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INSTRUCTIONAL DESIGN AND ASSESSMENT

Student and Preceptor Perception of Performance in Advanced Pharmacy Practice Experiences

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Objective. To compare student self-assessment of confidence in drug knowledge and proficiency in skills before the start and at the end of the advanced pharmacy practice experiential program. Student self-assessment of knowledge and skills were also compared with preceptor evaluations.

Design. A survey instrument to assess student drug knowledge and pharmacy skills was created and administered at the end of the P3 and P4 years. The preceptor survey instrument was administered at the conclusion of the rotation year (May to April).

Assessment. P4 students displayed increased confidence in their drug knowledge and skills after completing the advanced pharmacy practice experiences. However, students rated themselves higher than their preceptors rated them in 6 areas of drug knowledge and 16 areas of pharmacy skills.

Conclusion. Students' level of confidence about their drug knowledge and skills increased significantly during the advanced pharmacy practice experiences. Pharmacy educators should teach students to improve their accuracy in self-assessment and develop the habit of regular introspection about their professional competence.

Keywords: self-assessment, assessment, advanced pharmacy practice experience, metacognition

INTRODUCTION

In making the transition from novice to expert, greater skill and accuracy in assessing one's own performance must be developed. Kruger & Dunning found that people tend to harbor overly positive views of their abilities in many domains.[1] The authors contend, "skills that engender competence in a particular domain are often the same skills necessary to evaluate competence in that domain."[1(p24)] In a series of 4 social psychology studies, they found that incompetent individuals overestimated their abilities, while the burden of expertise is the consistent tendency to underestimate and criticize one's own performance. Incompetent individuals fail to learn by observing the performance of others, whereas in the same situation, top performers tend to revise their self-assessment upward during their observations of other practitioners, probably because of their ability to assess competence in others.[1] Similar results are reported in medical education, but have not been documented in the literature of pharmacy education.[2-7]

The skill lacking in inexperienced individuals is metacognition, the ability to think about one's own thinking,[8] revealed in a lack of accuracy in evaluating personal performance. Individuals with metacognitive skills have insight into their own thought processes and can change their learning strategies based on an assessment of how well they are doing.[9] Research on metacognition indicates that it involves the regulation of learning that includes skills in planning, information management, comprehension monitoring, and evaluation.[10-11] Metacognitively aware people are able to use more learning strategies and perform better than their less aware peers.[12] Furthermore, Coutts & Rogers found that students who consistently overestimated their performance actually performed less well than their peers.[13] There is some evidence that women tend to underestimate their performance yet perform better, while men tend to overestimate their own performance yet perform less well than their female peers.[13] This has implications for pharmacy education because pharmacy classes are becoming increasingly female dominated.

Knowledge of both cognition and its regulation are required for metacognition to occur. The learner needs an understanding of self and strategies (declarative knowledge), how to use the strategies (procedural knowledge), and when and why to use the strategies (conditional knowledge).[14] The control, or regulation, of cognition requires the learner to plan, sequence, and monitor their

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learning in a way that improves performance.[12] Some researchers claim that there are meta-competencies, such as communication and problem-solving skills, that cross professional disciplines,[10] but these overarching qualities do not by themselves produce professional competence. Metacognition requires the learner to form a detailed mental model of the intended problem-solving situation, and therefore it tends to be domain specific. The better the individual can imagine or model "the situation in which they must use their knowledge, the easier it is [for them] to assess their level of preparation."[15(p309)]

Metacognitively aware learners are not necessarily more intelligent than their unaware peers, but they are more strategic and more accurate in their self-assessments, and therefore tend to perform better at solving professional problems.[16] Metacognitive skills are required for task analysis and self-management of the problem-solving process. If a problem is presented for which the learner does not immediately know what procedure to use, more metacognitively aware individuals will search for alternative methods for its solution. They may look for and recognize previously overlooked but relevant information, ways of combining information, or connections between prior knowledge and the current problem. Experts create mental representations of the problem that are linked to abstract principles of the professional discipline, whereas novices tend to fixate on concrete but possibly irrelevant aspects of the problem. Skilled problem solvers use metacognitive processes to modify their mental representation [of a problem] during the course of problem solving."[14(p52)] People who are effective problem solvers spend more time on higher-level planning to select a strategy and less time engaged in actual problem solving. Domain-specific knowledge tends to influence the type and amount of metacognitive planning in which individual practitioners engage.

