BRIEF

Evaluating the Impact of Advanced Pharmacy Practice Experience on Student Pharmacist Metacognition

Alex N. Isaacs, PharmD, MS,^a Taylor D. Steuber, PharmD,^{b, c} Meredith L. Howard, PharmD,^d Eliza A. Dy-Boarman, PharmD,^e Sarah A. Nisly, PharmD, MEd^{f, g}

^a Purdue University, College of Pharmacy, West Lafayette, Indiana

^b Auburn University, Harrison School of Pharmacy, Auburn, Alabama

^c University of Auburn Birmingham, School of Medicine, Huntsville, Alabama

^d The University of North Texas Health Science Center at Fort Worth, College of Pharmacy, Fort Worth, Texas

^e Drake University, College of Pharmacy & Health Sciences, Des Moines, Iowa

^f Wingate University, School of Pharmacy, Wingate, North Carolina

^g Wake Forest Baptist Medical Center, Winston-Salem, North Carolina

Corresponding Author: Alex N. Isaacs, Purdue University, College of Pharmacy, 575 W. Stadium Mall, West Lafayette, IN 47907. Tel: 1-317-880-5423. Email: isaacs5@purdue.edu

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Objective. The objective of this study was to assess factors impacting metacognition during the advanced pharmacy practice experience (APPE) year for student pharmacists at five different institutions.

Methods. Student pharmacists completed a pre- and post-APPE year survey, which collected data on demographics, curricular and co-curricular experiences, and the 19-item modified metacognition assessment inventory (MAI). Additionally, the post-APPE survey collected data on learning activities completed during the APPE year. Matched survey responses were analyzed using paired t-tests and Spearman's correlation to identify associations between change in MAI and individual experiences.

Results. A total of 139 matched responses were analyzed. A statistically significant improvement in overall student pharmacist metacognition was seen in matched pre- versus post-APPE surveys. Several statistically significant, moderate to weak correlations were associated with a change in MAI over the APPE year.

Conclusion. The APPE year resulted in a statistically significant change in student pharmacists' metacognition at five institutions. This improvement was multifactorial as individual factors had minimal association with the change in metacognition.

Keywords: metacognition, experiential education, pharmacy education

INTRODUCTION

Metacognition was originally defined by Flavell as the "knowledge and cognition about cognitive phenomena as well as monitoring of one's own memory, comprehension, and cognitive enterprises."¹ Metacognition encompasses both knowledge of cognition (metacognitive knowledge) and regulation of cognition (metacognitive regulation).¹⁻⁵ Metacognition, including both metacognitive knowledge and regulation, is vital in the essential skills of pharmacists: clinical reasoning and critical thinking.¹ Student pharmacists' intrinsic ability to "think about thinking" can heavily influence confidence and performance within their professional development as a learner and in their future as a practitioner.¹⁻⁸

While not explicitly stated in the ACPE Standards, student pharmacists and pharmacists possessing greater metacognitive awareness may have improved ability to develop and apply clinical reasoning, and would therefore be important to address.^{2,6-9} The impact on clinical reasoning is not only intrinsic for the learner or practitioner, but there is also new evidence showing the impact of metacognition on patient outcomes.¹⁰ Additionally, metacognition is linked with self-regulated and lifelong learning, both of which are also essential skills for pharmacists as they navigate advances in practice and newly published literature.^{3,11,12} In order to produce competent and impactful practice-ready graduates, the academy must promote metacognition within learners to enable continuous reflection along with knowledge and skill acquisition throughout their careers.^{2,3,7-13} Metacognition is often intertwined with expertise, as an expert must be able to be aware and monitor their thinking.^{13,14} While expertise itself is a product of time and experience, pharmacy educators

can promote and facilitate metacognition within student pharmacists to aid in the transition to practitioners and experts.^{13,14}

