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RESEARCH ARTICLE

Enhancing pharmacy students' professional awareness through integrated dispensation education: A mixed-methods study in Taiwan

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Abstract

Background: Increasing complexity in pharmacy practice requires stronger alignment between academic training and clinical demands. In Taiwan, pharmacy students lack professional self-awareness and confidence in high-level technical roles. This study assessed an integrated dispensing experimental course's impact on professional awareness, attitudes, and readiness. **Methods:** This observational mixed-methods evaluation was conducted at a southern Taiwan university, involving a cross-sectional course-evaluation survey (n=106) and qualitative data from reflection questionnaires, focus groups, and interviews (n=30). Qualitative data were analysed using thematic coding and grounded theory, with findings integrated through joint displays and a convergence-coding matrix. **Results:** Students had positive perceptions of the integrated course and felt motivated to engage with the material. They reported higher confidence in low- to moderate-level technical tasks, while confidence in high-level clinical functions was limited. Qualitative feedback indicated a gap between academic training and clinical practice, especially regarding experiential learning and non-technical skills like self-awareness and leadership. The results reflect perceived experiences rather than changes within individuals, based on a single post-course survey and unpaired qualitative reflections. **Conclusion:** The course was perceived to support foundational learning, but students' self-reported readiness for advanced clinical roles remained limited. Future curricula should integrate advanced simulation, expanded experiential learning, and non-technical skill development to enhance pharmacist readiness.

Introduction

In Taiwan, pharmacy education parallels other health professions (e.g., medicine, nursing), but students exhibit comparatively lower professional self-awareness than peers in other Asian countries and the United States (Al-Elq, 2010; Ashour *et al*., 2021). This discrepancy is attributed not only to curriculum content but also to structural and pedagogical limitations within pharmacy education (Depasquale & Gray, 2024). Traditional lecture-based teaching alone has proven insufficient in cultivating the professional identity and practice readiness required in modern healthcare environments (Diec *et al*., 2021). From a professional identity development perspective, the Dreyfus model of skill acquisition and Miller's pyramid of clinical competence offer frameworks for assessing pharmacy students' progression from novice to proficient practitioners (Mylrea *et al*., 2017; Kellar & Austin, 2022; Park, 2015).

In Taiwan, pharmacy education follows three primary pathways: a 4-year programme (two years of

foundational sciences and two years of applied pharmacy, including advanced pharmaceutics, pharmacotherapy, clinical pharmacy, regulations, and internships), a 5-year programme (adding extended professional coursework or experiential components), and a 6-year Doctor of Pharmacy curriculum with comprehensive clinical training. Programme length and structure influence baseline competencies, with longer programmes generally providing greater experiential integration and professional identity formation. Nonetheless, despite uniform licensure requirements, variability in practice readiness persists across graduates (Huang *et al*., 2022; Shen *et al*., 2008; Supapaan *et al*., 2019).

Many Taiwanese pharmacy students—particularly those in shorter-duration programmes—report feeling underprepared when entering clinical internships or transitioning to the workforce (Donohoe *et al*., 2016). These concerns are often linked to curricular fragmentation and the limited integration of practical training into pre-clinical coursework (Diec *et al*., 2021). Despite technological advances expanding pharmacists' roles in hospital and community settings, Taiwanese pharmacy curricula have been slow to adapt; evidence suggests the traditional 4-year model is insufficient to meet evolving professional demands (Donohoe *et al*., 2016). A 6-year Doctor of Pharmacy programme was introduced to enhance clinical training; however, continued operation of 4- and 5-year programmes sustains variability in graduates' readiness and competencies despite uniform licensure (Hung *et al*., 2023).

To address these challenges, integrated pharmacy courses—guided by frameworks such as Miller's pyramid—seek to strengthen core competencies and professional attitudes, enabling students, particularly in shorter programmes, to progress from "*knows*" and "*knows how*" to "*shows how*" and ultimately "*does*" in clinical practice (Mylrea *et al*., 2017; Kellar & Austin, 2022; Park, 2015). They aim to standardise essential learning outcomes across educational pathways, minimise variability in clinical performance among licensed pharmacists, and bridge the gap between theoretical knowledge and practical application (Hung *et al*., 2023).

In this context, the present study implemented an integrated course—combining dispensing theory with laboratory-based practice—within a 4-year or 5-year Bachelor of Pharmacy program. Supplementary teaching materials and innovative instructional strategies were employed to enhance students' clinical reasoning, communication, and confidence. The primary objective of the study was to evaluate pharmacy students' professional self-awareness and readiness for practice following completion of this integrated learning experience.