Educational research focused on metacognition has sought to answer the question of whether students' learning can be improved with instruction in metacognitive skills.[9] The research provides an affirmative answer, and has moved from the laboratory to the classroom and other naturalistic learning settings necessitating acknowledgment that learning is context driven.[17] Students' perceptions of the demands of the learning situation and the setting where knowledge will be applied affect their use of skills and strategies, and to some degree the depth of their learning. Guided experience with self-assessment is fundamentally important for success in transferring knowledge and skill to a practice situation. Without feedback, there is little motivation to monitor one's current level of understanding and preparedness, particularly if there are no opportunities to revise based on one's assessment.[15] Without the expectation that students will monitor and revise their performance, students do not have the opportunity to be reflective, a critical element of self-assessment and metacognition. Multiple opportunities for feedback allow students to rehearse metacognitive strategies they will require for effective practice.

Metacognitive awareness allows students and practitioners to plan, organize, assess, and control their learning in order to maximize performance. Accuracy in self-assessment of skill performance is generally considered essential to effective professional practice in the health professions, and is one of the skills a student must learn to gain competence.[18-20] In order to take more responsibility for their own learning and developing abilities, learners need to increase their understanding of their current performance in relation to what they aim to do as well as the accepted standards for expected performance. "A successful active and reflective learning process includes learner engagement, self-assessment and feedback."[21(p233)] Reflective self-assessment allows learners to shape future performance based on understanding their current work and cognitive processes. As students graduate to become practitioners, their ability to maintain effective professional performance is essential to the success of the individual and the profession. Pharmacy education that does not teach students self-assessment skills has failed to equip them with the tools needed to continue to learn and expand their knowledge throughout their professional lives.

METHODS

The coordinators of the pharmacotherapy courses at Virginia Commonwealth University (VCU) School of Pharmacy developed 2 survey instruments to assess student drug knowledge and skills. One survey was prepared for the students and 1 was developed for the faculty preceptors. The response items were the same, but the instructions were different. Each item was rated on a 5-point Likert scale. The student survey was administered to the class of 2001 at the end of the third-professional year (P3)of didactic training, about 1 month before the advanced practice experiences commenced. This survey was administered to the same class when they were P4 students during their last rotation experience. Faculty preceptors were selected if they were assigned more than one rotation of students during the previous year. The faculty preceptor survey was mailed after the conclusion of the advanced practice experiences. The VCU Institutional Review Board approved the research project.

For statistical analysis, the median scores for each of the Drug Knowledge and Pharmacy Skill items were calculated. The Mann-Whitney rank sum test was used

Table 1. Survey Response Rates

Group Surveyed	Responses	Enrolled	Rate of Return
P3 students	72	83	87%
P4 students	76	83	92%
Faculty preceptors	77	148	52%

because it allowed the researchers to compare median scores from two independent samples. In this case, it was used to compare student assessment of drug knowledge and clinical skills before and at the end of the advanced practice experiences. It was also used to compare student assessment of knowledge and skills during the last experience and faculty preceptor evaluations. This test was selected because it was less likely than other parametric measures to produce Type II error. The level of significance was set a priori at 0.05. Survey data were analyzed using SPSS Version 11.5.

RESULTS

The survey response rates appear in Table 1. The student response rates were higher than the faculty preceptor response rates, mainly because this survey was completed during a scheduled on-campus meeting time of the students. The response rates for the faculty members exceeded 50%, and the student surveys were in the range of 90%. Sample size was limited by the number of students enrolled in the advanced pharmacy practice experience program and the number of preceptors taking significant numbers of students. Nevertheless, statistical power estimates were acceptable for an alpha of 0.05 and moderate effect size (ie, estimates of 0.80 to 0.90).

