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RESEARCH ARTICLE

Early career pharmacists' perspectives on whether/how their student research experiences influenced their essential skills: A mixed-methods study

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Abstract

Background: While many pharmacy school guidelines advocate enhancing student knowledge, skills, and scientific thinking in the classroom, the value of research experiences has received less attention. This study examined how research experiences influence professional pharmacy students' essential skills from the perspective of recent graduates. **Methods:** Using a convergent mixed-methods design, pharmacists who conducted research at while enrolled completed an online survey assessing their collaboration, communication, critical thinking, and creativity and then a semi-structured interview explaining their ratings. Friedman's rank-order test was used to analyse perceived skill development. Framework analysis was used to identify themes across interviews. **Results:** Participants rated collaboration as their strongest skill, significantly higher than critical thinking and creativity. Three qualitative themes emerged. The first describes factors influencing their quantitative rankings, including standards for achievement and professional identity. The second describes how research experience supported skill development. The third describes whether these skills could be developed in the classroom setting. **Conclusion:** Participants' perceptions echo pharmacy education's curricular emphasis on collaboration and communication. In addition to these skills, research experiences can support critical thinking and creativity skills. Explicitly linking how research opportunities enhance accreditation required outcomes could better highlight how research experiences add value to the existing pharmacy curriculum.

Introduction

Professional pharmacy education equips students with knowledge about drug pharmacology, pharmacokinetics, efficacy, and safety (Medina *et al.,* 2023). Within the United States, it emphasises clinical applications that establish a solid foundation for passing the North American Pharmacist Licensure Examination (NAPLEX). As computer systems become increasingly capable of retrieving medication-related information, the pharmacy profession is shifting toward a stronger emphasis on preparing students to create and apply new knowledge (Adebisi, 2022; Choong & Leung, 2022; Raza *et al.,* 2022). Although undergraduate research experiences are known to improve related student outcomes (Chameley-Wiik *et al.,* 2023; Council on Undergraduate Research, N.D), their value for pharmacy students remains underexplored, particularly as many pharmacy

programmes do not require a prior bachelor's degree (Pharmacy College Application Service, 2025).

The core Pharm.D. curriculum typically requires 140 to 180 credit hours in addition to the prerequisite requirements for admission. While a typical bachelor's degree is composed of 120 credit hours, of which at least 30 are distributed across academic disciplines (Higher Learning Commission, 2026), the median Pharm.D. programme requires just 60 prerequisite credit hours largely in science and math courses (Pharmacy College Application Service, 2026). Consequently, pharmacy students may have fewer opportunities to participate in research experiences available through traditional undergraduate pathways. This possibility is reinforced by the fact that prerequisites vary across institutions, and bachelor's degrees without the specified prerequisites are largely insufficient for admission (Chesnut *et al.,* 2022).

The American College of Clinical Pharmacy (ACCP) Taskforce on Research in the Professional Curriculum advocates for eight key research competencies to be incorporated into routine academic activities, e.g., case work, practical examinations, etc. (ACCP *et al.,* 2010; Karnes *et al.,* 2022). However, engaging student pharmacists in research experiences that provide exposure to formulating research questions, developing study designs, implementing methodologies, generating results, and disseminating new knowledge is often not prioritised, largely because of limited space and time within the required Pharm.D. curriculum.

Post-graduation, the American Society of Health-System Pharmacists (ASHP) residency training standards require that residents "*demonstrate [an] ability to evaluate and investigate practice, review data, and assimilate scientific evidence*" (American Society of Health-System Pharmacists, 2018; Personett *et al.,* 2018; Murphy *et al.,* 2024). The success of residency programmes could be measured, in part, with dissemination metrics, e.g., presentations or publications of original research or service evaluations (Morbitzer *et al.,* 2019; Bingham *et al.,* 2020). However, dissemination metrics may not adequately capture the pedagogical value of research experiences (Ellison & Patel, 2022).

