |         |
| Presentation 3                            | -0.2     | 0.2      | 0.5      |         |
| Combined                                  | -0.6     | -0.1     | 0.1      |         |

| Overall Score                             | Tertile 1 | Tertile 2 | Tertile 3 | p Value |
|-------------------------------------------|----------|----------|----------|---------|
| Presentation 1                            | -0.2     | 1.5      | 1.8      | .01c    |
| Presentation 2                            | 0.3      | 0.8      | 3.7      |         |
| Presentation 3                            | -0.2     | 1.8      | 5.2      |         |
| Combined                                  | 0        | 1.4      | 3.5      |         |

- Tertile 1 = top five course performers; Tertile 2 = middle five course performers; Tertile 3 = bottom five course performers; NS = not significant
- Overall differences reported were calculated by averaging the differences between predicted and actual scores for each tertile on each section
- P values were calculated using combined overall difference between self-predicted and actual scores among tertiles using a multiple comparisons ANOVA
- Significant difference between Tertile 1 and Tertile 3 for combined difference in score prediction
- Significant difference between Tertile 1 and Tertile 3 and between Tertile 2 and Tertile 3 for combined difference in score prediction; p = .03 for both interactions
at the beginning and end of the semester. Additionally, students could also be asked to reflect on why their scores differed from faculty scores when completing action plans for improvement. These strategies will hopefully allow students to assess their performance in a more thoughtful manner.

Student performance prediction was also evaluated in groups of top, middle, and bottom performers (tertiles). Top performing students more accurately predicted their scores on multiple sections and overall scores compared to bottom performing students (Table 5). The top performing students were also more likely to display under-confidence. Conversely, the bottom tertile of course performers tended to display overconfidence, which increased with subsequent presentations. The trend found echoes one study conducted by Hacker and colleagues in undergraduate psychology students who were asked to predict their exam performance and received feedback on their self-assessment. Low performing students were found to be the most overconfident group, with overprediction increasing with each subsequent exam. This finding may be explained by the “unskilled and unaware” effect, a theory in which lack of skill leads to incorrect responses and inflated self-assessments. Performance prediction observed in our study among top performers could be secondary to undue modesty. Top performing students also tend to overestimate how well other people perform, resulting in underestimation of their performance compared to their peers. 

Providing individualized feedback for students may be a time-consuming endeavor for faculty and have conflicting results on metacognitive processes, as demonstrated previously. In our study, two pharmacy residents who served as course co-coordinators split this responsibility. On average, each took approximately one hour per activity to draft and send comments for their respective group of seven to eight students, or roughly eight to 10 minutes per student. To reduce faculty burden, more selective timing of feedback would likely be required for a class size larger than 15 students or in a setting with a single instructor. Feedback given did not appear to have any appreciable impact on quality of self- or peer-assessments. Though this activity was designed to help enhance metacognitive skills, individualized comments for these evaluations may not have the effect to warrant the amount of faculty time required.

The small sample size is an important limitation to our data analysis and may be susceptible to significant effects from outliers. The large outlier on presentation three may have influenced the statistical findings. Additionally, with the small sample in the current study, it may have been difficult to detect small differences in improvement in performance prediction over time or differences among levels of performers. Nonetheless, there were a few significant findings and data trends observed that were discussed. It is important to note that the changes in metacognitive judgment accuracy are likely influenced by thoughtful strategies employed over the semester; however, improvement from routine class experience should be considered.

CONCLUSION

Metacognitive skills are essential for any professional, though difficult to cultivate in a brief encounter or course. Incorporation of longitudinal continuous feedback may help learners become more aware of their own performance. Overall, integrating this strategy within our course helped students begin the process of developing and applying metacognitive strategies and devising plans for enhancement. These skills are integral to fostering life-long learning in the profession.

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