At the end of the P3 year students rated themselves as knowledgeable in the categories of generic name, intended use, therapeutic category, patient counseling, and monitoring patients, and as moderately knowledgeable in the remaining 23 categories. By the end of the P4 year, students rated themselves as knowledgeable in 11 categories (6 more in addition to the 4 from the previous year) and moderately knowledgeable in the remaining 17 categories. However, preceptors rated students as moderately knowledgeable in only 18 categories, and knowledgeable in 10 (Table 2). The items on which students overrated themselves in comparison to preceptor evaluation were precautions and controlled drug class; and they underrated themselves in mechanism of action. A graph depicting the distribution of median ratings of overall drug knowledge from the 3 surveys can be found in Figure 1. The difference between student ratings of themselves before and after the P4 year was significant for all pharmacy knowledge items (Table 3). By the end of the advanced pharmacy practice experiences, students rated themselves significantly higher than preceptors in 6 areas: generic name ($p = 0.029$), intended use ($p = 0.013$), unlabelled use ($p = 0.013$), therapeutic category ($p = 0.025$), patient counseling ($p \leq .001$), and controlled drug class ($p = 0.002$). See Table 3 for complete results.

Table 2. Comparison of Student and Preceptor Responses to Drug Knowledge Items

	Median Scores		
Drug Knowledge Item	P3 2001 (N=72)	P4 2001 (N=76)	Preceptors (N=77)
Generic name	4	4	4
Trade name	3	4	4
Intended use	4	4	4
Unlabeled use	3	3	3
Therapeutic category	4	4	4
Mechanism of action	3	3	4
Pharmacokinetics	3	3	3
Pharmacodynamics	3	3	3
Adverse effects	3	4	4
Precautions	3	4	3
Contraindications	3	3	3
Drug/drug interactions	3	3	3
Drug/food interactions	3	3	3
Drug/herb interactions	3	3	3
Patient counseling	4	4	4
Controlled drug class	3	4	3
Dosage forms available	3	3	3
Initial dose	3	3	3
Usual dose	3	4	4
Dose in elderly/pediatrics	3	3	3
Dose in renal impairment	3	3	3
Dose in liver impairment	3	3	3
Dietary considerations	3	3	3
Therapeutic guidelines	3	4	4
Therapeutic range	3	3	3
Monitor patients	4	4	4
Packaging and storing	3	3	3
Pharmacoeconomics	3	3	3

Rating Scale: 1 = not knowledgeable, 2 = somewhat knowledgeable, 3 = moderately knowledgeable, 4 = knowledgeable, 5 = very knowledgeable

In the pharmacy skills assessment, students rated themselves as proficient at the end of the P3 year in 3 categories (ie, communicating with patients, writing pharmacy notes, and independent retrieval of drug information) and moderately proficient in the remaining 14 categories. By the end of the P4 year the students rated themselves as very proficient for 2 items (ie, communicating with patients and independent retrieval of drug information)