Pedagogically, research experiences could contribute to the development of several competencies outlined in the American Association of Colleges of Pharmacy (AACP) 2022 Curricular Outcomes and Entrustable Professional Activities (COEPA), such as collaboration, communication, scientific thinking, and problem solving (Petrella & Jung, 2008). The COEPA framework was integrated into the Accreditation Council for Pharmacy Education (ACPE) Accreditation 2025 Standards for professional programmes leading to the Pharm.D. degree. While these skills are certainly promoted with existing educational activities, e.g., casework, presentations, etc., often these activities have specific pre-determined correct answers; by its very nature, original research seeks to generate new knowledge. Within pharmacy education, these skills are called "*essential skills*" (Frenzel *et al.,* 2021). Outside of academia, these skills are called "*21st-century skills*" to denote their importance to 21st-century employers (Chen, 2021).

Despite growing recognition of the importance of these competencies, little is known about how research experiences contribute to pharmacy students' development. The present study investigates whether and how professional pharmacy student research experiences influence the development of essential, knowledge-generating skills from the perspective of early-career pharmacists.

Methods

Study design

A convergent mixed-method study was conducted of the fully integrated variant, in which the "*quantitative and qualitative strands of a study interact with each other during the implementation instead of the researcher keeping them separate and independent*" (Cresswell & Plano Clark, 2018, p. 74; University of Health Sciences and Pharmacy, IRB Code: 2023-23). In this design variant, integration is an incidental part of implementation. The methodological approach was pragmatic, prioritising the qualitative aspect, i.e., quant+QUAL (Yvonne Feilzer, 2010). The current report focuses on student skill development. A separate report focuses on student belonging (Schmidtke *et al.,* 2026). No a priority theory guided how participants would assess their skills.

The study was led by KAS (PhD, female), who had over 10 years of experience conducting mixed-methods research. At the time the study was conducted, KAS was a new faculty member who had not worked with study participants in classes or research. Study materials were co-produced with professors of pharmacy (PY, KB, SG, SM) and a pharmacy research fellow (JA). A quantitative researcher (SO) advised on the quantitative survey selection and analysis. The semi-structured interview guide was piloted with a pharmacy professor and a student researcher.

Participant selection and setting/context

To inductively identify themes, we aimed to recruit up to 30 participants (Malterud *et al.,* 2016; Hennink & Kaiser, 2022). Participants were required to be graduates of a professional pharmacy school, 2024 or prior, who engaged in research while enrolled. Graduation was checked against the school's records. At the time, students could enroll in a pre-pharmacy programme to complete prerequisites before enrolling in the professional school. Research opportunities were largely offered through an apprenticeship model in which students contribute to mentors' existing projects.

Participants were identified using previous research symposium agendas, faculty connections, emails, and social media accounts. Snowball methods were used to identify additional participants. Participants provided informed consent before completing the survey and reaffirmed consent before the interview.

To be included, participants' research activities had to be mentored by a faculty or staff member and conducted outside the common curriculum. Where students engaged in multiple projects, they were encouraged to discuss them and a non-university mentor may have played this role for some projects. No minimum duration or dissemination activities were required. The diversity of project topics participants ultimately discussed is an unplanned study finding.

Data collection

Quantitative online survey

Participants self-assessed their collaboration, communication, critical thinking, and creativity skills using Kelley and authors' "*21st-Century Skills*" survey (Kelley *et al.,* 2019). The survey was originally designed with senior high school students, and items have been adapted for use with college students (Rachevski & Vaknin-Nusbaum, 2025; Zhong *et al.* 2025). In the survey, participants report how much they agree with statements using Likert scales in which 1 indicates "*strongly disagree*," and 5 indicates "*strongly agree*." Example items are provided here: 1 of the 9 collaboration items states, "*I'm confident in my ability to improve my work when given feedback*"; 1 of the 5 communication items states, "*I am confident in my ability to present all information clearly, concisely, and logically*"; 1 of the 11 critical thinking items states, "*I am confident in my ability to evaluate reasoning and evidence that support an argument*"; and 1 of the 5 creativity item states, "*I am confident in my ability to elaborate and improve on ideas*." No survey has been designed to evaluate the COEPA skills. Regarding the COEPA outcomes (Standards 2.1), the collaboration and communication skills relate to at least the following outcomes: Interprofessional Collaboration (Collaborator) and Communication (Communicator). The critical thinking and creativity skills relate to at least the following: Scientific thinking (Learner), and Problem-solving process (Problem-Solver).

