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Enhancing pharmacology education through role-play: impact on student attitudes

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Abstract

Background Pharmacology is a cornerstone of medical education, essential for rational prescribing and patient safety. However, students often perceive it as abstract and overwhelming due to its memorization-heavy nature and limited clinical relevance. This study aimed to evaluate the impact of a role-play-based clinical pharmacology internship on medical students' attitudes towards learning the pharmacology course.

Methods A mixed-methods interventional design was employed. In the quantitative phase, a one-group pretest-posttest design was used with 97 fifth-year medical students. Participants completed the "Attitude Scale Toward the Pharmacology Course for Medical School Students" before and after a one-week internship focused on rational drug use and structured around role-play activities. Paired sample t-tests were used to assess attitudinal change. In the qualitative phase, semi-structured focus group interviews were conducted with eight students selected based on pre-post changes in attitude scores. Data were analysed using inductive content analysis.

Results There was a statistically significant improvement in students' attitudes following the role-play-based internship (pretest mean = 37.24, posttest mean = 41.15; $p < .001$), with a large effect size (Cohen's d = 0.959). Qualitative findings revealed three major themes: (1) pharmacology as difficult but essential, (2) burden of memorization, and (3) the need for clinically relevant, functional learning. Students appreciated the realism and interactivity of role-play, which enhanced their understanding of drug interactions and rational prescribing. However, some still viewed pharmacology as anxiety-provoking and overly burdensome, indicating a need for longitudinal curricular integration.

Conclusions Role-play-based clinical pharmacology education significantly improves medical students' attitudes toward learning pharmacology. Embedding realistic, scenario-based learning within pharmacology curricula may enhance student engagement, promote rational prescribing, and contribute to safer clinical practice. This positive change was supported by a high effect size of Cohen's d = 0.96, demonstrating the significant educational impact of the intervention.

Keywords Pharmacology education, Medical students, Role-play, Rational drug use, Active learning, Attitudes, Medical curriculum

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Introduction

Pharmacology plays a central role in medical education, forming the basis for safe prescribing practices, patient safety, and sound therapeutic decisions. For future healthcare professionals, a strong grasp of pharmacological principles is essential to ensure proper medication use and reduce the risk of prescribing errors [1]. Although pharmacology is clearly relevant to clinical care, many medical students view it as a complex and theoretical subject that feels removed from real-world practice [2, 3]. When pharmacology is taught through traditional, lecture-based methods, students may feel less motivated, rely on superficial learning techniques, and struggle to retain information over time. These factors can ultimately impair their ability to prescribe safely in the future [4]. In response, educators have begun adopting active learning approaches such as role-play to help students connect theoretical knowledge with practical clinical skills.

Research indicates that difficulties in pharmacology education arise not only from the increasing volume of material [5], but also from an overreliance on lecture-based, instructor-driven teaching methods [6]. Traditional lecture-based methods are often insufficient in linking pharmacological content to the clinical settings that students are expected to encounter, which may contribute to perceptions of limited relevance and practical value [7]. As a result, students may find it difficult to relate theoretical knowledge to clinical use, which can impede the development of their clinical reasoning abilities. To address this, educators have increasingly adopted methods such as simulation and particularly role-play, as effective tools for making pharmacological content more applicable to clinical settings [2]. Participating in realistic scenarios allows students to better understand how pharmacological principles apply in clinical practice and supports the development of clinical reasoning. Including role-play in rational pharmacotherapy teaching may strengthen both practical skills and students' appreciation of pharmacology's relevance in patient care.

To improve teaching effectiveness in health professions education, many institutions have begun incorporating active learning approaches, including role-play, simulation, and problem-based learning [8, 9]. These approaches are grounded in constructivist theory, emphasizing the role of hands-on experience in helping students build their understanding. Among active learning techniques, role-play stands out as an engaging method that involves students in clinical simulations by taking on roles such as the physician, patient, or a family member [7]. By placing students in realistic learning situations, this method helps them build key communication and clinical reasoning skills [10, 11]. It can also promote more favourable attitudes toward pharmacology by reducing anxiety and enhancing motivation to learn. Role-play may help students overcome the perception of pharmacology as a subject based primarily on rote memorization by offering opportunities to apply their knowledge in meaningful clinical scenarios [2, 12].