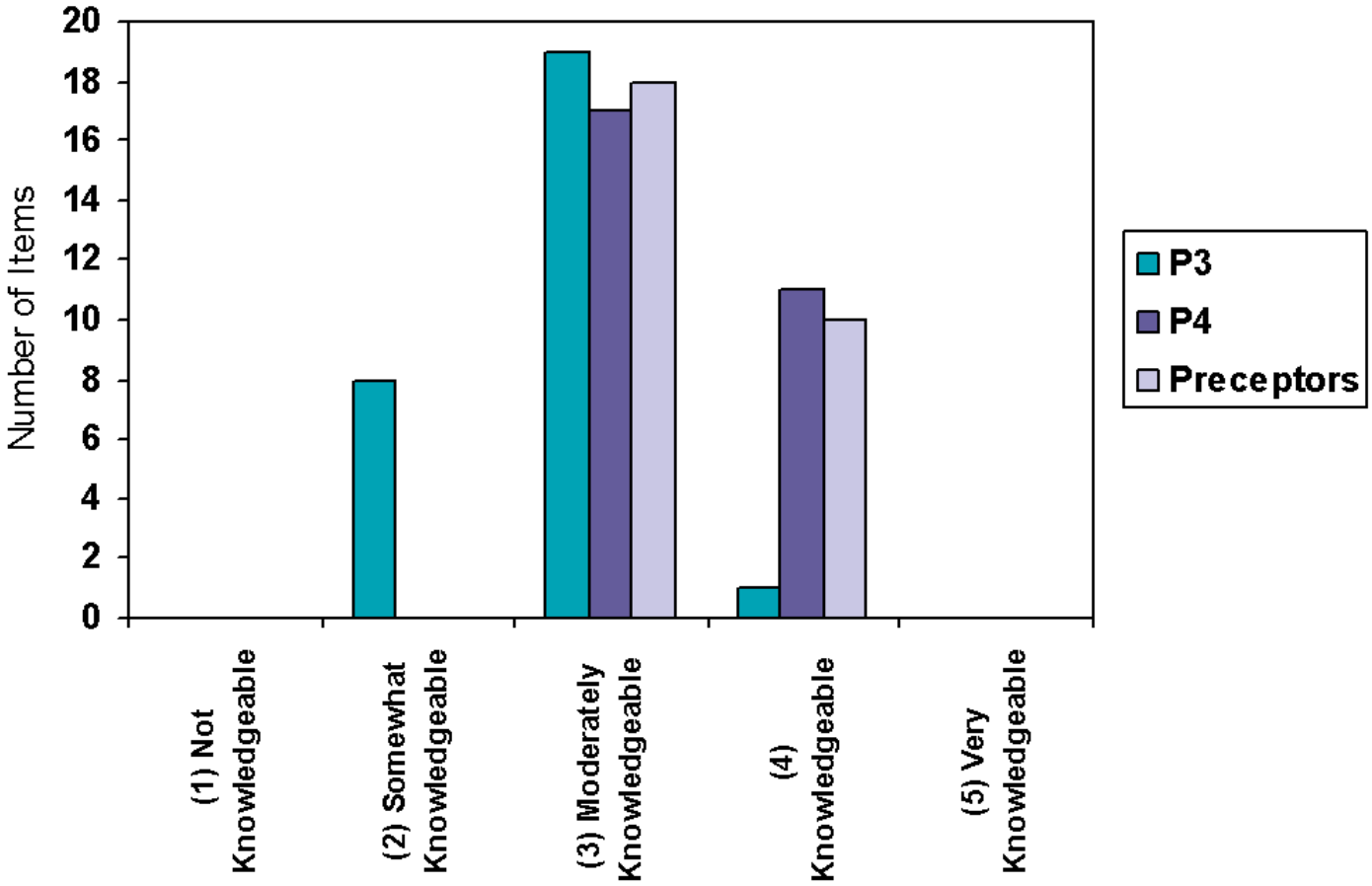

Figure 1. Distribution of the median scores of drug knowledge items.

and proficient in the remaining categories, with the exception of applying pharmacokinetic principles, which was rated as moderately proficient. The difference between median scores for students' skills revealed that faculty preceptors found students to be proficient on 7 items and moderately proficient for 10 items. The faculty preceptors did not rate students as very proficient for any item. Students overrated their proficiency in comparison to preceptor evaluation in 11 of 17 areas: communicating with patients, problem solving, independent retrieval of drug information, application of knowledge to specific patients, monitoring drug therapy, determining the appropriate drug within a therapeutic class, recognizing drug-related problems, solving drug-related problems, detecting drug interactions, identifying adverse drug reactions, and applying clinical practice guidelines. These results are depicted in Table 4. A graph of the distribution of median scores of overall pharmacy skill items for P3 and P4 students and preceptors can be found in Figure 2. Again, the difference between student ratings of themselves before and after the P4 year was significant for all pharmacy skill items (Table 5). The students' level of confidence after completion of the advanced pharmacy practice experiences was significantly higher than preceptors' evaluations on 16 categories ($p < 0.05$). The only area where there was not a significant difference was in applying pharmacokinetic principles. See Table 5 for complete results.

DISCUSSION

Student's level of confidence about their drug knowledge and the proficiency of skills increased significantly during the advanced pharmacy practice experiences. However, P4 students rated themselves significantly higher on 29% (8/28) of drug knowledge items compared with faculty preceptor evaluation of student knowledge. P4 students assessed their skill levels higher than did faculty preceptors in 16 of 17 categories or 94%.