In the survey, participants also indicated their graduation year and sex. The survey setup required participants to complete all items before scheduling their interview via the Calendly app.

Qualitative interviews

Individual interviews were conducted and recorded on Microsoft Teams from May 2024 to September 2024. The interviews lasted a median duration of 22 minutes (range: 10.5 to 35.5 minutes), during which KAS flexibly engaged a semi-structured interview guide (see Appendix A) and took field notes to aid theme development. At the beginning of their interview, participants described their student research experience. Then, the interviewer reminded participants about their skills assessments. Participants were asked to explain why they rated their skills the way they did and were invited to describe whether and how their research and classroom experiences influenced those skills. Next, participants were asked which skill their current employer most valued. Lastly, participants were offered an opportunity to review their transcripts.

After each interview, the interviewer wrote brief summaries capturing the main points raised. Then, the interviewer transcribed the interview verbatim and redacted identifiable information. A draft of the manuscript was sent to participants for final checking.

Data analysis

Demographic data

Demographic data are summarised using tables, tallies, and descriptive statistics.

Quantitative online survey

A mean score was calculated for each participant's four 21st-century skills. Then, Friedman's rank-order test is used to compare participants' perceptions of their essential, knowledge-generating skills. Mean rank orders are reported for each 21st-century skill. Differences between pairs of skills are assessed using Wilcoxon signed-rank tests, and significant differences are determined at a 0.05 alpha level with Bonferroni corrections.

Qualitative semi-structured interview

Framework analysis is used to explain why participants assessed their skills the way they did and to explore factors influencing skill development (Gale *et al.,* 2013). KAS guided this iterative and reflective analysis with two student researchers (GS and ZV).

The initial 27 transcripts were independently reviewed and collaboratively discussed to develop codes, categories, and a thematic framework describing participant perspectives. Conforming and divergent cases were discussed. Once a framework was agreed, previous transcripts were reviewed. Then, the final 3 transcripts were reviewed. As no new inductive codes emerged, the research team agreed that saturation had been achieved. Relevant quotes were selected to represent each inductive theme. The data was organised using Microsoft Excel. A concept map was created to summarise findings.

During reflective analysis, the research team collaboratively decided to create two sets of codes to be quantified in the report. The first set of codes describes whether skills were developed in the research setting (or not); here, the student researchers independently coded each skill for each participant as: "*being developed in the research setting*," "*not being developed in the research setting*," or "*unspecified*." The second set of codes describes whether the research setting provided something beyond the classroom setting to promote skill development; here, the student researchers independently coded whether each participant expressed that these skills could be developed in the classroom setting: "*yes*," "*maybe yes*," "*maybe no*," or "*no*." Disagreements were resolved through consensus discussions with KAS arbitrating. Initial agreements are captured with percentages and Cohen's Kappa statistics. In line with the framework analysis method, these statistics are provided to describe our collaborative process.

Results

Participant characteristics

Of the 30 participants, 21 identified as female, 8 as male, and one chose not to disclose. Difficulties in scheduling prevented three potential participants from taking part. Participants graduated between 2018 and 2024, inclusive. A total of 22 participants conducted research with faculty in the pharmacy department, seven worked with the basic science department, and six worked with the liberal arts department. Some participants worked with multiple professors within or across departments. Descriptions of the participants' student research experiences are in Table I.Table I: Description of the research participants conducted and their current job titles.

Table I: Description of the research participants conducted and their current job titles