Methods

This study was an observational mixed-methods evaluation of an integrated dispensing and experimental pharmacy course implemented at a university in southern Taiwan. The quantitative component comprised a single post-course cross-sectional course-evaluation survey with embedded open-ended items. The qualitative component comprised open-ended reflection questionnaires collected pre-course and post-course, plus post-internship focus groups and individual interviews. Integration was conducted at the post-course time point using joint displays and a convergence-coding matrix (agreement/complementarity/discordance) to derive meta-inferences; post-internship qualitative findings were used to elaborate and contextualise the post-course patterns. The instructional intervention was an integrated dispensing and experimental pharmacy course to enhance professional self-awareness among pharmacy students in Taiwan. The course was offered as 1 credit, 2 hours/week in the first semester of the final year of the 4-year Bachelor of Pharmacy programme. The original 18-week dispensing course was revised into five core competency domains across twelve units (Table I), aligned with updated experiential and professional education objectives. The emergent three-tier competency description is presented as a tentative, hypothesis-generating framework, not a definitive model.

Table I: Integrated dispensing course

Core theme	Unit
A: Prescription reading	A-1: Screening and analysing problematic prescriptions
	A-2: Models and procedures for handling problematic prescriptions
B: Dispensing operations	B-1: Oral medicine dispensing and powdered medicine dispensing
	B-2: Liquid medicine dispensing
	B-3: Injection medicine dispensing
	B-4: Traditional Chinese Medicine dispensing
C: Sterile dispensing operations	C-1: Providing total parenteral nutrition (TPN)
	C-2: Chemotherapy medicine dispensing (C/T)
D: Drug information and consultations	D-1: Medicine information search and application
	D-2: Providing medication guidance and consultations
E: Pharmacy operation and management	E-1: Special and narcotic medicine management
	E-2: Pharmacy inventory management

To promote teaching effectiveness and engagement, the authors embedded multimedia and technology-enhanced learning. QR codes linked to AR modules deliver content before/during/after classes (Table II): (1) Traditional Chinese Medicine basics; (2) correct use of medical devices; (3) principles of external preparations; (4) folding paper-based medication wrappers; (5) inhaler administration; (6) mist-spray application.

Table II: Core competence operation exercises

Work station	Operation exercise
Dose conversion	Find the problem(s) in a prescription and provide appropriate advice.
Patient health education	Provide relevant medicine information to a patient.
Health promotion	Provide lifestyle advice to a patient, such as lifestyle changes for preventing coronary heart disease.
Drug therapy monitoring	Calculating loading doses (with equations provided), such as the loading dose of aminoglycosides.
Medication history	Visit a newly hospitalised patient and record their medication history.
Medication guidance	Demonstrate the administration of special medicines, such as eye drops or inhalants, for a patient and confirm whether they understand how to use them correctly.
Patient information gathering	Identify the diagnosis, symptoms, and disease of a patient from their medical records.
Over-the-counter dispensing	Provide medication advice and guidance for over-the-counter medicine.
Severity of problematic prescriptions	Identify 4 problems in 2 prescriptions and evaluate their severity of threats to health.
Prescription management	A young doctor wants to prescribe a drug not listed in the formulary. Ask the doctor why.
Risk management	An attending physician wants to prescribe a course of administration that is not recommended, and this course could lead to potentially fatal danger. Provide firm guidance and persuade them to adopt the appropriate treatment.
Compliance guidance	Give advice to a patient who is unwilling to take prescription medicine, such as diuretics.
Asking a medical practitioner for a patient's medication history	Call a clinician and ask for the medication history of a patient.
Calculation of injections	Calculate the doses of injections based on body surface area, infusion rate, and other conditions.
Reviewing medication on discharge	Review a prescription on discharge.
Providing medication information	A patient asks why their relative was prescribed morphine. Provide the patient with medication advice.

Delivery followed a blended-learning sequence (lectures, multimedia demonstrations, simulation-based learning, design thinking, and group discussion). In the design-thinking component, students conducted site visits to a medical centre, Department of Pharmacy and, with reference to regulatory standards and operational constraints, proposed feasible service models. Scenario-based simulations reflected real counselling contexts (inpatient dispensing, discharge education, community pharmacy) and were scaffolded by concurrent pharmaceutical-science and clinical courses to support interdisciplinary role identity. To avoid coercion or grading influence, all facilitators were independent of student assessment, and participation was voluntary with no academic penalty.

Open-ended reflection questionnaire

Given that pharmacy students' perceived professional confidence may be insufficient, the authors developed a brief preliminary questionnaire (Supplemental S1) to solicit expert input on the competencies and confidence required for students who are about to start internships or have recently graduated. The questionnaire asked respondents to describe the essential competencies of a "*professional pharmacist*" across three domains—knowledge, skills, and attitudes—using open-ended prompts. It also included a dichotomous item asking whether graduating pharmacy students should possess professional confidence (yes/no) and an open-ended prompt requesting the rationale for their choice.

