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SHORT REPORT

PharmAssist4ID@USM: Clinical reasoning scaffolding for antimicrobial selection in final-year pharmacy students – A pilot study

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Keywords
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Abstract

Background: Students often struggle to move from recalling guidelines to making systematic, patient-centred decisions about antimicrobials. PharmAssist4ID@USM© was created as a structured framework to help final-year pharmacy students individualise antimicrobial therapy. This pilot study aimed to examine its implementation in an applied therapeutics course and assess students' perceptions of its usefulness. **Methods:** A pilot study was conducted in the Applied Therapeutics II course at the School of Pharmaceutical Sciences, Universiti Sains Malaysia. Ten infectious-disease case studies were discussed in small groups using PharmAssist4ID@USM©, with students presenting their reasoning and receiving immediate feedback. **Results:** A total of 64 students completed the voluntary survey. Most rated their ability to assess patient cases after using PharmAssist4ID@USM© as very good (53.1%) or good (40.6%). Students felt very effective (64.1%) or moderately effective (32.8%) in identifying pharmaceutical care issues. They reported high confidence in identifying and solving drug-related problems (96.9%) and in designing a monitoring plan (98.5%). Most believed the tool enhanced their ability to identify problems, propose interventions, and plan monitoring. **Conclusion:** PharmAssist4ID@USM© was feasible as a clinical reasoning tool in a final-year clinical pharmacy course. Students found it helpful for assessing infectious disease cases, making antimicrobial decisions, and developing monitoring plans.

Introduction

Antimicrobial resistance (AMR) is a critical global health threat, and pharmacists are expected to play a central role in antimicrobial stewardship (AMS) across the continuum of care. International policy frameworks, including the International Pharmaceutical Federation (FIP) Development Goals, call for pharmacy education programmes to equip graduates with the competencies required to optimise antimicrobial use and support AMS services (International Pharmaceutical Federation [FIP], 2021). Despite this, studies continue to report variable and often suboptimal knowledge, awareness, and confidence regarding antibiotic use, AMR, and AMS among senior health professions students, highlighting the need for more structured and practice-oriented AMS teaching within undergraduate curricula (Alshehri *et al*., 2025).

Infectious-disease therapeutics is cognitively demanding because students must integrate microbiology, pharmacology, patient-specific factors, and guideline recommendations to justify antimicrobial therapy. Effective antimicrobial decision-making, therefore, requires not only factual knowledge but also critical thinking, clinical reasoning, and metacognition (Persky *et al.*, 2019). Pharmacy education literature supports the use of explicit instructional strategies, including guided frameworks and structured learning activities, to make expert reasoning processes visible and support learners as they progress towards independent clinical decision-making (Begley *et al.*, 2025; Persky *et al.*, 2019).

Scaffolding is a pedagogical approach used in health sciences education to support the development of competence in complex tasks. Strategies such as sequenced activities, structured tools or worksheets, modelling, and gradual reduction of educator support can help students manage cognitive load and organise clinical information more systematically (Masava *et al*., 2023). However, scaffolded interventions in pharmacy education often focus on general problem-solving or medication therapy management, while fewer tools are designed specifically to guide students through infectious-disease pharmacotherapy and AMS-related reasoning (Begley *et al*., 2025; Masava *et al*., 2023). Digital and distance-learning AMS initiatives, including virtual learning environments, online stewardship curricula, and Massive Open Online Courses, have shown benefits for learners' knowledge and perceived competence, but these approaches may not directly support stepwise case-based antimicrobial decision-making within a single applied therapeutics course (Laks *et al*., 2019).

PharmAssist4ID@USM© was developed to address this gap as a locally contextualised clinical reasoning scaffold for final-year clinical pharmacy students. The tool guides learners through explicit steps, from characterising infection and patient-specific factors to identifying drug-related problems, selecting appropriate antimicrobials, appraising evidence, and formulating pharmacist-led recommendations. In this way, it aims to support systematic, patient-centred, and AMS-aligned reasoning in infectious-disease pharmacotherapy.

This pilot study had two aims. The first aim was descriptive: to describe the development, pedagogical rationale, and pilot integration of PharmAssist4ID@USM into a final-year applied therapeutics course for clinical pharmacy students. The second aim was exploratory: to examine students' self-reported perceptions of PharmAssist4ID@USM, including its usability, clarity, and perceived contribution to organising infectious-disease clinical information, identifying drug-related problems, and proposing evidence-based antimicrobial interventions.

Methods

Study design

This pilot descriptive study was conducted in Applied Therapeutics II, a 4-credit-unit course for final-year (fourth year) clinical-stream pharmacy students at the School of Pharmaceutical Sciences, Universiti Sains Malaysia, over a single academic year. The course is designed to consolidate and extend students' clinical decision-making skills for hospital-based conditions, with a particular emphasis on infectious disease pharmacotherapy.