ID	Department(s) worked with/ Brief description of research project(s)	Current Job
P1	Pharmacy/ Conducting studies to understand pain perception with mouse models	Clinical pharmacist
P2	Pharmacy/ Analysing patient data comparing the effectiveness of daptomycin and vancomycin for recurrent osteomyelitis	Pharmacy resident
P3	Pharmacy/ Conducting a quality improvement project about medication synchronisation	Policy advisor & Community pharmacist
P4	Basic Science and Pharmacy/ Designing a database with an amino acid mimicking a desired proteome and analysing patient neurological data	Informatics pharmacist
P5	Basic Science/ Collecting swabs to test for Methicillin-resistant Staphylococcus aureus (MRSA) in clinical settings	Clinical pharmacist
P6	Pharmacy/ Analysing ambulatory care data about adherence to pneumococcal vaccine schedules	Clinical pharmacist
P7	Basic Science and Pharmacy/ Writing a manuscript about staph bacteria growth and analysing student emergency outbreak preparedness	Executive assistant
P8	Pharmacy/ Analysing patient data about nephrotoxicity levels, Blinatumomab effectiveness for treating leukemia, and pediatric urinary tract infections	Pharmacy resident
P9	Liberal Arts/ Reviewing literacy text to understand how infectious diseases are characterised	Community pharmacist
P10	Basic Science/ Collecting swabs to test for MRSA in clinical settings	Clinical pharmacist
P11	Pharmacy/ Conducing studies to understand blood platelet thrombosis with mouse models	Community pharmacist
P12	Liberal Arts/ Analysing survey data about mediation savings behavior/hoarding	Clinical pharmacist
P13	Basic Science/ Conducting lab research to describe rhodotorula cell integrity	Clinical pharmacist
P14	Pharmacy/ Evaluating survey data about whether a new prep kit helps pharmacy students obtain residency	Clinical pharmacist

ID	Department(s) worked with/ Brief description of research project(s)	Current Job
P15	Pharmacy/ Evaluating survey data assessing whether a medical resident training rotation increased pharmacology knowledge	Clinical pharmacist
P16	Liberal Arts and Pharmacy/ Conducting surveys of student perceptions of elderly people and interviewing people in Guatemala about their wellbeing	Pharmacy supervisor
P17	Liberal Arts/ Reviewing comics to investigate how mental health is characterised	Community pharmacist
P18	Pharmacy/ Analysing data about patient medication adherence after receiving home blood pressure monitors	Clinical pharmacist
P19	Liberal Arts and Pharmacy/ Conducting student surveys about their perceptions of elderly people, community surveys about immigrant health screenings, and lab-based studies to develop a chemotherapy drug	Clinical pharmacist
P20	Basic Science and Pharmacy/ Evaluating the effects of gravity on bacteria growth; and evaluating patient data about infections and heart failure	Pharmacy resident
P21	Pharmacy/ Analysing data comparing the effectiveness of 2 treatments for heart failure (ACE and ARB medication with Entresto)	Conscription requirement
P22	Pharmacy/ Analysing patient data comparing the effectiveness of 2 pericarditis medications on infections	Community pharmacy
P23	Pharmacy/ Conducting a meta-analysis and conducting student surveys about new education outcomes	Clinical Pharmacist
P24	Pharmacy/ Analysing chart data and interviewing geriatric patients about medications before and after surgery	Pharmacy resident
P25	Basic Science and Pharmacy/ Conducting wildlife field research and literature reviews, and analysing public health data	Pharmacy resident
P26	Pharmacy/ Conducting cell cultures and polymerase chain reactions for estrogen receptors medications	Pharmacy resident
P27	Pharmacy/ Conducting a longitudinal study on graduate salaries and evaluating patient data about guideline adherence for hepatic dosing in hospital	Pharmacy resident
P28	Pharmacy/ Working with participants in a clinical trial about deprescribing, and analysing insurance and clinic data about opioid use	Pharmacy resident
P29	Pharmacy/ Working with participants in a clinical trial about deprescribing	Pharmacy resident
P30	Pharmacy/ Conducting a literature review assessing how Beta-lactam antibiotics infusions influenced patient outcomes	Pharmacy resident

Most participants identified as clinical pharmacists (11), followed by pharmacy residents (10), community pharmacists (4), or other (5). One participant was applying to serve their home country's conscription duties as a technical researcher. Most participants believed that their current employer most strongly valued critical thinking (9) or communication (9) skills, followed by collaboration (6). Fewer said a combination of collaboration and communication (4), or a combination of communication and critical thinking (1). No participant said creativity.

Quantitative results

Comparing rank orders of knowledge-generating skills

Participants perceived collaboration to be their most developed skill (mean rank = 3.42), followed by communication (mean rank = 2.55), creativity (mean rank = 2.17), and critical thinking (mean rank = 1.87). Friedman's rank-order test revealed a significant overall difference ($\chi^2(3) = 27.30$, $p < 0.001$). Pairwise comparisons revealed collaboration to be ranked significantly higher than critical thinking and creativity ($p < 0.005$). No other significant differences emerged.