Post-course cross-sectional course-evaluation survey development

Because no instrument existed for this specific context, the authors developed a new course-evaluation survey (Supplemental S2) and documented content validity. A five-pharmacist panel (Taiwan licence; KMU course alumni; ≥5 years hospital/community practice) completed structured ratings followed by consensus discussion. All item-level content validity indices (I-CVI) ≥ 0.78 and the scale-level S-CVI/Ave ≥ 0.90, with items retained and only minor wording revisions applied as needed. Additionally, the Delphi method was employed

to iteratively refine the instrument based on expert consensus. Three rounds of review guided revisions to item phrasing, ensuring clarity, appropriateness, and comprehensiveness of the final instrument. Modifications were made to enhance the relevance and interpretability of the questions in alignment with the study objectives.

Internal consistency. Cronbach's α was calculated for each domain (A–E) and is reported to summarise internal consistency; because α is sensitive to the number of items and may be inflated by item overlap, the overall α is reported for completeness but interpreted cautiously. Overall, Cronbach's α was 0.95. By domain: A = 0.90 (corrected $r_{(it)}$ 0.36–0.72; "*α if deleted*" 0.88–0.91), B = 0.92 ($r_{(it)}$ 0.39–0.77; "*α if deleted*" 0.91–0.93), C = 0.88 ($r_{(it)}$ 0.33–0.69; "*α if deleted*" 0.86–0.89), D = 0.87 ($r_{(it)}$ 0.31–0.66; "*α if deleted*" 0.85–0.88), E = 0.91 ($r_{(it)}$ 0.35–0.74; "*α if deleted*" 0.89–0.92). No single item deletion increased any domain α by more than 0.03, suggesting no single item dominated internal consistency; nevertheless, the high overall α may reflect some item overlap, and future work will evaluate item reduction and internal structure more formally. Repeat-rating agreement of the expert panel (1-month interval). During instrument development, the same five pharmacists repeated their ratings after one month. Two-way mixed, absolute-agreement ICC for domain score ratings were: A 0.82 (95% CI 0.68–0.90), B 0.85 (0.73–0.92), C 0.79 (0.62–0.89), D 0.76 (0.58–0.86), E 0.84 (0.70–0.91). Linearly-weighted kappa for ordinal item ratings had a median κ = 0.65 (IQR 0.57–0.72; range 0.52–0.78). These indices reflect the reproducibility of expert ratings during questionnaire development, and should not be interpreted as student test–retest reliability.

The final instrument comprised 31 items in five domains: (1) overall learning outcomes; (2) outpatient/inpatient dispensing perceptions; (3) compounding unit feedback; (4) TCM reflections; (5) design-thinking/interdisciplinary impressions. A semi-structured format combined open-ended prompts with a 5-point Likert scale ("*completely disagree*" to "*completely agree*").

Data collection and outcome

Timeline and participants. Data were collected at three stages: T0 (pre-course) anonymous open-ended reflections; T1 (post-course) cross-sectional course-evaluation survey plus embedded open-ended reflections; and T2 (post-internship) focus groups and individual interviews. All 107 students enrolled in the target semester were invited; one case with incomplete responses was excluded, yielding n=106 for study analyses. The structured course-evaluation survey was administered once at course completion in the university dispensing laboratory; therefore, no pre–post quantitative comparisons were performed. Open-ended reflections were collected anonymously and were not linkable at the individual level across stages (i.e., unpaired).

Quantitative outcomes. The post-course quantitative component consisted of a single cross-sectional course-evaluation survey. Outcomes are reported descriptively as item-level and domain-level Likert response distributions (stacked proportions), alongside internal consistency (Cronbach's α). The authors examined "*α if item deleted*" as a screening indicator of potential content overlap and screened item distributions for potential ceiling/floor effects using a pragmatic threshold (≥15% in the highest or lowest category). Where ceiling effects were present, interpretations emphasised response saturation rather than improvement.

Qualitative outcomes. Qualitative data included embedded open-ended responses in a post-course cross-sectional course-evaluation survey (T1) and stage-specific anonymous open-ended reflection questionnaires (T0/T1). Themes were compared descriptively cross stage to characterise patterns in students' perceived professional self-awareness and confidence over time, without making within-person change claims. Post-internship focus groups and individual interviews were facilitated by trained interviewers to deepen and contextualise post-internship perspectives (T2). Representative de-identified quotes were mapped to domains using joint displays. As all instruments were self-developed and not adapted from existing validated tools, no permissions were required.

Data processing and analysis

Relevant data and records were collected and reviewed by a trained teaching assistant and qualified interviewers. Any discrepancies or questionable entries were further verified by the principal investigator in collaboration with relevant members of the research team. Descriptive statistics were used to summarise participant demographics and responses to the post-course cross-sectional course-evaluation survey. For categorical variables, results were presented as frequencies and percentages. Quantitative data were reported as percentage distributions, and no inferential statistics were conducted due to the exploratory nature of the study.