Ethical approval

Ethical approval for the larger project, of which this pilot study formed part, was obtained from the Human Research Ethics Committee, Universiti Sains Malaysia (HREC), with JEPeM Code: USM/JEPeM/PP/24090853. Participation in the tool-specific survey was voluntary, and responses were collected and analysed to maintain student confidentiality.

Participants

The cohort comprised approximately 100 students; four lecturers across different therapeutic areas taught the course, but the PharmAssist4ID@USM© tool was implemented only for the infectious-disease topics. No formal sample size calculation was undertaken, as the study involved the entire available cohort in that year.

The applied therapeutic course

Applied Therapeutics II is a 4-credit final-year course delivered in a predominantly case-based format during the second semester. Students receive written case scenarios in advance and prepare in small groups. During scheduled sessions, cases are discussed interactively, with an emphasis on systematic problem-solving, the identification of drug-related problems, and the formulation of evidence-based therapeutic recommendations. The teaching block relevant to this study focused mainly on infectious diseases, supplemented by selected cases from other therapeutic areas involving hospitalised patients.

The course learning outcomes (CLOs) emphasise higher-order cognitive and interpersonal skills. Students are expected to evaluate clinical cases from multiple perspectives, including pathology, diagnosis, clinical manifestations, laboratory findings, pathophysiology, and management (C5; programme learning outcome (PLO) number 2); construct treatment and monitoring plans for identified drug-related issues using current guidelines and references (C6; PLO2); extract relevant patient information into a pharmaceutical care write-up template (C4; PLO2); and propose optimal pharmaceutical care through discussion with medical practitioners and patient counselling (A5; PLO4). These outcomes align with the programme's cognitive and interpersonal learning outcomes, particularly critical thinking, problem-solving, evidence-based patient care, and professional communication.

PharmAssist4ID@USM© was developed and introduced in this course as a structured teaching and learning scaffold to support students in achieving these CLOs, particularly by guiding the higher-order cognitive processes required for therapeutic decision-making in infectious diseases and pharmaceutical care planning. The tool was not used as a direct assessment instrument for CLO achievement. In particular, CLO4, which is classified at the A5 taxonomy level, is formally assessed through other course assessment methods, including the Objective Structured Pharmacy/Pharmaceutical Education assessment (OSPHE), where students demonstrate communication-related competencies by proposing recommendations to physicians or counselling patients. In this study, PharmAssist4ID@USM© was used during infectious-disease case discussions to support students' clinical reasoning and preparation for these subsequent assessment activities.

PharmAssist4ID@USM©: The teaching tool

Figure 1 shows the step-by-step flow of the PharmAssist4ID@USM© clinical reasoning scaffold, intended to externalise the reasoning sequence and provide structured support consistent with principles of scaffolding and clinical reasoning development in health professions education (Masava *et al*., 2023; Persky *et al*., 2019).