Limitations of the findings include faculty recall bias and use of an instrument that lacks validity and reliability. The response rate of faculty preceptors lagged behind the students' response rates, primarily because we could more easily obtain the data from students. In addition, faculty members were not responding to the knowledge and skills of a particular student; rather they were recalling the per-

Table 3. Comparison of P3 Student, P4 Student, and Preceptor Ratings of Drug Knowledge Items

	P3 and P4 Student Comparison		P4 Student and Preceptor Comparison	
	Mann-Whitney		Mann-Whitney	
Drug Knowledge Items	***U***	***P***	***U***	***P***
Generic name	1897	< 0.001	2394	0.029
Trade name	1355	< 0.001	2703	0.385
Intended use	1622	< 0.001	2306	0.013
Unlabeled use	1214	< 0.001	2196	0.013
Therapeutic category	1615	<0.001	2362	0.025
Mechanism of action	1571	< 0.001	2629	0.239
Pharmacokinetics	1869	< 0.001	2502	0.117
Pharmacodynamics	2101	0.007	2511	0.211
Adverse effects	1830	< 0.001	2607	0.197
Precautions	1994	0.002	2540	0.164
Contraindications	1872	< 0.001	2823	0.792
Drug/drug interactions	1754	< 0.001	2805	0.739
Drug/food interactions	1335	< 0.001	2533	0.171
Drug/herb interactions	1568	< 0.001	2536	0.332
Patient counseling	1573	< 0.001	1764	< 0.001
Controlled drug class	1708	<0.001	1848	0.002
Dosage forms available	1350	< 0.001	2457	0.142
Initial dose	1660	< 0.001	2661	0.357
Usual dose	1407	< 0.001	2849	0.875
Dose in elderly/pediatrics	1311	< 0.001	2685	0.825
Dose in renal impairment	1106	< 0.001	2475	0.164
Dose in liver impairment	1163	< 0.001	2469	0.152
Dietary considerations	1993	< 0.001	2542	0.264
Therapeutic guidelines	1365	< 0.001	2599	0.390
Therapeutic range	1512	< 0.001	2624	0.541
Monitor patients	1949	0.001	2450	0.084
Packaging and Storing	1664	< 0.001	2215	0.083
Pharmacoeconomics	1744	< 0.001	2570	0.336

formance of a number of students for 1 rotation year. Faculty members who were asked to participate precepted a large number of students per year, nevertheless asking faculty preceptors to rate a group of students may have added a layer of inaccuracy because of potential recall bias. The literature indicates that taking a pretest can alter performance on a posttest. This may not have been a factor since nearly 1 calendar year elapsed between students' completion of the survey instrument at the end of the P3 year and taking it again at the end of the Doctor of Pharmacy program. It would have been difficult in these circumstances to have used blinding and randomization. The survey results may not predict students' performance after graduation.

Despite the study's limitations, the results provide intriguing indications that our findings may substantiate research findings of studies conducted with other health professions students.[2-7,13] There were no major deficiencies detected by preceptors in the P4 students' drug knowledge and pharmacy skills. This correlates with the students' grades for the year. All the students passed the experiential program with grades of B or better. These students displayed increased confidence in their drug knowledge and skills at the end of the advanced pharmacy practice experiences. This is not surprising as a tremendous amount of learning occurs during the experiential program. However, P4 students appeared to be more confident in their skills than their faculty preceptors' assessment would justify. Perhaps because of their experience in the practice setting, preceptors have a more realistic perception of performance standards. However, alternate explanations of the data may include students' lack of

Table 4. Comparison of P4 Students and Preceptor Responses to Pharmacy Skill Items

Pharmacy Skills Items	Median Scores		
	P3 2001 (N = 72)	P4 2001 (N = 76)	Preceptors (N = 77)
Communicating with patients	4	5	4
Communicating with health care professionals	3	4	4
Writing pharmacy notes in medical record	4	4	4
Problem-solving	3	4	3
Dispensing	3	4	4
Independent retrieval of drug information	4	5	4
Information management	3	4	4
Application of knowledge to specific patients	3	4	3
Patient counseling	3	4	4
Monitoring drug therapy	3	4	3
Determining appropriate drug in therapeutic class for patient	3	4	3
Recognizing drug-related problems	3	4	3
Solving drug-related problems	3	4	3
Detecting drug interactions	3	4	3
Identifying adverse drug reactions	3	4	3
Applying pharmacokinetic principles	3	3	3
Applying clinical practice guidelines	3	4	3

Rating Scale: 1 = not proficient, 2 = somewhat proficient, 3 = moderately proficient, 4 = proficient, 5 = very proficient

metacognitive skills, overestimation of performance by male students, or that some students' egos led them to inflate their sense of confidence.