Triangulation was conducted by cross-verifying findings from the quantitative and qualitative strands. Likert-scale responses were used to describe patterns in students' perceived learning experiences, while

qualitative narratives enriched interpretation by providing contextual examples that helped explain the observed distributions. This integration facilitated the identification of converging themes—such as communication-related experiences and confidence-related perceptions—as well as areas of divergence, including instances where high self-reported preparedness contrasted with qualitative accounts of clinical challenges during internship experiences.

After completing the internship (T2), students from the same course cohort were invited to participate in focus groups or individual interviews using a voluntary, convenience sampling approach. Invitations were distributed via email by three research assistants who were not involved in student assessment. Participation was voluntary and did not affect grades. The authors did not maintain a formal log of declines. The qualitative sample (n=30) represents a self-selected subset of the course cohort from the same semester as the n=106 survey respondents. Focus groups comprised (approx. 5–6) students each, and interviews lasted 75 minutes; sessions were audio-recorded, transcribed verbatim, and de-identified prior to analysis.

Qualitative analysis followed COREQ-aligned procedures: two independent coders conducted open, axial and selective coding; discrepancies were resolved by consensus with an audit trail; coder backgrounds and reflexivity were documented as part of the audit trail; data sufficiency was judged by codebook stabilisation and the absence of new codes in the final two groups. Integration was achieved through joint displays that juxtaposed quantitative patterns with exemplar quotes, and a convergence coding matrix to classify agreement, complementarity or discordance; meta-inferences were drawn by weaving results across strands.

All qualitative data were managed and coded using Microsoft Word 2013, which facilitated the systematic comparison of textual data across time points and respondent groups. Although the approach facilitated a multifaceted understanding of professional identity development, triangulation could have been strengthened by more explicitly aligning survey constructs with interview guides during the study design phase. Moreover, the decision to use Microsoft Word for qualitative coding, rather than specialised software such as NVivo or ATLAS.ti, was based on resource availability and the manageable volume of qualitative data, but may have limited advanced analytical capabilities.

Ethics approval and informed consent

This study was performed upon approval of the Institutional Review Board (IRB) of Kaohsiung Medical University Hospital (KMUHIRB-SV(I)-20200087), which waived the requirement for written informed consent for students enrolled in the interview before or after the Dispensing Pharmacy Laboratory, because which were a part of course. Participants in focused group or interview after their internships was signed informed consent before they enrolled in this study.

Results

Students' opinions on the integrated dispensing experimental course

Quantitative summaries of students' post-course evaluations suggested variation across instructional units. Regarding overall satisfaction with the course, 34% of students agreed or completely agreed that it was helpful in preparing for the pharmacist licensure examination. In contrast, 92% reported that it was helpful for off-campus internships, and 63% indicated that the course met their overall expectations (Figure 1).

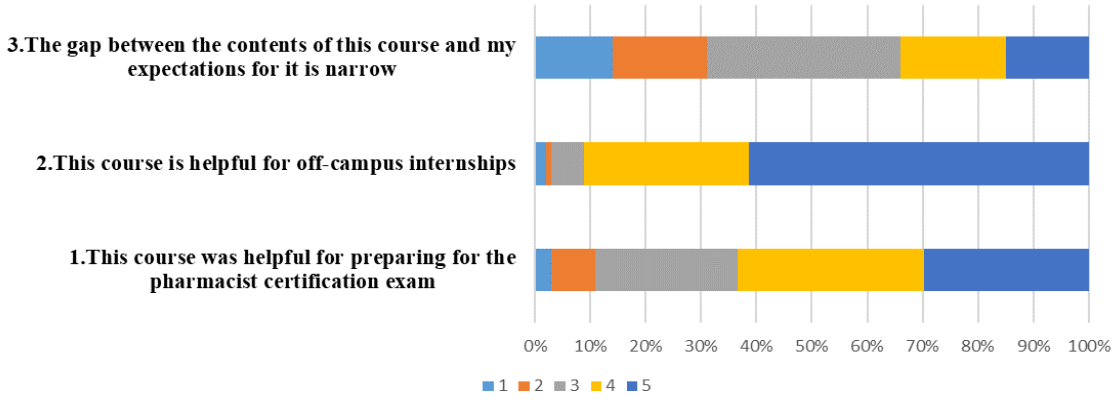

Figure 1: Students' opinions on the integrated dispensing experimental course

Students' opinions on the medicine dispensing unit

In the oral medicine dispensing unit, 97% of students agreed that the lectures were content-rich, and 80% reported that the instructional design supported knowledge absorption. Perceptions of instructional variation were mixed: 50% believed the teaching style in the experimental course differed from that of traditional classes. Although 37% reported that the experimental course was somewhat complex, 61% rated the explanations as satisfactory. Notably, 72% disagreed that the course was monotonous, suggesting that the unit was generally perceived as engaging (Figure 2).