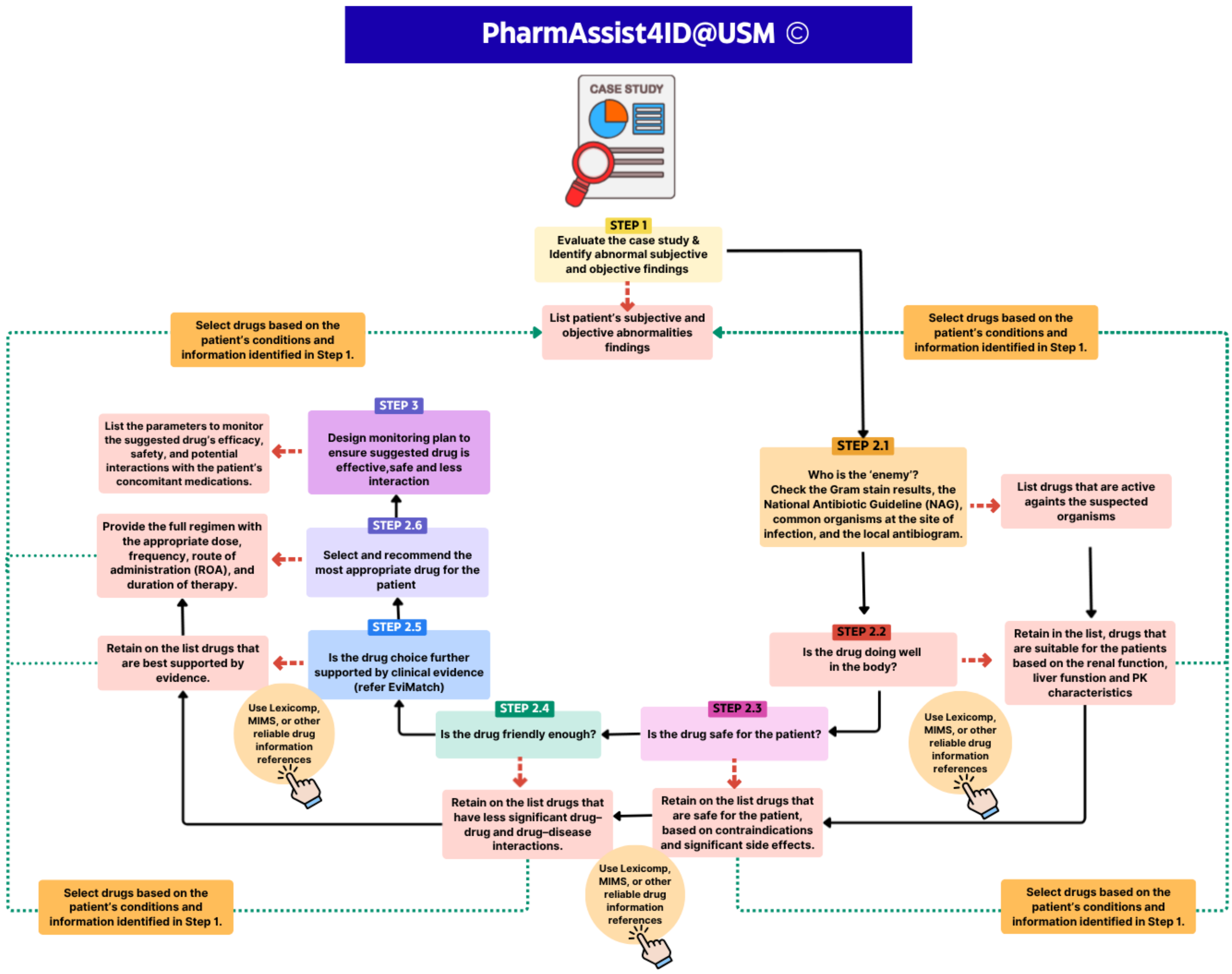

Figure 1: PharmAssist4ID@USM© clinical reasoning scaffolding flowchart for antimicrobial selection and monitoring

In Step 1 (identifying abnormal findings)**,** students list key subjective and objective abnormalities (clinical presentation, vital signs, laboratory values, renal and hepatic function, comorbidities, and other host factors). This step is intended to anchor antimicrobial selection to patient- and host-specific characteristics and to reduce inappropriate empirical choices that do not account for individual risk factors.

In Step 2.1**,** the tool progressively narrows potential antimicrobial options. Step 2.1 is the pivotal stage in which students determine "*who is the enemy*" by identifying suspected organisms for empirical therapy or documented organisms for definitive treatment. They are guided to use Gram stain results, common causative organisms at the site of infection, national antibiotic guidelines, and, where available, local antibiograms to reduce the list of agents based on the spectrum of activity. From this short list, students then evaluate drug-related factors (Step 2.2), particularly pharmacokinetic properties (distribution, metabolism, elimination, and absorption) in relation to the patient characteristics identified in Step 1. Within the tool, this is expressed in simple language as whether "*the drug is doing well*" in the patient, to help students link these considerations to pharmacokinetic/pharmacodynamic principles and further narrow the candidate agents.

Subsequent sub-steps (Step 2.3) require students to screen remaining options for significant adverse effects, contraindications, and the potential to worsen patients' existing conditions (assessed and listed in Step 1), followed by clinically significant drug–drug and drug–disease interactions (Step 2.4)**.** This emphasises that an antimicrobial may be microbiologically appropriate yet still unsuitable due to safety or interaction concerns. By the end of Step 2.4, students are expected to arrive at one to two "*drug-friendly enough*" candidates, again using simple phrasing to support understanding and recall.

A final, explicitly evidence-based step 2.5 (outlined in the tool but not analysed in detail in this report) prompts students to consider clinical trial and guideline data on specific outcomes (e.g., mortality or length of hospital stay) when choosing between the remaining options. Step 2.6 then requires students to make the final antimicrobial selection from the remaining suitable options and translate this choice into a complete therapeutic regimen. At this stage, students are guided to recommend the most appropriate drug for the individual patient and to specify the dose, dosing frequency, route of administration, and intended duration of therapy. This step reinforces that antimicrobial selection should not stop at naming the agent, but should include a patient-specific regimen that accounts for the infection, organism coverage, pharmacokinetic considerations, safety, interactions, and supporting clinical evidence considered in the preceding steps.

The last step (Step 3) of the scaffold then guides students to design a monitoring plan for the selected antimicrobial(s)**,** specifying parameters to ensure that therapy is effective, safe, and not compromised by clinically significant drug–drug or drug–disease interactions. Overall, the clinical reasoning scaffold is designed to direct students towards one to two well-justified antimicrobial interventions for each case and to increase their confidence in proposing evidence-based, patient-tailored recommendations.