Research on student self-assessment has consistently demonstrated that students will tend to overestimate their performance compared to preceptor assessment,[2-7] and that students in the lower third of the class are likely to be even less accurate in their self-assessments.[13] Unfortunately, this tendency can lead them to remain poor performers in practice after graduation. The development of metacognitive skills to improve the accuracy of self-assessment of performance is an integral part of both professional and lifelong learning. If we expect students to take increasing responsibility for their own learning and shape their future performance, they need to develop greater understanding of their current performance in relation to professional expectations.[21] Developing curricular structures that facilitate judging performance make requirements for learning in the professions more visible to students.[20-21] Curricular elements supportive of reflective learning include explicit performance criteria that integrate knowledge and ability components, discussions with peers and faculty members, and the use of fair and honest feedback about learning and performance progress. Assessment of multiple performances over time can form a structured learning cycle in which students are actively engaged, able to reflectively self-assess, and receive constructive feedback.[14-15]

One example of a curricular element supportive of metacognition is the competency-based assessment process we have since implemented for the advanced pharmacy practice experiences. These establish detailed performance criteria for 19 graded competencies that are grouped in 4 categories: communication/education, pharmacy care plan, professionalism/initiative, and practice specific competencies. The scale for performance levels is: 1 = poorest anticipated performance level, 2 = less than expected performance level, 3 = average performance level, 4 = better than expected performance level, 5 = best anticipated performance level. Detailed expectations were written for each performance level for all 19 graded competencies. The purpose of creating new assessment forms and policy were to provide faculty members with better guidance in assessing students' performance according to criteria set for the graded competencies. The performance criteria also help students visualize the skilled performance they are expected to achieve in order to become successful practitioners. This grading rubric is used to structure the midpoint grading and the feedback that faculty provide to students regarding their achievement of the competencies. A student competency checklist is provided that students can use to facilitate the initial conversation between the student and faculty mem-