Various strategies, activities, experiences, and approaches have been proposed to enhance metacognition in health professions students.^{2-5,7,8-20} In the didactic setting, methods include structured and specific learning objectives to guide learners, activities that allow them to monitor their understanding, and opportunities to evaluate their thinking during the learning and assessment processes.^{2,3,7,8,11,13,15-19} One medical school has incorporated an entire course focused on metacognition to stress the importance of the topic and facilitate development of this vital skill through readings, reflective activities, and group dialogue.⁹ Other proven methods to enhance metacognition in classroom-based environments include exam reviews and utilization of guided reflections.³ However, a recent study in nursing education revealed the deficiencies in students utilizing metacognition in a clinical simulation, further supporting the need to identify and implement strategies to facilitate this skill in health professions students.²⁰

In clinical education, suggested strategies to develop metacognition include mastery goal setting with reflective exercises, utilization of written and verbal communication to explain thought processes and reasoning, and scaffolded activities which increase autonomy.^{2-4,7,8,11,12,16} Additionally, modeling and coaching by clinical educators have been proposed to facilitate metacognition in health professions education.¹⁶ However, research is lacking in the experiential education setting to support the development of student metacognition in health professions education.³ Identifying opportunities or characteristics of clinical learning environments that contribute to improved metacognition would be beneficial in developing competent, autonomous pharmacists. Therefore, the objective of this study was to assess factors impacting pharmacy student metacognition throughout their advanced pharmacy practice experience (APPE) year.

METHODS

Participants & Recruitment

This preliminary study was conducted at five schools of pharmacy throughout the United States of America (USA) and consisted of two anonymous surveys. Doctor of Pharmacy students in their final year at all institutions were invited to participate in the study at the beginning of their APPE year. The APPE year commenced in May for all institutions with a variable APPE duration of four to six weeks. Student pharmacists were invited by email to complete the electronic pre-APPE survey in May 2019 via Qualtrics® (Qualtrics LLC, Provo, UT). All student pharmacists also received email invitations to complete the electronic post-APPE survey at the end of the APPE year in April 2020. For both surveys, student pharmacists received a follow-up reminder email one week after the initial invitation, with both surveys available for three weeks. Participation in the study was voluntary across all institutions; however, two institutions incentivized participation by selecting five recipients for a gift card award through a random drawing.

Survey Instrument

Metacognition was assessed using a modified version of the Metacognitive Awareness Inventory (MAI).^{21,22} The original MAI is a 52-item self-report instrument created to measure knowledge of cognition and regulation of cognition.²¹ Harrison and colleagues further examined the function of the MAI within higher education and based on the results created a shortened, modified 19-item MAI that resulted in a better model fit.²² This modified MAI utilizes a 5-point Likert scale to assess metacognitive knowledge (8 items) and metacognitive regulation (11 items). Metacognitive knowledge relates to the awareness of individuals to their thought process and learning while metacognitive regulation is the planning for learning.²² The MAI can have a total score of up to 95, with higher scores indicating a higher degree of metacognition.²²

After consenting, participants created a unique identifier to be used in both the pre-APPE and post-APPE surveys. The pre-APPE surveys collected data on baseline demographics, metacognition as assessed by the modified MAI, and participation in curricular and co-curricular activities (educational, cultural, self-awareness, leadership, innovation/entrepreneurship, and professionalism) prior to APPEs.⁶ The post-APPE survey similarly collected data on student pharmacists' demographics, metacognition (using the modified MAI), participation in curricular and co-curricular activities during the APPE year, and details about their APPE year (eg, type of clinical experiences, learning activities, and performance).

Analysis

Following completion of the study, survey results from all institutions were combined for data analysis. Results from the pre-APPE and post-APPE surveys were matched using the unique student identifiers. Data was analyzed to assess for changes in MAI scores and factors influencing any changes to those scores. Only matched responses, utilizing unique identifiers from student pharmacists who completed both the pre-APPE and post-APPE surveys, were included in

the data analysis. Paired t-tests were used to analyze the change in pre-APPE and post-APPE MAI scores. A Spearman's correlation was conducted on the paired data to evaluate associations with the change in MAI. A p -value <0.05 was considered statistically significant. The project was deemed exempt by all five institutional review boards.

RESULTS

Of the 560 eligible participants, 245 completed the pre-survey (44% response rate), 257 completed the post-survey (46% response rate), and 139 completed both, leaving them eligible for data analysis (25% response rate). Baseline characteristics and co-curricular experiences for matched respondents are detailed in Table 1 and Table 2, respectively.