As mentioned, all students in the course were provided with written case studies for each topic. For infectious disease cases, students were instructed to work through PharmAssist4ID@USM© alongside the case. The completed scaffold then served as the basis for in-class case discussion and feedback. While using the PharmAssist4ID@USM© scaffold, students were required to consult reliable drug information resources to support their decisions, such as the institutional Lexicomp® database, MIMS®, and other approved formularies and clinical references.

Teaching activities and assessment

In this pilot, assessment of the intervention extended beyond the usual summative, case-based evaluation for the course. A total of 10 infectious disease case scenarios were provided to students, who worked in small groups to solve each case using the PharmAssist4ID@USM© clinical reasoning scaffold and decision-support tool. In each case, each group was required to present its answers in class, explicitly demonstrating the stepwise process of antimicrobial selection and the justification of the final recommended intervention.

During these presentations, the lecturer provided immediate, case-specific feedback to each group, highlighting strengths, correcting misconceptions, and modelling more appropriate reasoning where necessary. Through this iterative process across the ten cases, the lecturer observed progressive refinement in students' ability to narrow antimicrobial choices and to justify more appropriate, patient-centred selections using the tool.

Student evaluation measures

The primary variables were students' self-reported perceptions of PharmAssist4ID@USM, including its perceived impact on their ability to assess cases, identify drug-related problems and pharmaceutical care issues, provide recommendations, and design monitoring plans, as well as perceived ease of use and convenience.

Student evaluation was obtained from two sources. First, all students completed the standard institutional online course evaluation at the end of the semester, a general university-administered evaluation covering course delivery, student engagement, learning resources, facilities, assessment implementation, and overall lecturer-related comments, using a five-point agreement scale from "Strongly Disagree" to "Strongly Agree". As this evaluation was not specific to PharmAssist4ID@USM, it was used only as contextual feedback.

Second, a short, voluntary, tool-specific survey was distributed via Google Form at the end of the final infectious disease case discussion session and served as the primary basis for the findings reported in this pilot study. The survey consisted of one cohort-identification item, 11 closed-ended perception items, and one open-ended item for additional comments or suggestions. The closed-ended items explored students' perceived ability to assess patient cases, recognise drug-related problems and pharmaceutical care issues, identify appropriate interventions, provide recommendations, design monitoring plans, and evaluate the ease of understanding, navigation, and convenience of using the algorithm. Response options varied by item. Several items used categorical responses of "Yes", "No", and "Not sure", while ordinal rating items used response anchors such as "Very poor" to "Very good", "Not effective at all" to "Very effective", "Not confident at all" to "Very confident", and "Very inconvenient" to "Convenient". The final item allowed students to provide open-ended comments and suggestions regarding their experience with the tool. The survey tool is provided in Appendix A.

Bias

Several steps were taken to minimise potential bias in students' perceptions of the tool and teaching delivery. PharmAssist4ID@USM© was incorporated as part of the routine learning and teaching activities without additional formative grading; only the usual summative case-based assessment was used to avoid adding pressure or high-stakes consequences linked specifically to the tool. Ten case studies were discussed, mirroring the number used in previous years before the tool was introduced, so that students were already familiar with the course structure and expectations, and the scaffold functioned only to enhance and organise their existing case-based learning. All students were required to prepare, present, and discuss cases in small groups, with approximately equal group sizes and a one-week preparation period to ensure comparable time and opportunity for engagement. Completion of the tool-specific feedback survey was entirely voluntary and not linked to grades or lecturer expectations, and students were explicitly informed that their responses would not affect their assessment, to reduce response bias.

Analysis

As this was a descriptive and exploratory pilot study, data were analysed using descriptive statistics. Categorical responses from the tool-specific survey and institutional course evaluation were summarised using frequencies and percentages. No inferential statistical testing was conducted because the study aimed to describe the implementation of PharmAssist4ID@USM and explore students' self-reported perceptions, rather than to evaluate effectiveness or compare objective performance outcomes.

Results

Contextual institutional course evaluation

As contextual feedback, the institutional course evaluation results are summarised in Appendix B. Among 96 respondents (response rate: 96%), the core institutional evaluation items showed consistently positive responses, with 97.9% to 100.0% of students selecting "Agree" or "Strongly agree" for items related to course relevance, organisation, achievement of learning outcomes, delivery, clarity of explanation, use of e-learning and teaching aids, learning resources, opportunities for feedback, stimulation of critical thinking, relevance of coursework to learning outcomes, and lecturer-related items. No students selected "Disagree" or "Strongly Disagree" for these items. These institutional findings were interpreted solely as general contextual feedback on the course environment and were not treated as primary evidence of PharmAssist4ID@USM's perceived usefulness.