Qualitative findings

Findings are organised across three thematic areas, see Figure 1. The first thematic area aims to explain why participants quantitatively assessed their skills as they did. The second explores whether/how participants developed each skill in the research setting. The third examines whether/how participants believe such skills can be developed in the classroom setting.

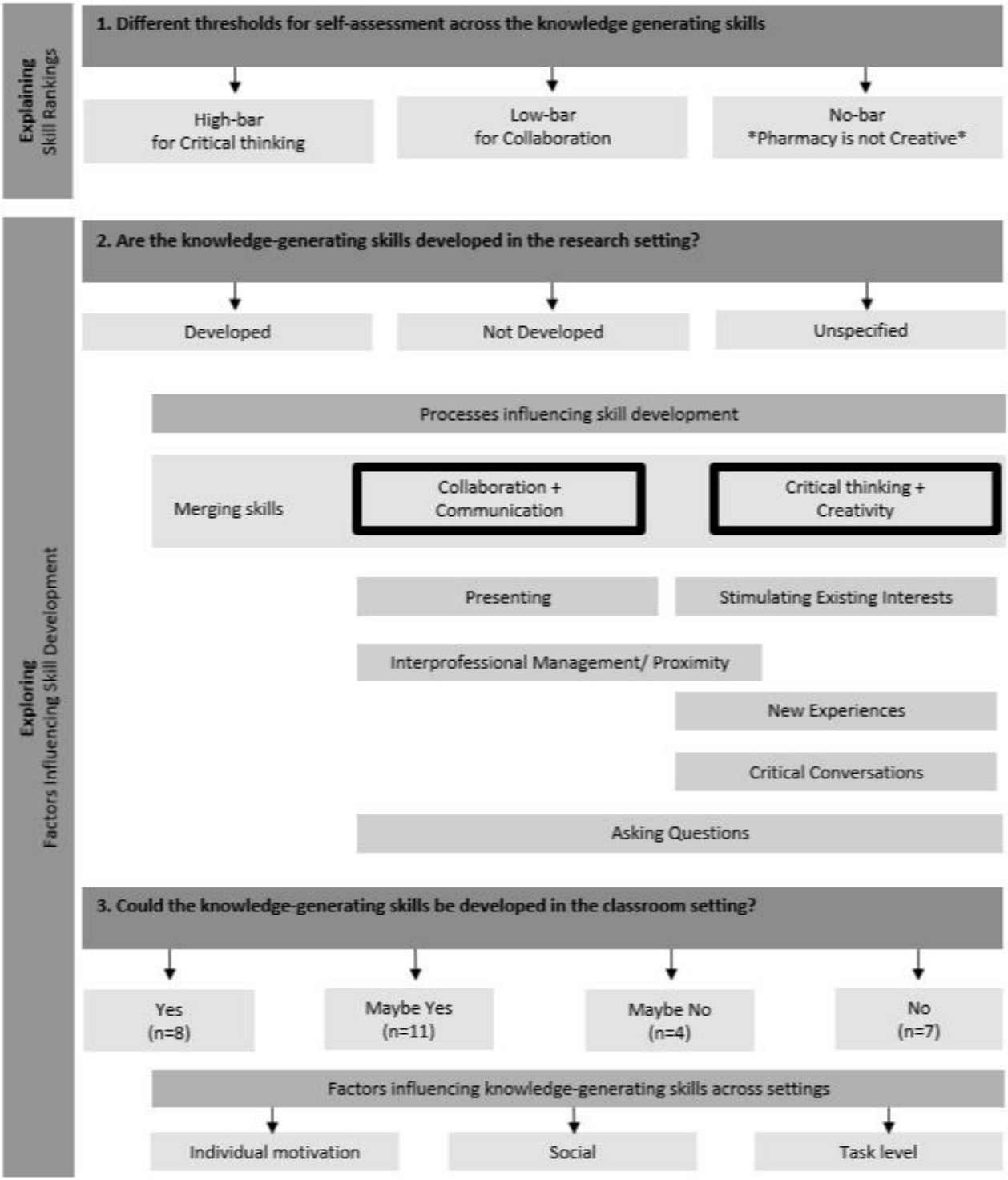

Figure 1: Concept map of thematic findings. Numbers indicate the section where more details can be found in the current article