The pre-APPE combined metacognitive median score was 72 (interquartile range [IQR] 65-80) with a metacognitive knowledge median of 32 (IQR 29-36) and metacognitive regulation median of 40 (IQR 36-45). There was a significant enhancement in all post-APPE median metacognitive scores: combined (74, IQR 69-82, $p<0.01$), metacognitive knowledge (32, IQR 30-36, $p=0.03$), and metacognitive regulation (42, IQR 38-46, $p<0.01$). Table 3 details significant associations between the change in metacognition and student characteristics. Pre-APPE metacognition had a moderate association in the change in metacognition (0.50, $p<0.01$), while others showing statistical significance only had a weak association.

DISCUSSION

In this study, there was a statistically significant change in overall student metacognition during the APPE year. Additionally, specific factors such as higher pre-APPE combined metacognition scores, professional work experience, quantity of self-reflections, and participation in professionalism journal clubs were associated with positive change in metacognition. With limited literature evaluating factors impacting metacognition in experiential education, this expands upon existing literature by evaluating the change over the APPE year and the associated factors impacting metacognition.

For health professions students, including student pharmacists, there is a lack of evidence regarding factors and activities which can impact metacognition in the experiential setting.³ Within pharmacy education, Martirosov and Moser introduced the concept of metacognition and assessed student metacognition before and after a semester-long team-based learning course for second-year student pharmacists at one institution.¹⁵ Their study found that after the course, there was a significant improvement in metacognition, as measured by the 52-item MAI (77% vs. 84%, $p<0.01$).¹⁵ Their study points to an option to enhance metacognition during the didactic curriculum, but no evaluation was done within experiential education.¹⁵ A recent article in experiential education showed the enhanced metacognitive accuracy of student pharmacist self-assessment as compared with faculty assessment of student performance on entrustable professional activities (EPA) between introductory pharmacy practice experiences and the beginning of APPEs; however, there was no overall difference noted in accuracy enhancement throughout the APPE year.¹² The only EPA with enhanced metacognitive accuracy was for documentation in an electronic health record, possibly due to the reflective nature and/or increased experience with documentation.¹²

During APPEs, student pharmacists participate in numerous patient care and learning activities, but commonalities across experiences are some level of self-directed learning, self-assessment, reflection upon feedback, and growth in clinical knowledge.⁶ While metacognitive skills are assumed to grow throughout APPEs, this current study provides evidence of that metacognitive change, as there was statistically significant improvement in combined metacognition, metacognitive knowledge, and metacognitive regulation at the end of the APPE year. For factors associated with the change in metacognition, pre-APPE combined metacognition had the strongest association, potentially indicating that students with strong metacognition prior to APPEs may already possess the processes needed to achieve higher metacognitive growth during the APPE year. This points towards the need to not only facilitate metacognition in experiential education, but doing so in the didactic curriculum may enable further growth during APPEs.

When evaluating other individual factors associated with a change in metacognition during the APPE year, there were only weak associations, pointing to a multifactorial impact. Outside of pre-APPE metacognition, the second largest association with the change in metacognition was with the quantity of self-reflections. This aligns with previous studies highlighting the importance of intentional reflection to facilitate metacognition.^{3,5,11,12,18} Work experience, although a weak association in the current study, does align with expertise and enhanced metacognition within the literature.^{11,12,18} The observational nature of this study did not allow for control of time and the experiences themselves, which were potentially responsible for the enhanced metacognition over the APPE year. Based on the current study as well as previous literature, causative factors during the APPE year resulting in metacognitive growth may be due to clinical experience, time, the educator and structure of the learning experiences, and intentional reflection.^{11-14,23} For experiential preceptors looking to facilitate metacognitive growth, implementing regular reflective exercises and activities, such as professionalism journal clubs, on their rotation may help. Future research is warranted to evaluate these interventions

alone and in combination within pharmacy experiential education. An additional area needed for future research is the impact of metacognition on patient outcomes for health professions students.^{2,3,7,8,10} In a study in obstetrics, physicians with a higher metacognition were more likely to have better maternal and neonatal outcomes.¹⁰ Their study, in non-trainees, shows an impact on patient outcomes; however, there is a lack of data from this study or others in relation to learner metacognition and its influence on patient outcomes. Finally, research evaluating longitudinal metacognitive changes in student pharmacists in the curriculum as a whole, including both didactic and experiential learning, is warranted.