Tool-specific survey findings

Among the 64 respondents (response rate: 64%), most perceived their ability to assess patient cases after using PharmAssist4ID@USM© as very good or good (53.1% and 40.6%, respectively; Figure 2a). Students also perceived themselves as very effective (64.1%) or moderately effective (32.8%) in identifying pharmaceutical care issues (PCIs) (Figure 2b). In terms of confidence, 29.7% reported feeling very confident and 67.2% moderately confident in identifying and solving drug-related problems/PCIs (Figure 2c). In comparison, 43.8% and 54.7% perceived themselves as very and moderately confident, respectively, in designing a pharmacist's monitoring plan (Figure 2d). Regarding usability, 57.8% perceived the tool as convenient and 28.1% as very convenient, whereas 10.9% were neutral and only 3.1% perceived it as inconvenient (Figure 3).

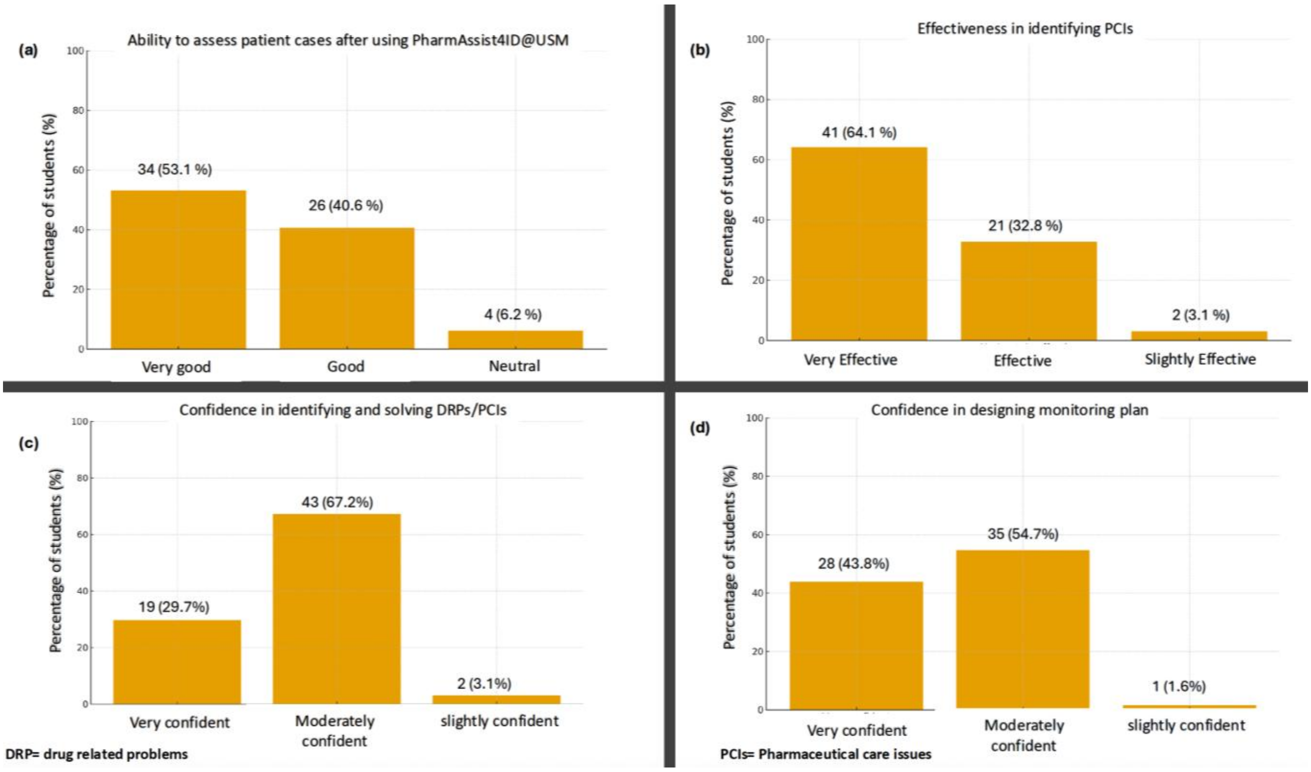

Figure 2: (a) Student ratings of their ability to assess patient cases after using PharmAssist4ID@USM© (n = 64); (b) Student ratings of their effectiveness in identifying pharmaceutical care issues (PCIs) after using PharmAssist4ID@USM© (n = 64); (c) Student confidence in identifying and solving drug-related problems (DRPs) or pharmaceutical care issues (PCIs) after using PharmAssist4ID@USM© (n = 64); (d) Student confidence in designing a pharmacist's monitoring plan after using PharmAssist4ID@USM© (n = 64)