Attitude, in the context of medical education, refers to an individual's relatively stable and enduring evaluations, feelings, and tendencies toward specific aspects of the medical profession, learning, or patient care [13]. Attitudes encompass a range of cognitive, emotional, and behavioural components, influencing how students approach their studies, interact with patients, and ultimately practice medicine [14]. Positive attitudes are associated with increased motivation, deeper engagement with the material, and a greater likelihood of adopting patient-centred approaches [15]. For example, a study found that medical students who actively created and used pharmacology flashcards demonstrated more positive attitudes toward the subject, alongside improvements in academic performance [16]. However, it's important to acknowledge that attitudes can be complex and ambivalent, as some students may still harbor negative perceptions despite positive interventions. Cultivating professional attitudes in medical students is of critical importance for the training of future physicians, as these attitudes directly influence the quality of care they will provide once they begin practicing [15]. Therefore, understanding and fostering positive attitudes, while also addressing negative sentiments and promoting attitudinal alignment, is crucial for cultivating competent and compassionate future physicians.

A recent study showed that using role-play in pharmacology education can support knowledge acquisition, strengthen students' confidence in medication counselling, and encourage greater empathy in patient interactions [17]. Studies have shown that role-play improves students' communication abilities, particularly in situations where they need to discuss prescriptions with patients [12, 18]. Simulation-based activities have been shown to be effective in teaching the communication skills needed for successful medication counselling and promoting patient adherence [19, 20]. Furthermore, working with simulated patients through role-play has been associated with improved communication and greater empathy among medical students [21]. A study found that role-play simulation-based case studies significantly improve motivation and positively change learning strategies among health science students. Specifically, it was shown to improve intrinsic goal orientation, task value, self-efficacy, metacognitive self-regulation, elaboration and critical thinking, and peer learning and help-seeking among students [22]. Role-play also aligns with constructivist educational theories by promoting experiential learning, learner autonomy, and cognitive engagement [23]. Engaging in realistic role-play scenarios helps

students apply pharmacological concepts in patient care and promotes deeper, more independent learning.

While many studies support the use of role-play and other active methods in education [2, 24], some important questions have yet to be addressed. Despite its potential, the impact of role-play-based pharmacology education on students' attitudes toward the discipline remains largely unexplored. Positive attitudes toward pharmacology can foster deeper engagement and better learning outcomes [15]. Role-play has also been shown to make pharmacology more accessible and clinically meaningful for students [25]. Thus, promoting favourable perceptions of pharmacology through engaging methods like role-play may be key to shaping more confident, patient-centred prescribers.

The present study aims to examine the impact of a one-week, role-play-based clinical pharmacology (rational drug use) internship on fifth-year medical students' attitudes toward the pharmacology course. Utilizing a psychometrically validated attitude scale [15] within a mixed-methods interventional design, we seek to capture both the quantitative magnitude and the qualitative depth of any attitudinal changes. This is crucial, as student attitudes significantly influence their engagement, learning outcomes, and future prescribing behaviour. Previous studies have emphasized that student attitudes shaped during medical education can impact professional identity development, learning engagement, and academic achievement. Each of these elements forms the basis for future prescribing behaviours and effective patient communication [26, 27]. By providing robust empirical data, this study seeks to contribute to the limited but critical body of literature at the intersection of pharmacology education, rational prescribing, and attitudinal change, thereby offering insights for curriculum developers and medical educators aiming to foster rational, patient-centred prescribing behaviours and improve future patient outcomes.

Methods

This research is a study using a mixed method interventional design that examines the effect of role-play-based clinical pharmacology education on medical students' attitudes toward the pharmacology course. The mixed method interventional design allows the use of qualitative data to support the quantitative data obtained as a result of the experimental study [28].

In the quantitative part of the study, a one-group pretest-posttest quasi-experimental design was used. This design involves working with a single group, applying a measurement related to the dependent variable as a pretest, administering certain factors or treatments assumed to cause change to this single group, and finally applying the same measurement as a posttest related to the dependent variable [29–31]. In the quantitative dimension of the study, the independent variable is the role-play-based clinical pharmacology education, and the dependent variable is the attitude toward the pharmacology course. The quantitative dimension of the study is presented in Fig. 1.

In the qualitative part of the study, a focus group interview was conducted. The most important characteristic of a focus group interview is that it allows the collection of data through interaction, which cannot be obtained through individual interviews. During the group discussion, participants share their opinions and, by listening to the views of others, may reconsider and rearticulate their own perspectives [32, 33] or may reconstruct their own understanding [34]. The qualitative dimension of the study is presented in Fig. 2.