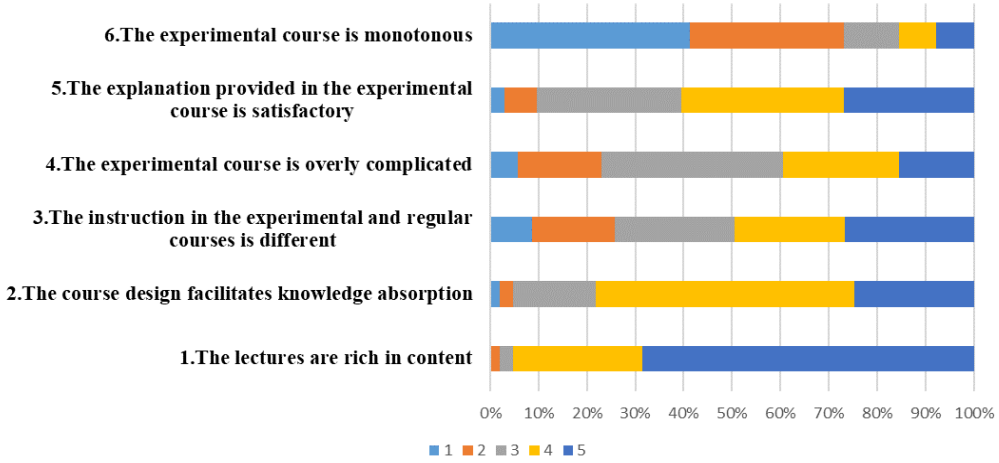

Figure 2: Students' opinions on the oral medicine dispensing unit

Students' opinions on the compounding unit

In the compounding unit, 93% of students rated the lectures as rich in content, and 67% reported that the course design was beneficial for learning. However, perceived challenges related to complexity and equipment use were common: 54% felt that the experimental content was overly complicated, and 47% found the equipment difficult to operate. Ratings of instructional clarity were mixed, with 49% reporting positive perceptions (Figure 3).

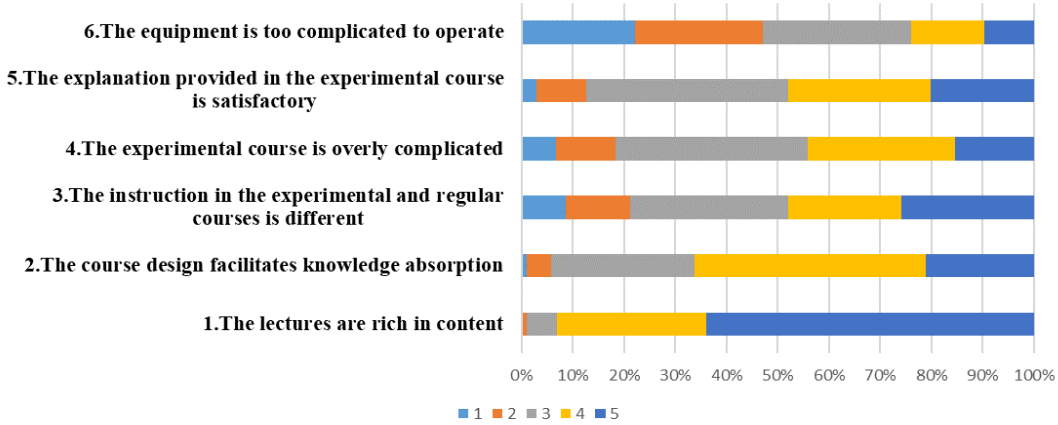

Figure 3: Students' opinions on the emergency drug preparation unit

Students' opinions on the Traditional Chinese Medicine dispensing unit

In the TCM dispensing unit, 95% of students found the content rich, and 82% felt the instructional design supported learning. However, 42% found the content too complicated. Despite this, 67% disagreed that the course was monotonous, and 70% reported favourable perceptions of the instructional explanations (Figure 4).