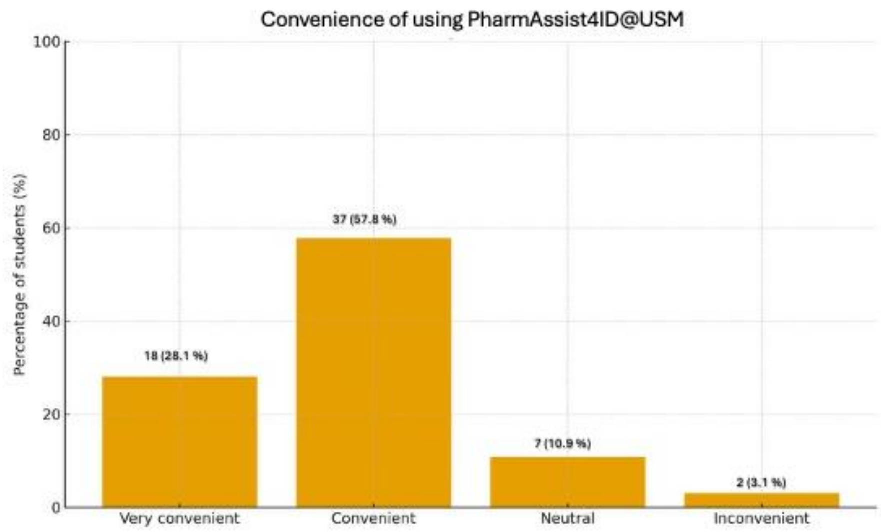

Figure 3: Student ratings of the convenience of using PharmAssist4ID@USM© (n = 64).

Students' responses indicated positive self-reported perceptions of PharmAssist4ID@USM's educational value. Most respondents perceived that the tool supported their ability to identify drug-related problems (DRPs) and appropriate interventions (98.4%), increased their confidence in giving recommendations (98.4%), helped them identify pharmaceutical care issues (PCIs) (95.3%), and supported their confidence in providing interventions (98.4%). All respondents (100%) reported that the tool was easy to understand and navigate (Table I). These findings reflect students' perceived usefulness of the scaffold and should not be interpreted as objective evidence of improvement in clinical reasoning performance.

Table I: Students' perceptions of the impact of PharmAssist4ID@USM© on their abilities and confidence (n = 64).

	Yes n(%)	Not sure n(%)	No n(%)
Enhanced ability to identify DRPs and interventions	63 (98.4%)	1 (1.6%)	0 (0%)
Improved confidence in giving recommendations	63 (98.4%)	1 (1.6%)	0 (0%)
Improved skills to identify PCIs	61 (95.3%)	3 (4.7%)	0 (0%)
Improved confidence to provide interventions	63 (98.4%)	1 (1.6%)	0 (0%)
Easy to understand and navigate	64 (100.0%)	0 (0%)	0 (0%)

In the open-ended survey items, students' comments illustrated the perceived value of PharmAssist4ID@USM© as a scaffold for antimicrobial decision-making.

> *"The module… really helps me better understand how to choose medicines" [Student 1]*

while another highlighted that

> *"The techniques/steps for understanding the antibiotic lectures are so helpful… showing us how we actually should tackle the case situations." [Student 2]*

These comments suggest that students perceived the structured steps as useful in guiding their approach to infectious-disease case analysis and antimicrobial selection.

Discussion

The findings from this pilot study suggest that PharmAssist4ID@USM© is feasible to implement as a clinical reasoning scaffold for infectious-disease pharmacotherapy within an applied therapeutics course. Students' responses indicated positive self-reported perceptions of the tool, particularly regarding case assessment, identification of pharmaceutical care issues, selection of interventions, and monitoring plan development. These findings should be interpreted as exploratory, as they were based on a voluntary, tool-specific survey rather than an objective assessment of performance. The institutional course evaluation provided supportive contextual feedback on the broader teaching and learning environment, but it was not used as the primary source of evidence for the perceived usefulness of PharmAssist4ID@USM©.

These findings are consistent with health professions education literature supporting scaffolding as a strategy to help learners manage complex clinical tasks. Masava *et al*. described scaffolding in health sciences education as involving sequencing of learning activities, structured tools or resources, frameworks, modelling, and gradual removal of support (Masava *et al*., 2023). Similarly, Begley *et al*. reported that a scaffolded medication therapy management instructional series improved pharmacy students' confidence across several skill domains and supported progressive development of patient-care skills (Begley *et al*., 2025). PharmAssist4ID@USM© reflects these principles by sequencing antimicrobial decision-making into explicit steps, beginning with patient assessment and abnormal findings, followed by likely organism identification, antimicrobial spectrum, pharmacokinetic suitability, safety, interactions, evidence-based selection, regimen design, and monitoring.

The emphasis on explicit reasoning also aligns with literature on critical thinking in pharmacy education. Persky *et al*. highlighted that critical thinking is a key but challenging competency for pharmacy students and requires deliberate learning environments, modelling of expert thinking, and guided support until learners can perform independently (Persky *et al*., 2019). In infectious-disease pharmacotherapy, students must integrate multiple data sources, including clinical presentation, microbiology, laboratory values, renal and hepatic function, comorbidities, concurrent medicines, guideline recommendations, and stewardship principles. PharmAssist4ID@USM© was designed to make this reasoning process visible by prompting students to justify why a particular antimicrobial is appropriate for a specific patient.