Participants

A total of 97 fifth-year medical students enrolled at Çanakkale Onsekiz Mart University Faculty of Medicine during the 2023–2024 academic year participated in this study. There were 198 students enrolled in the fifth year during the 2023–2024 academic year. Participation in the study was based on voluntary consent. Out of 198

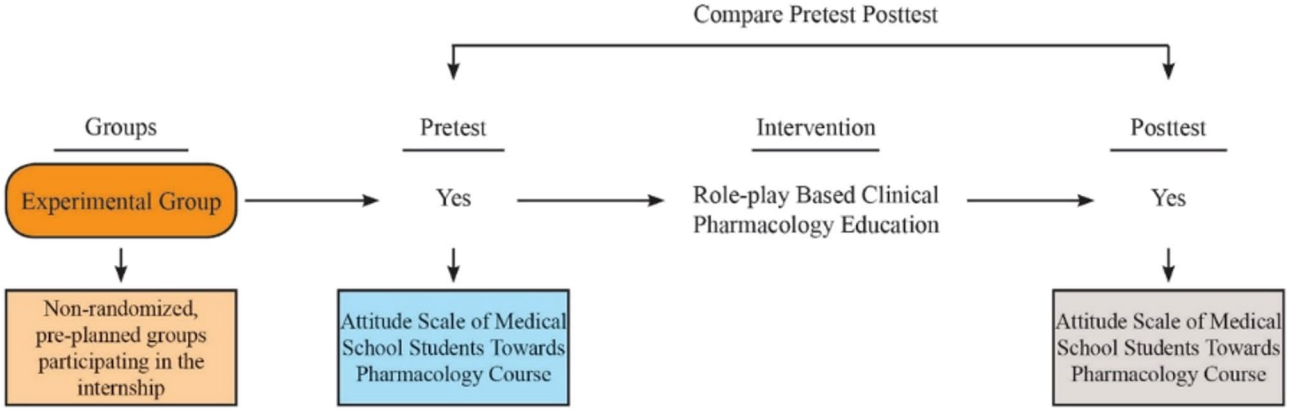

Fig. 1 The quantitative dimension of the study

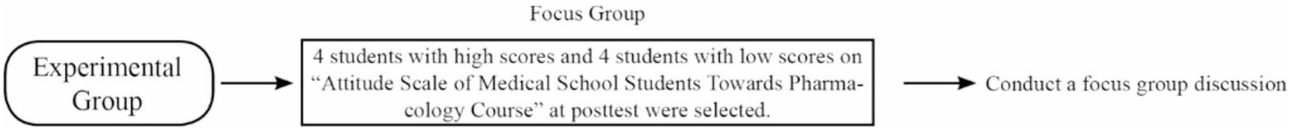

Fig. 2 The qualitative dimension of the study

students, 97 voluntarily agreed to participate. Among the participants, 52 (54%) were female and 45 (46%) were male.

Data collection tools

Two data collection tools were used in this study. The first was the "Attitude Scale Toward the Pharmacology Course for Medical School Students", and the second was the "semi-structured interview form."

Attitude scale toward the Pharmacology course for medical school students

Within the scope of the research, the "Attitude Scale Toward the Pharmacology Course for Medical School Students", developed by Tekeş [15], was used to examine medical students' attitudes toward the pharmacology course (see Supplementary File 1 for the full scale). The scale consists of 12 items. It is a 5-point Likert-type scale. The scale comprises two factors: "Pharmacology as an indispensable course in medical education" and "Pharmacology as a useless course." The Cronbach's alpha coefficient calculated to determine the internal consistency of the overall scale and its subscales was 0.800 for the total scale, 0.900 for the first subscale, and 0.900 for the second subscale. The McDonald's omega reliability coefficient was calculated as 0.903 for the first factor and 0.905 for the second factor. The overall McDonald's omega reliability coefficient for the entire scale was calculated as 0.819. The confirmatory factor analysis fit indices for the scale were RMSEA = 0.731, CFI = 0.941, and TLI = 0.924.

Semi-Structured interview form

In the study, the attitude levels toward the pharmacology course were measured before and after the internship. Based on the scale results, 4 students who showed a positive change in their attitude and 4 students who showed a negative change or no change at all were selected. Pre-test and post-test scores were taken into account when determining two individuals whose attitudes remained unchanged, two individuals whose attitudes became more negative, and four individuals whose attitudes became more positive.

- The pre-test attitude scale scores of the four individuals whose attitudes changed positively increased from the first quartile to the fourth quartile in their post-test attitude scale scores.
- The first of the two individuals whose attitudes remained unchanged scored in the first quartile in their pretest attitude scale scores but again in the first quartile in their post-test attitude scale scores. The other individual scored in the second quartile in their pretest attitude scale scores but again in the second quartile in their post-test attitude scale scores.
- The two individuals whose attitudes turned negative were in the second quartile in the pre-test attitude scale scores but fell into the first quartile in the post-test attitude scale scores.