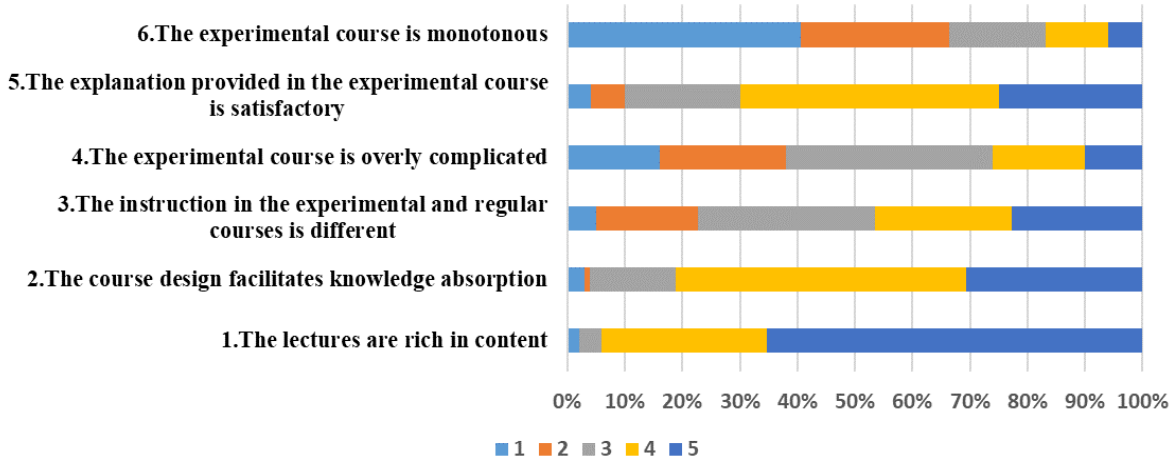

Figure 4: Students' opinions on the Traditional Chinese Medicine dispensing unit

Students' opinions on the design thinking and other courses

In the design thinking and miscellaneous modules, 68% of students viewed the lectures as rich in content, and 59% agreed that the course structure facilitated learning. Although 49% perceived a distinction between experimental and regular course delivery, 37% expressed dissatisfaction with the method of content presentation. The visits organised as part of the course were well-received, with 76% of students finding them meaningful. Perceptions of monotony varied, with 60% disagreeing that the course was repetitive (Figure 5). Taken together, these descriptive findings suggest that while most instructional units were positively received, elements involving complex compounding procedures and non-traditional content delivery may warrant further refinement to improve clarity, reduce cognitive load, and support student engagement.

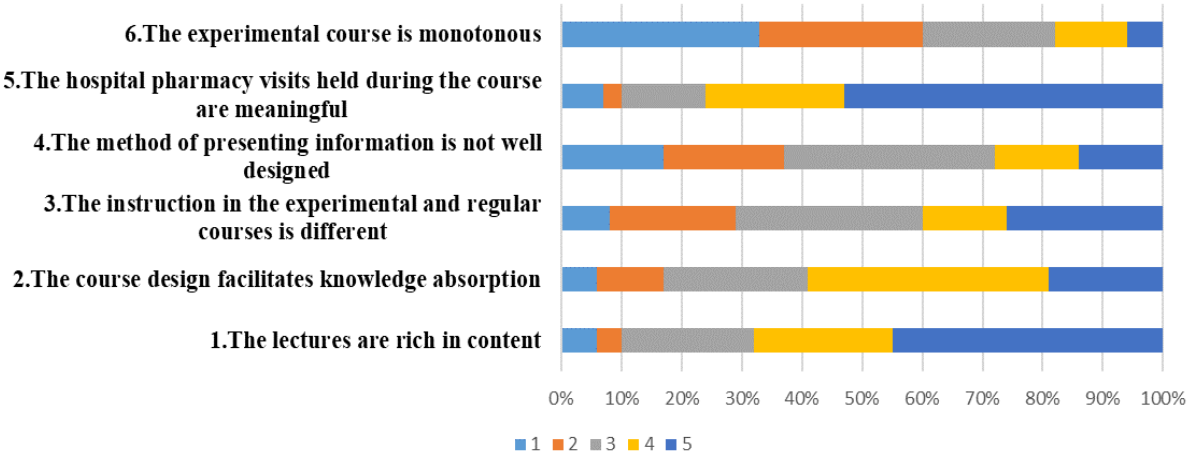

Figure 5: Students' opinions on design thinking and other courses

Open-ended reflection questionnaire and focus groups/ individual interviews

In total, 106 professional self-confidence questionnaires were collected across the pre-course (T0) and post-course (T1) administrations; responses were anonymous and could not be paired at the individual level. At T0, 11% of respondents reported confidence in becoming a professional pharmacist (Supplemental Table S1). At T1, 23% of respondents reported confidence (Supplemental Table S2). As the questionnaires were anonymous and unlinked across stages, these proportions are presented descriptively and should not be interpreted as within-student

change or evidence of improvement attributable to the course.

In addition to quantitative surveys, qualitative data were obtained from eight individual interviews and three focus groups conducted after internship completion. These interviews included 30 pharmacy students (16 from focus groups, 14 from individual interviews), aged 22–25 years (mean approximately 24 years). The male-to-female ratio was approximately 3:5, and most participants completed internships in medical centres located in southern Taiwan. Interviews explored three dimensions: professional attitude, pharmaceutical knowledge, and practical competence.