The findings are also comparable with pharmacy education studies involving simulation and structured decision-support approaches. Studies on MyDispense and virtual patient simulation have reported positive effects on students' confidence, decision-making, problem-solving, counselling, and application of theoretical knowledge in practice-based scenarios (Aksoy & Ozturk, 2021; Beshir *et al*., 2022; Khera *et al*., 2023). Although PharmAssist4ID@USM© is not a dispensing simulation or virtual patient platform, it shares a similar educational purpose: to provide repeated, structured opportunities for students to apply knowledge to clinical cases and receive formative feedback. The present study therefore adds to this literature by describing an antimicrobial-specific scaffold focused on clinical reasoning in infectious-disease pharmacotherapy.

From an antimicrobial stewardship perspective, PharmAssist4ID@USM© is relevant because AMS education requires students to consider not only the choice of antimicrobial agent, but also indication, likely pathogen, spectrum of activity, dose, route, duration, safety, interactions, de-escalation, and monitoring. Previous literature has emphasised the importance of strengthening AMS education among health professional students, including pharmacy students, and has highlighted the need for structured educational approaches that move beyond passive knowledge delivery (Alshehri *et al*., 2025; Laks *et al*., 2019). The stepwise structure of PharmAssist4ID@USM© supports this approach by embedding AMS principles within case-based learning and encouraging students to balance efficacy, safety, and appropriateness of antimicrobial use.

However, the positive findings should be interpreted cautiously. This study measured students' perceptions rather than objective improvement in clinical reasoning or antimicrobial decision-making. Therefore, although students perceived the scaffold as useful and easy to use, these results do not confirm that the tool improved performance across the 10 infectious-disease cases. Future studies should include validated survey instruments, pre- and post-intervention assessment, objective scoring of case performance, and evaluation of communication-based assessments such as the OSPHE. This would allow stronger conclusions about whether repeated use of PharmAssist4ID@USM© improves students' clinical reasoning, antimicrobial recommendations, and monitoring plan development.

The survey findings on convenience also highlight areas for refinement. Although most students rated the tool positively, a small proportion perceived it as less convenient. This may reflect the additional time and cognitive effort required to complete a detailed paper-based scaffold during case discussions, particularly while students are still becoming familiar with the process. Ongoing work to convert PharmAssist4ID@USM© into a web-based application may improve usability by streamlining data entry, linking students to guidelines or local antibiograms, and allowing students to save and revisit their reasoning across cases. However, future digital development should preserve the tool's educational purpose: to support active reasoning rather than simply provide answers.

Limitations

Several limitations of this pilot study must be acknowledged. First, the study has limited external validity because it was conducted with a single cohort of final-year pharmacy students, in one course, at one institution. Therefore, the findings may not be generalisable to other pharmacy programmes, institutions, year levels, clinical topics, or teaching contexts. Second, the evaluation was based mainly on students' voluntary self-reported perceptions and confidence ratings rather than objective measures of clinical reasoning or antimicrobial decision-making performance. As the tool-specific survey was not formally validated, and no validated outcome measures were used, the findings should be interpreted as preliminary exploratory data rather than evidence of improved clinical reasoning performance. Although improvement in students' antimicrobial selection appeared to be observed informally across the ten cases, this was not measured using pre- and post-testing, validated rubrics, or independent performance assessment. In addition, students were aware that the tool was developed by their lecturer, which may have introduced positive response bias. Finally, the pilot was conducted in a classroom setting using written cases; its impact on performance in real ward-based clerkships or interprofessional clinical settings remains unknown.

Conclusion

PharmAssist4ID@USM was feasible to implement as a structured clinical reasoning scaffold within a final-year applied therapeutics course. Students reported positive perceptions of its usability and usefulness in supporting infectious-disease case assessment, identification of drug-related problems, antimicrobial recommendations, and monitoring plan development. However, as the findings were based on a voluntary, self-reported survey from a single cohort, they should be interpreted as exploratory. Future work should involve more rigorous educational evaluation, including controlled pre- and post-intervention studies, validated marking rubrics, objective assessment of case-based performance, and evaluation of transfer to clerkship or OSPHE performance. Further studies may also examine how a web-based version and integration with complementary tools, such as virtual patient simulations or MyDispense, affect usability, adoption, and antimicrobial stewardship competencies.

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Conflict of interest

The authors declare no conflict of interest.

Source of funding

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Appendix A: Survey questions

Short survey on the use of PharmAssist4ID@USM algorithm

~~* Indicates required question~~

1. Cohort *

   Mark only one oval.

   - Cohort A
   - Cohort B

2. How would you rate your ability to assess patient cases after using the PharmAssist4ID@USM algorithm?

   Mark only one oval.