Interviews were conducted with these 8 students using a semi-structured interview form. The interviews were conducted collectively, with all students present and in the presence of the researcher, based on focus group interview literature [33]. Unlike other qualitative research methods, individual interviews are not conducted. Relevant literature highlights the advantage of focus group interviews [33] as "the ability of a participant to listen to the responses of other participants after answering a question, to review their own answers and thoughts, and to recall or revise any opinions they may have missed." Through these interviews, in-depth information regarding the possible reasons for attitude changes was obtained. The semi-structured interview form was developed by the researchers. For the appropriateness of the interview form, feedback was obtained from two academicians specialized in medical education and one academician specialized in measurement and evaluation. Based on the feedback received, revisions were made, and the final version of the interview form was created. The form is provided as Supplementary File 2.

Process

The following steps were followed in the execution of the study:

- Ethics approval was obtained from the Scientific Research and Publication Ethics Committee of the Graduate School of Çanakkale Onsekiz Mart University on 08.09.2023, with decision number 11/55.
- A meeting was held with the students who would take the clinical pharmacology internship during the 2023–2024 academic year. In the meeting, the purpose of the study was explained, and it was

stated that only students who voluntarily agreed to participate and signed the consent form would be included in the study.
- In each internship group, students who voluntarily participated and signed the consent form were included in the study. At the beginning of the internship, the attitude scale toward the pharmacology course was administered to these students.
- During the internship, all students received a role-play-based clinical pharmacology education.
- The educational intervention was implemented as part of a five-day, full-time clinical pharmacology internship. The intervention consisted solely of rational drug use education and role-play exercises; there were no other classes or internships during the same week. On the first day of the week, a short presentation was provided on the definition and importance of rational drug use, along with a multifaceted analysis and the P-drug selection approach. On the following days, students worked in groups each morning to create a list of treatment options for selected diseases (e.g., upper and lower respiratory tract infections, urinary tract infections, gastroenteritis, anaemia, osteoarthritis, hypertension, asthma, and diabetes). The students then began role-playing exercises. All students in each internship group assumed the role of a physician at least once and the role of a patient at least once, with the roles being rotated. The student playing the patient was separated from the class and guided through the scenario details (for example, items such as pregnancy or penicillin allergy were defined as information to be given only if asked). No real patients or professional simulated patients were used; Students role-played for each other. Different scenarios were used in each case, and approximately 20 different clinical case scenarios were implemented throughout the internship. Students were encouraged to access information online regarding drug selection and dosage adjustments through summary of product characteristics and current clinical guidelines.
- At the end of the internship, the posttest administration of the attitude scale toward the pharmacology course was carried out for the students who voluntarily participated.
- The data were analysed. Four students with the highest attitude scores in the posttest and four students with low attitude scores or no change compared to the pretest were selected. Focus group interviews were conducted with these eight students.
- The research data were analysed and reported.

Trustworthiness/reliability, credibility, transferability, validity

For the quantitative part of the study, the following strategy was used to prevent student identities from being revealed and to ensure they could confidently express their opinions: Instead of writing their names on the pretest and post-test responses, students were asked to write the last two digits of their Turkish ID number and the last two digits of their phone number. This way, the pretest and post-test scale forms were matched. To ensure validity and reliability in the quantitative part, data were collected using the "Attitude Scale Toward the Pharmacology Course for Medical School Students," a previously developed scientifically validated instrument with proven validity and reliability. Finally, participation in the study was voluntary.

Creswell & Miller [35] presented some suggestions for the validity and reliability of qualitative research. According to them, data triangulation, searching for disconfirming or negative evidence, researcher reflexivity (researchers explaining their assumptions, beliefs, and biases so that readers can consider them while reading the research text), sharing data and interpretations with participants and obtaining their approval (member checks), prolonging the researcher's engagement in the field, collaboration with participants (e.g., participants can help develop research questions, collect data, and analyse data), creating an audit trail (e.g., creating an audit trail by keeping a research journal that documents the research process with short notes and reflects all activities), using thick, rich descriptions, and finally, obtaining peer debriefing are among the things that should be done.

Ensuring participants' voluntary participation in research is one of the primary measures that can be taken to ensure data reliability [36]. This study utilized participant verification to ensure credibility [37]. Data analysis was completed, and findings were generated. Before the findings were written, students who participated in the focus group interview were contacted again to assess whether the findings reflected their views. Furthermore, three external experts, not involved in the research, were asked to review and evaluate the data and findings. These three experts were selected from among those working in medical education at state universities in Turkey and who have previously conducted qualitative research. The data analysis conducted by the researchers was submitted to these experts for review. Peer debriefing was conducted through this method [35, 38]. Finally, participants' statements were quoted verbatim. This utilized the direct quotation strategy [30].