Thematic analysis yielded the following core findings:

1. Pharmacist professionalism: Knowledge, competence, and attitude
   Participants described a persistent gap between academic instruction and real-world pharmacy practice. After completing the integrated course and internship training, many reported greater awareness of professional expectations and a stronger sense of self-efficacy. Several students noted that, although challenges remained, they felt better prepared to assume pharmacist roles.
2. Instructional reflections and theoretical development
   A grounded theory model (the "*Theory of Cultivating Professional Pharmacists*") was developed to describe how students perceived the instructional process. This model was informed by four reflective questions: (1) How do students become professional pharmacists? (2) How do students perceive the role of a professional pharmacist? (3) Do students feel confident in becoming professionals? and (4) What instructional approaches best support the development of professional competence?
3. Coding, visualisation, and thematic mapping
   Coding and visual mapping highlighted three frequently occurring codes related to professional development: "*University-based coursework*," "*internship experience*," and "*self-directed learning*." Students attributed the acquisition of theoretical knowledge primarily to university instruction, whereas hands-on skills were often linked to internships and experimental coursework. Participants also emphasised soft skills such as communication, adaptability, and professional attitude as important for effective practice (Supplemental Figure S1).

Collectively, these qualitative insights suggest that integrating experiential learning with theoretical instruction may support aspects of professional identity formation. Based on thematic interpretation, the authors propose a tentative, hypothesis-generating tri-level framework for discussing pharmacist professional competency:

(1) High-level technical clinical competencies – advanced medication therapy management, evidence-based recommendations, and interprofessional decision-making.

(2) Moderate-level technical competencies – patient counselling, medication reconciliation, and specialised compounding.

(3) Low-level technical routine tasks – dispensing, labelling, and inventory management.

This proposed classification (Figure 6) is presented as an organising scheme to facilitate interpretation and discussion, and it should be refined and formally validated in future studies before being treated as a standard.

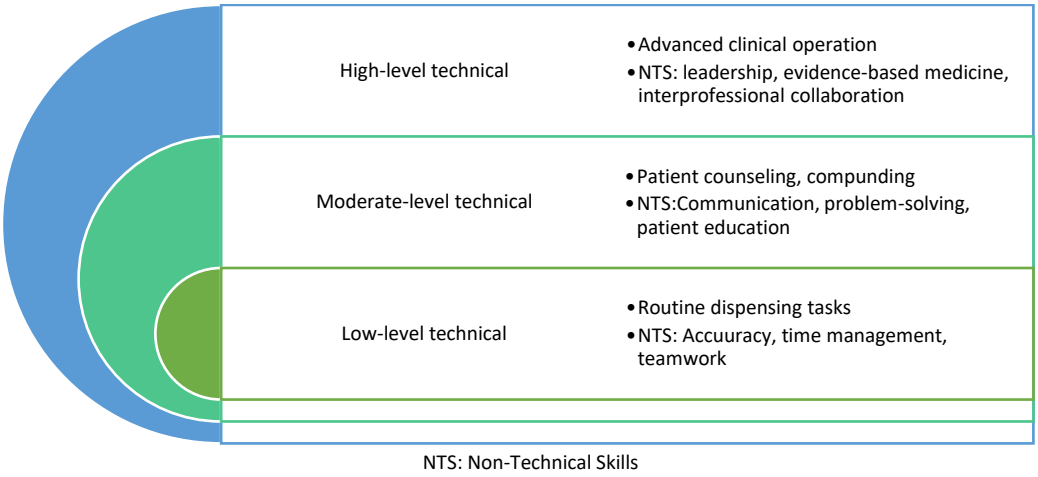

Figure 6: Pharmacist professional competency of tri-level framework

Discussion

Building on these descriptive findings, pharmacist professional competency may be conceptualised as spanning three levels. This proposed categorisation could be useful for generating hypotheses about why professional confidence, job satisfaction, and compensation might differ among pharmacists working in different institutional contexts, and it may also help frame discussions around attrition among postgraduate pharmacy trainees. Rather than offering prescriptive recommendations, these results suggest that healthcare institutions may consider explicitly articulating competency expectations and aligning assessment and support mechanisms accordingly, pending further validation of this framework.

Students reported greater confidence in low-technical tasks such as medication dispensing, and many attributed this to preparatory experimental coursework. This is consistent with literature indicating that simulation-based education can support foundational knowledge and procedural proficiency in safe, structured settings (Kannegaard & Holm, 2014). However, ensuring adequate instructor quality and simulated patient resources remains challenging (Kannegaard & Holm, 2014; Katoue & Ker, 2019). In this study, the university-based curriculum appeared to support perceived development of low- to moderate-level competencies (Diec *et al*., 2021; Lin *et al*., 2020). Students reported lower confidence in high-level clinical roles, citing limited hands-on exposure and psychological readiness. Input from five consulted pharmacists suggested that professional assurance may develop gradually and can fluctuate in unfamiliar roles, highlighting the potential importance of repeated exposure and longitudinal skill-building opportunities.