Thematic area 1. Explaining: Different thresholds for self-assessment across skill

Part of the reason participants assessed their collaboration and communication skills as being stronger than their critical thinking skills is because they set different thresholds for mastery. As one participant said: "*I didn't score it [critical thinking] as high because there's always room for improvement, especially in critical thinking*" (P7, Executive assistant). Further room

for skill growth was not acknowledged for collaboration or communication.

In explaining why different thresholds were set, participants acknowledged a progression of skill development. Collaboration and communication were recognised as foundational skills. Commenting on their classroom experience, one participant noted: "*I think that collaboration and communication is something that I started to develop when I was an undergraduate student*" (P19, Clinical pharmacist). Commenting on their later professional experience, another participant noted: "*Critical thinking skills were probably more developed in the professional programme and with research as well. When developing research projects, you have to think outside of the box for some things*" (P27, Pharmacy resident). Reflecting on their career development, another participant explained: "*My employer heavily feels our critical thinking skills and creative skills can be fostered throughout the time, but it's kind of harder if we don't have those communication skills*" (P8, Pharmacy resident).

For many participants, creativity was not seen as an essential part of being a pharmacist. Participants who identified as being creative often linked this skill with hobbies outside of work. One participant expressed: "*I couldn't be a top score on creativity, because I chose pharmacy. I think deep down I'm a more creative person. I've just spent so long doing STEM stuff that's not super creative. I do feel like I'm pretty creative, but it's no longer my default*" (P25, Pharmacy resident).

Thematic area 2. Exploring: *Are the knowledge-generating skills developed in the research setting?*

The researchers largely agreed about whether participants believed their skills were developed in the research setting (85% agreement; Kappa = 0.65, $p < 0.001$). Descriptively, creativity was the least likely to be coded as "*developed*" in the research setting, see Table II.

Table II: Numbers indicating whether participants specified a knowledge-generating skill being developed in the research setting

	Collaboration	Communication	Creativity	Critical thinking
Developed	23	23	20	24
Not developed	4	6	4	3
Unspecified	3	1	6	3
Total	30	30	30	30

When explaining the processes influencing skill development in the research setting, participants often merged the collaboration and communication skills and merged the critical thinking and creativity skills. While merging collaboration and communication, a participant said: "*Communication with the research team and just collaborating with the team to try to fix all of those kinks. It's all very interrelated*" (P29, Pharmacy resident). Merging critical thinking and creativity, another participant said: "*I think being able to think outside of the box goes hand-in-hand with critical thinking. Being able to problem solve and to think of what you might not be thinking of takes some creativity*" (P25, Pharmacy resident). Other skill combinations were not casually merged.

Regarding how research experiences influenced skill development, six subthemes were identified. Two more strongly aligned with collaboration and communication skills, including interprofessional-proximity/management, and presenting. The interprofessional theme included instances of working one-on-one with a mentor or with larger teams within the college, across organisations, and even across evolving stages of projects. One participant who took part in a multistage study said: "*We even had to collaborate with past students, from her old college. We picked up where they left off*" (P13, Clinical pharmacist). For the presenting theme, participants created drafts for presentations/publications. Describing this process, one participant said: "*We did the mock presentations before the real poster presentation. Those skills and that knowledge I've gained in that lab helped me*" (P1, Clinical pharmacist).

Three subthemes are more strongly aligned with the development of critical thinking and creativity skills, including stimulating existing interests, new experiences, and critical conversations. The stimulating existing interest subtheme involved giving students the opportunity to engage in a topic or technique more deeply, e.g., interest in how illness was characterised in vampire novels or how fluorescent microscopes work. One participant describes their interest in dataset

research: "*A retrospective data chart is just so dirty. I learned how to clean it up. … I felt like I had to be very creative in those situations*" (P28, Pharmacy resident).