The role of researchers

Four researchers conducted this study. Three of the researchers are faculty members in the pharmacology department of a medical school. One researcher is a faculty member in the medical education department of a medical school. In a qualitative study, interaction will often occur between the researcher and the participant. Even a short-term interaction between the researcher and the participant is outside the participants' daily routines. In qualitative research, it is accepted that researchers have certain assumptions, preconceptions, biases, and preconceived notions in their mindset, and that these can influence the research. These characteristics of researchers can influence the research, from the planning phase to the execution, analysis, and reporting. In qualitative research, mentioning these characteristics of researchers in the research report will help readers understand the researchers' characteristics [39, 40].

In this study, a conflict of interest may arise between three faculty members from the pharmacology department and the students completing the relevant internship. Because students are eager to successfully complete their internships, they may respond according to the faculty members' expectations during the interview. This situation was taken into account in the study. The researcher, a member of the medical education department, played an active role in the research planning, data analysis, and student interviews. Pharmacology faculty members were not permitted to interfere in these areas. The researcher, a faculty member from the medical education department, conducted the student interviews, conducted the qualitative data analysis, and submitted it to an external reviewer for approval. During the manuscript writing phase, the medical education department researcher, who supervised the writings on the relevant sections, checked the consistency of the results and interpretations with the findings.

Data analysis

In the quantitative part, the data were examined for missing values. No missing data were detected. The data were transferred to the JAMOVI statistical software. The differences between the scores obtained from the pretest and posttest were calculated, and it was examined whether these differences followed a normal distribution. The Kolmogorov-Smirnov and Shapiro-Wilk tests revealed that the differences were normally distributed ($p > .05$). Possible differences between the pretest and posttest were analysed using the Paired Sample T-Test. A significance level of $p < .05$ was accepted to determine statistical significance.

The data obtained in the study were analysed using content analysis. Mayring [41] stated that there are various ways to categorize data in content analysis and identified two main types: inductive and deductive analysis. In this study, inductive content analysis was utilized. The analysis of participants' statements during the focus group interviews was conducted through the following steps:

- The four researchers independently coded the open-ended questions.
- The codes were grouped under categories and combined into overarching themes.
- The researchers submitted their coding to the review of the other researchers involved in the study, thereby ensuring internal auditing [42].
- A panel was organized for codes, categories, and themes on which the researchers could not reach a consensus, and agreement was achieved through discussion.
- Three external experts, who were not involved in the study, were asked to review and evaluate the researchers' coding and theme construction, thereby ensuring external auditing [30, 43].

Results

The effect of role-play-based clinical pharmacology education on medical students' attitudes

The "Attitude Scale Toward the Pharmacology Course for Medical School Students" was administered to the students who voluntarily participated in the study as a pretest and posttest before and after the internship. The pretest and posttest scores were compared using the Paired Sample T-Test. The results of the comparison are presented in Table 1.

As a result of the analysis, it was determined that the role-play-based clinical pharmacology education had an effect on medical students' attitudes and that there was a statistically significant difference between the pretest and posttest attitude scores ($p < .05$). This significant difference was in favour of the posttest scores. The posttest scores were higher than the pretest scores. Thus, it can be interpreted that students' attitudes toward the

Table 1 Comparison of Pharmacology attitude pretest and posttest scores (Paired sample T-Test)

Measurement	*N*	Mean (Std. Deviation)	t	Degree of Freedom	*p*	Cohen's d Effect Size
Pretest Total Attitude Score*	97	37.24 (3.73)	−9.447	96	< 0.001	0.959
Posttest Total Attitude Score*	97	41.15 (4.11)				

*While calculating the total score from the attitude scale, the negative items were reverse coded. Accordingly, a higher score on the scale indicates a positive attitude toward the pharmacology course, whereas a lower score indicates a negative attitude

pharmacology course became more positive after the internship. According to Cohen's [44] classification, the significant difference indicated a large effect size (d = 0.959). Based on the sample size, the obtained effect size, and the alpha and beta error rates, the power of the study was calculated. At the end of the study, a power of 99% was achieved.

The participants' attitudes towards pharmacology in each item of the attitude scale in the pre-test and post-test are given in Table 2.

As shown in Table 2, items 9, 10, 11, and 12 are the scale items that indicate negative attitudes toward the pharmacology course. There was a positive change in attitude from the pre-test to the post-test, particularly for items 10 and 11. However, no positive change was observed for items 9 and 12. This suggests that some students' ongoing feelings of anxiety and reluctance towards pharmacology may persist after the course.