Interview data also suggested that, while technical skills were emphasised, non-technical skills (NTS)—such as empathy, patience, and teamwork—were discussed less frequently; communication was most consistently identified as essential for effective practice. Accreditation Council for Pharmacy Education standards emphasise NTS such as self-awareness, leadership, and innovation as key components of professional development (Shen *et al*., 2008; Stockman *et al*., 2021). Prior U.S. studies have reported improvements in NTS following advanced pharmacy practice experiences across care settings (Tang *et al*., 2011). NTS may be particularly important in geriatric care; for example, a geriatrics APPE at Virginia Commonwealth University was associated with improved knowledge scores (Wang & Ho, 2020). A separate study using the Adaptive Healthcare Team Attitudes Scale also reported improvements in interprofessional collaboration attitudes after a five-week experiential education model (Stockman *et al*., 2021).

Although students reported positive post-course perceptions, many still described a gap between academic preparation and real-world demands. Differences between standardised curricula and heterogeneous clinical experiences underscore the need for continued alignment and strengthened transitions from university to practice (Lin *et al*., 2020; Schafheutle et al., 2012; Newsom *et al*., 2024). In this study, NTS-related learning activities (scenario-based simulations, debriefing, peer feedback) were mapped to the proposed tri-level framework to align objectives with each tier. The course was associated with stronger perceived comfort in low- to moderate-level competencies; however, higher-order skills likely require direct clinical exposure and/or advanced simulation. Interviews suggested that knowledge, competence, and communication were central to students' emerging professional identity (Newsom *et al*., 2024; Wang & Ho, 2020).

In Taiwan, performance-based reimbursement for pharmacists managing polypharmacy and renal disease reflects movement toward value-based care. Pharmacy curricula may benefit from earlier NTS-focused modules, progressively advanced simulations, and structured experiential placements. For example, geriatrics training could combine AR-based communication exercises with APPE rotations in long-term care to allow staged practice of NTS from foundational to advanced contexts (Wang & Ho, 2020). Overall, these findings highlight the potential importance of parallel development of technical skills and NTS within a provisional tri-level competency framework, supported by visual tools and embedded learning, to prepare graduates for complex interdisciplinary roles (Wang & Ho, 2020; World Health Organization, 2013).

Several limitations should be acknowledged in interpreting the findings of this study. First, the sample was drawn from a single pharmacy programme in southern Taiwan, which may limit the generalisability of the results to other institutions or international contexts. Second, the self-reported nature of the questionnaire or survey data is susceptible to response bias, particularly in measuring constructs such as confidence and professional self-awareness. Third, while qualitative interviews provided rich insights, the number of participants in the focus groups and individual interviews was relatively small, which may not fully capture the diversity of student experiences. Moreover, the study did not conduct a long-term follow-up to assess whether the improvements in perceived professional competence translated into sustained performance during practice. The classification of pharmacy

competencies into high, moderate, and low technical levels, while helpful as a conceptual framework, was based on thematic interpretation and not validated through an established rubric. Fourth, the authors did not assess student test–retest reliability; the reported ICC and κ reflect repeat expert ratings during instrument development. Fifth, because individual identifiers were not collected, pre–post pairing was not possible. Accordingly, any between-stage summaries (where presented) reflect unpaired, cross-sectional contrasts rather than within-person change. The authors therefore present the findings as descriptive differences in perceived confidence, rather than verified competence, and avoid causal language. Finally, the impact of the integrated course on actual clinical performance was not assessed through objective evaluations or external assessments. Future studies should consider multicentre designs, larger and more diverse samples, and longitudinal follow-up to validate and extend these findings. Additionally, incorporating standardised assessments or performance-based evaluations would strengthen the evidence for curriculum impact and provide a clearer picture of student readiness for professional practice.

Conclusion

This study provides descriptive, self-reported findings from a single post-course survey and unpaired qualitative reflections. Students reported relatively higher perceived professional awareness and greater comfort with some low- to moderate-level technical tasks after course completion, whereas confidence in high-level clinical activities remained limited. Given the self-report nature of the evaluation, the lack of pre–post pairing, and the absence of objective performance assessments, these findings should not be interpreted as demonstrated competence gains or attributed causally to the course.

Future work should include longitudinal, paired follow-up from early coursework through post-graduation, incorporate objective performance-based assessments, and evaluate interprofessional learning outcomes. Expanding simulation for high-stakes decision-making and conducting multi-centre evaluations would strengthen the evidence base and enable more robust inference. The proposed tri-level curriculum framework integrating technical and non-technical skills may be shared for local adaptation, but it should be treated as hypothesis-generating and formally validated before being positioned as a standard.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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