This study serves as an important preliminary study, measuring the change in metacognition over the APPE year for student pharmacists. However, there are limitations which may impact the findings. First, student pharmacists from the five different schools of pharmacy had varying institutional-based factors, such as varied duration of APPEs, assignment requirements, geographical practice patterns, etc.⁶ However, this is generalizable across the academy, reflecting the inherent differences amongst programs and expanding generalizability. Additional limitations include the weak associations found, as noted above. Finally, the paired overall matched response rate was low at 25%, which impacts generalizability and must be taken into consideration when reviewing the results.²⁴ Despite this limitation, this current study represents the largest sample evaluating metacognition change in experiential education amongst health professions students to date.

CONCLUSION

A statistically significant change in overall metacognition was noted during the APPE year for student pharmacists at five institutions. The improvement was multifactorial as individual factors had minimal association with the change in metacognition. There may be opportunities for institutions to further incorporate learning activities to enhance student metacognition within the didactic and experiential curricula, such as introducing metacognition concepts and implementing or expanding intentional reflective activities. Additional studies are warranted to identify how experiential education can impact metacognitive growth in student pharmacists.

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Table 1: Baseline Characteristics of Matched Respondents (N=139)

Pre-APPE Characteristic	
Gender – n (%)	
Female	107 (77%)
Male	32 (23%)
Age – median (IQR) ^a	25 (24-26)
School – n (%)	
Institution A	10 (7%)
Institution B	28 (20%)
Institution C	42 (30%)
Institution D	29 (21%)
Institution E	30 (22%)
Pre-APPE GPA – median (IQR)	3.6 (3.3-3.8)
≥ 1 APPE with a full-time faculty member	115 (83%)

^a Age at completion of pre-survey; IQR = interquartile range; APPE = advanced pharmacy practice experience

Table 2: Co-curricular Experiences Before and During APPE Year (N=139)

Co-curricular Experience ⁶	Before APPEs – n (%)	During APPEs – n (%)
Professional work	128 (92%)	114 (82%)
Education	115 (83%)	101 (73%)
Cultural	106 (76%)	64 (46%)
Self-awareness	103 (74%)	103 (74%)
Leadership	122 (88%)	81 (58%)
Innovation	76 (55%)	35 (25%)
Professionalism	84 (60%)	44 (32%)

Table 3: Significant Associations with Pre-APPE, Post-APPE, and Change in Metacognition (N=139)

Characteristic	Association with metacognition (r_s)	p value
<i>Pre-APPE</i>		
Gender	0.19	.02
Age	0.20	.02
Education co-curricular experience	0.20	.02
Mentoring health professional students	0.19	.02
Participating in a health fair	0.17	.04
Collegiate leadership	0.18	.03
Participating in innovation healthcare competition	0.23	<.01
Professionalism co-curricular experience	0.20	.02
<i>Post-APPE</i>		
Clinical teaching to group of patients	0.18	.03
Volunteering at an underserved clinic	0.18	.04
Participating in a health fair	0.23	<.01
Creating a pharmacy business plan	0.17	.04
Participating in innovation healthcare competition	0.19	.02
Creating a professional portfolio	0.19	.03
Leading a professionalism journal club	0.22	.01
Quantity of APPE full-time faculty	- 0.18	.03
Student reported APPE autonomy afforded	0.22	<.01
Quantity of clinical discussions led	0.25	<.01
Quantity of journal clubs led	0.35	<.01
Quantity of formal patient case presentations	0.25	<.01
<i>Change in metacognition over APPE year</i>		
Pre-APPE combined metacognition	0.50	<.01
Professional work experience	0.19	.04
Leading a professionalism journal club	0.21	.02
Quantity of documented self-reflections	0.26	.04

 r_s =Spearman's rho correlation coefficient