When discussing critical conversations, participants often expressed wanting more opportunities to talk about technical matters, e.g., interpreting literature, designing protocols, or analysing data. Reflecting fondly on such conversations, one participant recalled: "*The research process certainly contributed to me having to think critically about what we were doing, why we were doing it, and why we thought this would be the case. That was certainly a skill I built in research*" (P3, Policy advisor & Community pharmacist).

The final subtheme highlighted across all the skills is the importance of asking questions. This reflects building the confidence to openly acknowledge gaps in understanding. One participant shared: "*Asking questions. Understanding that it feels uncomfortable. But it's necessary. ... My research experiences taught me to be more comfortable with it*" (P16, Pharmacy supervisor).

Thematic area 3. Exploring: Could the knowledge-generating skills be developed in the classroom setting?

The researchers largely agreed about whether participants believed similar skills could be developed in the classroom (88% agreement; Kappa = 0.83, p<0.001). Eight participants were coded as "*yes*," 11 as "*maybe yes*," 4 "*maybe no*," and 7 "*no*." Strong feelings were expressed across the spectrum. When asked if similar skills could be developed in the classroom, a participant coded as "*yes*" noted: "*Absolutely, because that's where you can also receive real-time feedback*" (P15, Clinical pharmacist). In contrast, a participant coded as "*no*" noted: "*Participating in research is an entirely different frame of mind compared to what you learn in the classroom*" (P14, Clinical pharmacist). Participants coded as "*maybe yes/no*" expressed it was possible but less likely, e.g., "*Yes, they can be, but I think it's a lot harder*" (P16, Pharmacy supervisor) and "*I don't think they can be developed as well*" (P7, Executive assistant).

Participants identified individual, social, and task-level factors as factors influencing skill development across settings. In the research setting, participants noted that internal motivation facilitated skill development; one participant said: "*I wanted to be there… Everybody I worked with wanted to be there*" (P13, Clinical pharmacist). In the classroom, external motivations were noted; a participant said: "*In a classroom, you want to get a good grade, but at the end of the day you're not publishing this*" (P25, Pharmacy resident).

Participants expressed that social interactions were an important component of skill development but noted challenges with classroom group work, e.g., when collaboratively working on case studies or practical examinations. One participant noted: "*Group projects can either be like a big success or very difficult. I remember seeing both sides of that during school*" (P29, Pharmacy resident).

Task-based factors involved how long they took part in a project, how authentic the project felt, and how deep/complex the task was. Students often engaged with research projects longer than classroom projects and felt research was a more authentic experience that required deeper engagement. Reflecting on their research experience, one participant expressed: "*I think that going as ridiculously in-depth as we did into a single topic promotes skill development maybe more than what you get in the classroom. I mean the curriculum is great. But you move on from one topic to another, to another, to another, and another, to try and cover this enormous breadth of knowledge*" (P3, Policy advisor/Community pharmacist). This participant expressed that the enormous breadth of knowledge was unquestionably important. As expressed by many participants, the research experience had added value, further increasing skill development in a way that influenced their career trajectory.

Discussion

The present study investigated whether and how pharmacy student research experiences influence the development of knowledge-generating skills, including collaboration, communication, critical thinking, and creativity. Overall, participants believed that research experiences can promote skill development. Skill ranking was largely influenced by their internal performance standards and sense of professional identity (theme 1). The ways in which research experiences supported skill development varied across skills (theme 2). Finally, students expressed different perspectives regarding whether the skills could be developed in the classroom setting (theme 3).

Our interviews suggest that students believe their research experiences strongly support communication and collaboration skills. While they also believed their research experience enhanced critical thinking skills (i.e., related to COPEA's scientific thinking and problem solving outcomes), they were more modest about their current abilities and thought critical thinking would be further supported in the workplace. These findings largely mirror Frenzel and authors' list of essential skills for pharmacy, emphasising that building

communication skills helps graduates collaborate effectively as they enter the workplace (Frenzel *et al.,* 20019; Bingham *et al.,* 2020). That said, concerns have been raised about interprofessional experiences post-graduation increasing passivity, rather than active leadership, in the workplace (Lake *et al.,* 2024). Our finding that early career pharmacists did not believe creativity was part of their professional identity is noteworthy. While COPEA does not specifically include the term creativity, it is encompassed in the definition of their Problem Solver outcome as the ability "*to use problem solving and critical thinking skills, along with an innovative mindset to address challenges and to promote positive change*" (ACPE, 2025, Standard 2.1b). If critical thinking and creativity skills are not promoted in pharmacy school, their continued development post-graduation may be less certain.