Student opinions on the role-play-based clinical pharmacology education

At the end of the quantitative phase of the study, where the attitude scale toward the pharmacology course was administered before and after the internship, four students with a high level of positive attitude in the post-test and four students with a low level of attitude or no change compared to the pretest were identified. A focus group interview was conducted with these eight students to determine their thoughts on the role-play-based clinical pharmacology education they participated in. The interviews were analysed through content analysis. As a result of the analysis, three categories—[a] difficult but inevitable, [b] memorization and burden, and [c] should provide useful information—were combined under the general theme of pharmacology. The theme, categories, and codes resulting from the analysis are presented in Fig. 3.

Although students acknowledged that the pharmacology course is difficult, they were also aware that it is indispensable for the science of medicine. They recognized that pharmacology is an absolute requirement for reaching a level of expertise in medical science and for practicing medicine successfully. One of the most important strengths of a competent and qualified physician is pharmacological knowledge. Students expressed that one should not become a physician without passing this course. Incorrect or incomplete knowledge in pharmacology can cost human lives. Despite its essential and valuable role, pharmacology is undeniably a challenging course. It exhausts students and resembles a fearful nightmare. Perhaps most concerning, for many students, pharmacology is a subject in which memorized knowledge is quickly forgotten once the course is completed. Some of the students' remarks within this category are as follows:

> *"If I become a general practitioner, where could I be assigned? It could be to an emergency department in a state hospital, to a family health centre, or to a community health centre. In family and community health centres, what patients most frequently expect from their physicians is for them to prescribe*

Table 2 Students' responses to each item of the attitude scale towards Pharmacology in the pre-test and post-test (Descriptive Statistics)

Items		*N*	Pre-Test		Post-Test	
			Mean (S. Deviation)	Median (Min.-Max.)	Mean (S. Deviation)	Median (Min.-Max.)
Item 1	Learning about drugs and their mechanisms of action in pharmacology makes me feel like a doctor.	97	3.80(0.92)	4.00(1–5)	4.21(0.85)	4.00(1–5)
Item 2	Pharmacology provides a foundation for service delivery in all other fields of medical science.	97	3.77(0.91)	4.00(1–5)	4.20(0.81)	4.00(1–5)
Item 3	Learning pharmacology makes me happy.	97	2.11(0.91)	2.00(1–5)	1.80(0.72)	2.00(1–4)
Item 4	Pharmacology courses are interesting when taught as rational drug use.	97	4.43(0.61)	4.00(1–5)	4.73(0.49)	5.00(3–5)
Item 5	Pharmacology knowledge should be refreshed at the beginning of each clinical internship.	97	1.21(0.49)	1.00(1–4)	1.13(0.42)	1.00(1–3)
Item 6	Pharmacology course is essential in medical education.	97	3.82(0.97)	4.00(1–5)	4.34(0.85)	5.00(1–5)
Item 7	A person who does not have a detailed knowledge of drugs and their mechanism of action cannot be a physician.	97	3.91(0.78)	4.00(1–5)	4.38(0.68)	4.00(3–5)
Item 8	I would not call a person who does not know pharmacology a physician.	97	3.36(0.98)	3.00(1–5)	4.10(0.93)	4.00(1–5)
Item 9	Just hearing the name of the pharmacology drives me crazy.	97	3.57(0.97)	4.00(1–5)	3.89(0.90)	4.00(1–5)
Item 10	When the word "pharmacology" is mentioned, I get goosebumps.	97	3.45(1.05)	4.00(1–5)	2.74(1.12)	3.00(1–5)
Item 11	If I were the health minister, I would remove the pharmacology course from the curriculum of medical schools.	97	2.28(0.77)	2.00(1–5)	1.47(0.81)	1.00(1–5)
Item 12	I would like to prevent the pharmacology course from being taught in its current form.	97	3.89(0.90)	4.00(1–5)	4.15(0.92)	4.00(1–5)