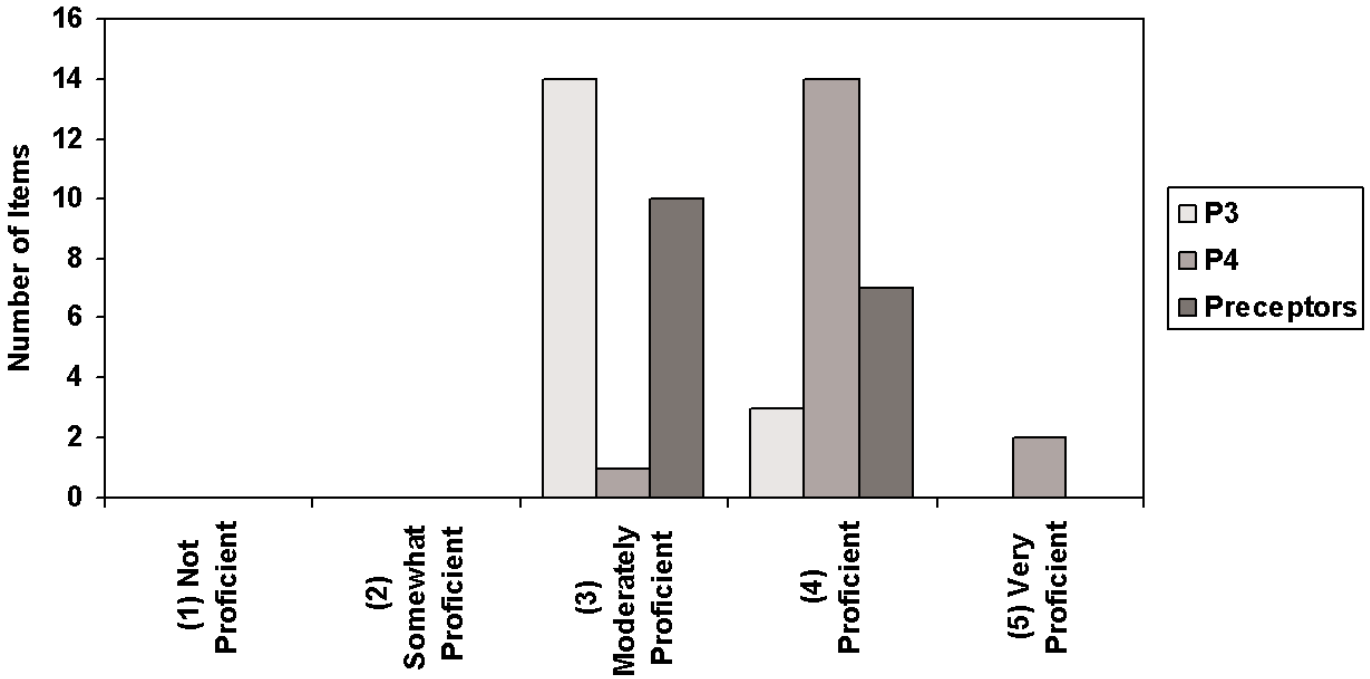

Figure 2. Distribution of median scores pharmacy skill items.

Table 5. Comparison of P3 Student, P4 Student, and Preceptor Ratings of Pharmacy Skill Items

	P3 and P4 Student Comparison		P4 Student and Preceptor Comparison	
	Mann-Whitney		Mann-Whitney	
Pharmacy Skill Items	***U***	***P***	***U***	***P***
Communicating with patients	1475	< 0.001	1505	< 0.001
Communicating with health care professionals	1516	< 0.001	2007	< 0.001
Writing pharmacy notes in medical record	2062	0.006	1834	0
Problem-solving	1964	0.002	1744	< 0.001
Dispensing	1454	< 0.001	1243	< 0.001
Independent retrieval of drug information	1448	< 0.001	1663	< 0.001
Information management	1424	< 0.001	1804	< 0.001
Application of knowledge to specific patients	1463	< 0.001	1610	< 0.001
Patient counseling	1540	< 0.001	1644	< 0.001
Monitoring drug therapy	1604	< 0.001	1818	< 0.001
Determining appropriate drug in therapeutic class for patient	1499	< 0.001	1538	< 0.001
Recognizing drug-related problems	1692	< 0.001	1605	< 0.001
Solving drug-related problems	1759	< 0.001	1663	< 0.001
Detecting drug interactions	1354	< 0.001	2154	0.008
Identifying adverse drug interactions	1459	< 0.001	1643	<0.001
Applying pharmacokinetic principles	1507	< 0.001	2302	0.056
Applying clinical practice guidelines	1269	< 0.001	1618	< 0.001

ber. Other examples are provided by Hacker et al in *Metacognition in Educational Theory and Practice*.[9]

CONCLUSIONS

The purpose of this study was to compare student self-assessment of confidence in drug knowledge and proficiency in skills before and after the advanced pharmacy practice experiences, and student self-assessment of knowledge and skills with preceptor evaluations. Self-assessment is an essential component of continuing, self-directed learning and the development and maintenance of professional competence.[4] Early in their professional education, pharmacy students need to begin developing their skills in self-assessment of skills performance in order to

become effective in professional practice. The Accreditation Council for Pharmaceutical Education Accreditation Standards (adopted 1997)[22] state that the "the process of measuring outcome expectations should include student self-assessments of performance in the stated professional competencies." They also urge schools of pharmacy to "promote lifelong learning through emphasis on active self-directed learning . . . for maintaining and enhancing professional competence." The development of competence is a gradual process of skill acquisition that is fostered by reflection on experiences. The public holds health professionals to a high standard of self-monitoring, and curriculum assessment should nurture learning and metacognition by fostering habits of self-reflection and self-remediation.[15,23]

Pharmacy educators need to teach students to improve their accuracy in self-assessment, and to develop the habit of regular introspection on their professional competence. The curriculum needs to provide opportunities for students to learn metacognitive skills of reflective self-awareness, provide feedback on students' reflections, incorporate multiple opportunities for self-assessment using a variety of modes, and assist students to move to increasing sophistication and integrity in self-assessment. Becoming more self-aware needs to be linked with future roles and foster attention to both the implicit and explicit criteria for effective practice. Students are able to develop confidence in their ability to transfer their knowledge and skills to new contexts when they are able to observe themselves doing it. Faculty members should be involved in providing empathetic but realistic feedback, guiding discussions, encouraging students, modeling self-reflective behavior, and valuing student self-assessment.[21] Self-assessment is central to students' growth as learners, and the principles of self-assessment as well as the meaning of performance criteria and their value should become essential components of the pharmacy curriculum.

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