Pharmacy schools could further support students' critical thinking and creativity skills. While this training could take place in the classroom (Cain, 2016), several of our participants were more dismissive. Many students are seeking more authentic and career-linked opportunities that research experiences can provide (Flaherty, 2026; Gunnels *et al.,* 2024). While the 2025 ACPE standards do not require students to produce original research, schools are required to create environments that promote faculty research and scholarship (Standard 5.2.d). Thus, faculty research programmes already exist. Of course, involving students in research is not always straightforward. As professional pharmacy schools create environments that support faculty research, they could also consider mechanisms that support student involvement in research within and outside of the traditional classroom.

Within the traditional classroom setting, Morbitzer and authors describe integrating research and scholarship training as an elective pathway and barriers/facilitators schools may encounter (Morbitzer *et al.,* 2021b). Where modifying existing curriculum is infeasible, schools could consider existing elective space, e.g., advanced pharmacy practice experiences (APPEs). In 2012, Svensson and authors called on pharmacy schools to "prepare students to be innovative and create nontraditional career paths," beyond the required direct patient-care areas (Svensson *et al.,* 2012). Many of the research projects our participants engaged in took place in areas beyond direct patient care, e.g. analysing patient data (see Table I). In 2023, Kanmaz noted that the ACPE's 2016 Standards limit non-patient care elective APPEs (limit 2), and, in so doing, limit pharmacy contributions to areas beyond patient care, e.g., policy and technological transformations. Kamaz argues that while non-traditional pharmacy roles, e.g., informatic roles for population health, are not "*patient-facing*," they are certainly "*patient-focused*" and likely represent new roles that drive practice expansion.

Study limitations

Our convergent mixed-methods study design has limitations. Our prioritisation of the qualitative component resulted in a smaller quantitative sample. A future study could recruit more participants for a larger quantitative sample before conducting interviews with a subset of these participants. Additionally, as all our participants conducted research in a voluntary capacity, our findings may not generalise to mandatory experiences. Future studies could compare the perspectives of students who participate in a voluntary or involuntary capacity. Our study was also limited to pharmacy graduates, and a future study could explore experiences across different healthcare professions, e.g., nursing, physical therapy, and occupational therapy.

The 21st century skills survey (Kelley *et al.,* 2019) was selected to evaluate participants' skills because of its rigorous design and validation process. While its measures are conceptually connected with the COEPA knowledge/skills, they may not precisely capture what the AACP and ACPE intended. No survey has been designed to evaluate the COEPA skills. Doing so was outside the scope of the present study, but this could prove a valuable tool for a future research team to develop. Kelley and authors describe a rigorous creation and validation process that could be followed (Kelley *et al.,* 2019).

Research requirements of schools of pharmacy differ locally and internationally. Compared to the United States, similar research competencies are advocated for by the Association of Faculties of Pharmacy of Canada (2017) and the United Kingdom's General Pharmaceutical Council's Education Standards (2021). Some countries go further, e.g., the Pharmaceutical Society of Ireland's 2024 accreditation standards require students to produce a significant scholarly output. Future studies could compare the outcomes across countries with different requirements.

Conclusion

In conclusion, the current study investigated whether and how pharmacy student research experiences influence the development of knowledge-generating skills from the perspective of early-career pharmacists. In line with the COEPA outcomes, our early career pharmacists expressed higher confidence in their

collaboration and communication skills. While they believed research experiences enhance their critical thinking, they did not believe creativity was a meaningful part of their profession. We recommend that pharmacy programmes explicitly link the benefits of research experiences with COEPA outcomes to better articulate their contribution to student development.

Conflict of interest

The authors declare that there are no conflicts of interest.

Ethics approval and informed consent

The Ethics approval for this study was gotten from University of Health Sciences and Pharmacy IRB Code: 2023-23.

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