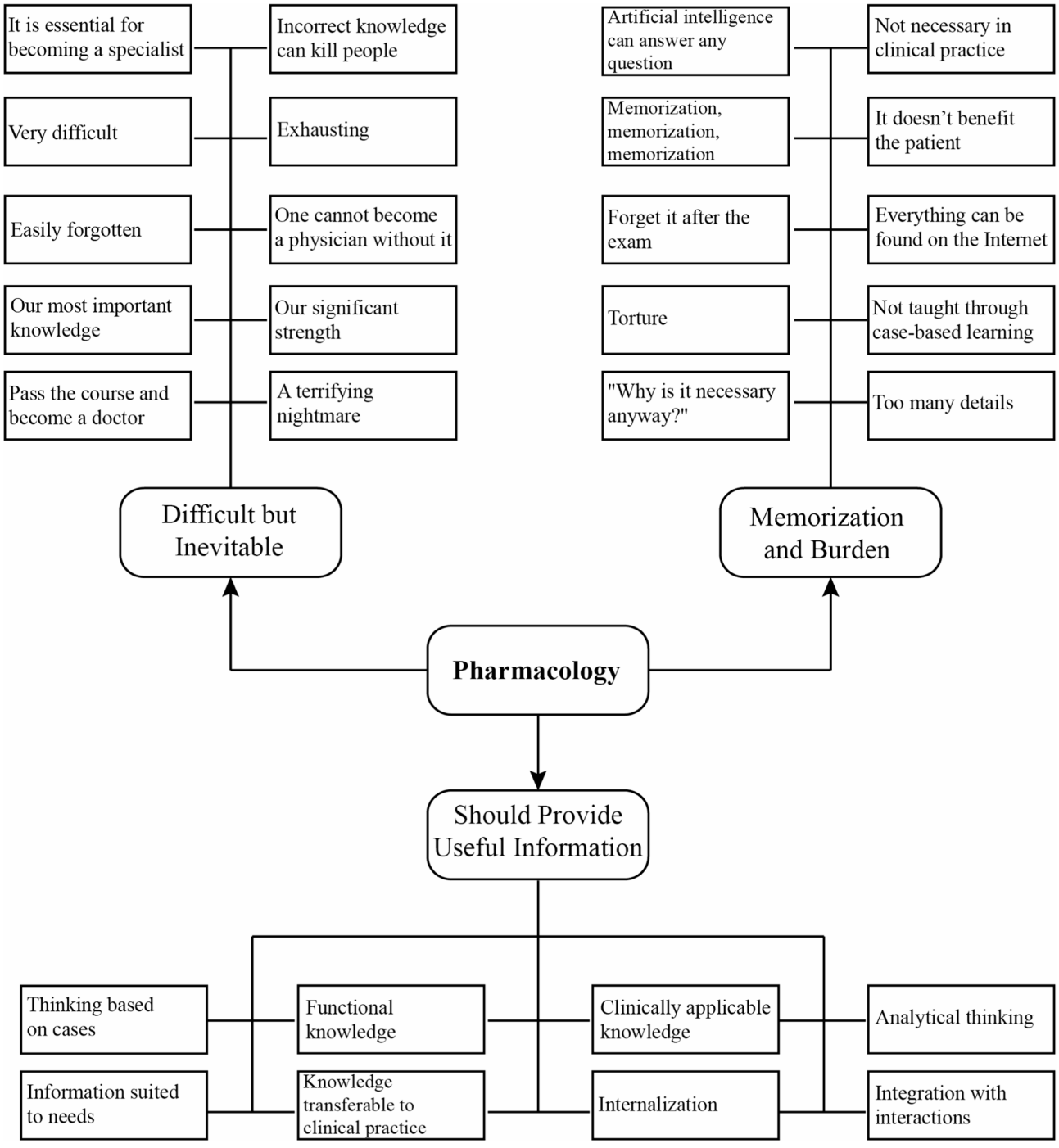

Fig. 3 Student Opinions Following the Clinical Pharmacology Internship: Thematic Map of Students' Perceptions Regarding Pharmacology After the Clinical Pharmacology Internship

medications. Therefore, I am well aware that the most essential knowledge for me is pharmacological knowledge. But believe me, it is an extremely difficult course. Drug groups, mechanisms of action, active ingredient groups, drug–drug interactions—it is all memorization, memorization, memorization. It is incredibly difficult. If I manage to pass this course, it will mean I have truly become a doctor." (Student 1, unchanged attitude after the process).

"Our rational drug use course was very different from the pharmacology courses we took in the third year. We engaged in role-playing. Sometimes I acted as the patient and my friend played the doctor, and sometimes I became the doctor while my friend

acted as the patient. Our instructor gave the necessary information only to the student who would play the role. The friend who acted as the doctor was not given extra information unless they specifically asked for it. During the early role-playing sessions at the beginning of the internship, almost all of us 'killed' our patients while prescribing drugs. We failed to consider drug interactions or comorbidities and simply overlooked them. Our profession is such that if medical practice is performed incorrectly, it can cost a human life. Even just realizing this created a shocking effect on me." (Student 5, positive attitude after the process).