   - Very Poor
   - Poor
   - Neutral
   - Good
   - Very Good

3. Did the PharmAssist4ID@USM algorithm enhance your ability to recognize drug-related problems and identify appropriate interventions?

   Mark only one oval.

   - Yes
   - No
   - Not sure

4. How effectively were you able to identify pharmaceutical care issues and drug-related problems after using the PharmAssist4ID@USM algorithm?

   Mark only one oval.

   - Not effective at all
   - Slightly effective
   - Moderately effective
   - Very effective
   - Not sure

5. Do you believe that the PharmAssist4ID@USM algorithm has enhanced your ability to provide interventions to solve DRPs or PCIs?

   Mark only one oval.

   - Yes
   - No
   - Not sure

6. After using the PharmAssist4ID@USM algorithm, how confident do you feel in providing interventions to address drug-related problems (DRPs) or pharmaceutical care issues (PCIs)?

   Mark only one oval.

   - Not confident at all
   - Slightly confident
   - Moderately confident
   - Very confident
   - Not sure

7. Do you believe that using the PharmAssist4ID@USM algorithm has improved your confidence in giving recommendations?

   Mark only one oval.

   - Yes
   - No
   - Not sure

8. How confident do you feel in designing pharmacist's monitoring plan after using the PharmAssist4ID@USM algorithm?

   Mark only one oval.

   - Not confident at all
   - Slightly confident
   - Moderately confident
   - Very confident
   - Not sure

9. Have you noticed any improvements in your skills to identify pharmaceutical care issues since using the PharmAssist4ID@USM algorithm?

   Mark only one oval.

   - Yes
   - No
   - Not sure

10. Have you noticed any improvement in your confidence level to provide interventions since using the PharmAssist4ID@USM algorithm?

    Mark only one oval.

    - Yes
    - No
    - Not sure

11. Did you find the PharmAssist4ID@USM algorithm easy to understand and navigate? *

Mark only one oval.

- Yes
- No
- Not sure

12. How would you rate the convenience of using the PharmAssist4ID@USM algorithm? *

Mark only one oval.

- Very inconvenient
- Inconvenient
- Neutral
- Convenient

13. Additional comments/suggestions *

Appendix B: The course evaluation by students at the end of the semester

Item no.	Evaluation statement	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)
1	The course content was relevant to the programme objectives.	0.0	0.0	0.0	7.3	92.7
2	The course materials were updated.	0.0	0.0	0.0	6.3	93.8
3	The course contents were well organised and systematic.	0.0	0.0	0.0	10.4	89.6
4	The course aims and objectives were explained at the beginning of the semester.	0.0	0.0	0.0	12.5	87.5
5	The learning outcomes of the course were achieved.	0.0	0.0	1.0	10.4	88.5
6	The practical/clinical were relevant to the theories taught.[1]	0.0	0.0	0.0	9.4	72.9
7	The preparation of practical/clinical reports or log book enhanced my understanding.[1]	0.0	0.0	0.0	8.3	74.0
8	Video conference conducted was beneficial to me.[2]	0.0	0.0	0.0	1.0	28.1
9	The course delivery helped me to understand this course.	0.0	0.0	0.0	10.4	89.6
10	The explanation of concepts was clear.	0.0	0.0	1.0	8.3	90.6
11	The language used was easy to understand.	0.0	0.0	0.0	11.5	88.5
12	The use of e-learning helped me to understand this course.	0.0	0.0	1.0	8.3	90.6
13	The use of teaching aids (audio-visual, static models, simulator, etc) helped me to reinforce my understanding.	0.0	0.0	2.1	9.4	88.5
14	Learning resources (notes, textbooks, web materials, multimedia materials, etc) for the course were helpful.	0.0	0.0	2.1	9.4	88.5
15	Students were given opportunities to ask questions and give feedback.	0.0	0.0	0.0	10.4	89.6
16	Students were stimulated to think critically, creatively and innovatively.	0.0	0.0	0.0	9.4	90.6
17	I had the opportunities to enhance social skills (leadership, tolerance, adaptation, etc) through planned activities.	0.0	0.0	0.0	9.4	90.6
18	Coursework (assignments/tests/projects/reports/clinical cases) was relevant to the course learning outcomes.	0.0	0.0	0.0	10.4	89.6
19	Students were given feedback on their coursework for improvement.	0.0	0.0	0.0	11.5	88.5
20	The lecturer tried to fulfil the course requirements, objectives and curriculum.	0.0	0.0	0.0	9.4	90.6
21	The lecturer showed exemplary personality.	0.0	0.0	0.0	7.3	92.7

[1] Items 6 and 7 were only answered by students who indicated that the course had a practical/clinical component (79 of 96 respondents).; [2] Item 8 was only answered by students who reported that the course used video conferencing/live online lectures (28 of 96 respondents), and the university report indicates that Q6–Q8 were not included in the institutional category averages due to response-pattern confusion