"Unfortunately, my opinion about pharmacology has not changed, even after experiencing the clinical pharmacology internship, with its active participation, role-playing, and simulations, compared to the traditional classroom lectures we had in the third year. Pharmacology remains a fearful nightmare and extremely difficult. Memorizing and retaining such an overwhelming amount of information is not for me. When I become a doctor, I will just learn the most well-known drugs. Without taking any risks, I will simply prescribe the most familiar medications and move on." (Student 4, unchanged/negative attitude after the process).

Students experienced both the classroom-based pharmacology courses taught through instructor-led presentations during the third year and the role-play, active participation, and simulation-based clinical pharmacology internship. As a common outcome of these experiences, students were still able to associate the pharmacology course with the words "memorization" and "burden." During the focus group interviews, it was observed that students questioned the necessity of pharmacology in clinical practice and its benefit for both patients and themselves. They expressed doubts such as: Why is this course necessary when it feels like sheer torment? The Internet and artificial intelligence have advanced to the point that any information can now be easily accessed online. Therefore, what is the point of burdening medical students so heavily with pharmacology at medical school? The course is mostly taught through memorization, and case-based discussions are rare. Some of the students' remarks within this category are as follows:

"Although one may not become rich as a physician in Turkey, it is still a prestigious and well-paying profession. For this reason, I am focused on becoming a doctor as soon as possible. If memorizing pharmacology is necessary to achieve that, I will memorize it and pass the course. After that, whatever I don't need, I will simply forget. Wasn't it the same with anatomy knowledge?" (Student 6, unchanged attitude after the process).

"A course based so heavily on memorization can only be described as a form of suffering. Nowadays, even patients can find any information online. Many patients research drugs that do not even require a doctor's prescription, and they go directly to the pharmacy to purchase them. In an era where even patients can access all information online, why are we expected to memorize so much pharmacological information? It feels entirely meaningless!" (Student 4, unchanged/negative attitude after the process).

"The pharmacology classes in the third year were absolutely terrible. The instructor just kept lecturing and lecturing. I felt like I was going to faint. I was so sleepy during those classes. However, rational drug use internship was completely different. I liked it very much. At least it was taught through real-life cases, similar to what we might encounter in practice. Actually, third-year courses could also be taught in this way. But pharmacology is generally not taught through case-based learning." (Student 8, positive attitude after the process).

Students expressed a desire for pharmacology to be taught in a manner that is clinically oriented, contains more functional knowledge, is adapted to real-life cases, and encourages physicians to think analytically. The course should be structured to meet the practical needs of physicians and should be stripped of unnecessary information. Every piece of knowledge learned should be transferable to clinical situations. Students reported experiencing difficulties in internalizing the course content. Some of the students' remarks within this category are as follows:

"I experienced the same difficulty in the pharmacology course as I did in the anatomy course. The anatomy course taught during the first and second years was also not functional and not clinically oriented. Much of what I learned in anatomy did not help me during my clinical internships. I believe pharmacology presents us with the same handicap. We should learn drug knowledge continuously through clinical cases. The information should be connected to real life and become concrete. In short, it should be functional and practically useful. Otherwise, everything turns into rote memorization just to pass." (Student 7, unchanged/negative attitude after the process).

"During the clinical pharmacology internship, my friend played the role of the patient. I forgot to ask many important questions, such as whether the patient had any comorbidities or whether she

was pregnant. I prescribed a drug without asking these. It turned out that the drug I prescribed could have killed the patient. Exactly this! This is what I wanted. I wanted to learn pharmacology in this way. Of course, we learned about drug interactions during the third-year pharmacology lectures. But in that setting, you cannot truly grasp it. When it is contextualized through such examples, we can really understand the consequences of our actions." (Student 3, positive attitude after the process).

"There are so many details in pharmacology that, honestly, I cannot internalize them. However, the course should have encouraged me to think analytically about the subject. I want to see myself as a successful physician. For that, I need to internalize pharmacological knowledge. I want more courses like the clinical pharmacology internship." (Student 5, positive attitude after the process).

An examination of the statements of students whose attitudes changed positively reveals that active participation, the relevance of role-playing practices to real-life situations, and context-based learning experiences are effective in shaping attitude change. In contrast, the statements of students whose attitudes remained unchanged or who exhibited negative attitudes suggest that pharmacology is still perceived as a difficult and anxiety-provoking course based on rote learning.

Discussion

This study provides compelling evidence that integrating role-play-based clinical pharmacology education significantly improved fifth-year medical students' attitudes toward the pharmacology course. The post-intervention scores demonstrated a statistically significant improvement, with a large effect size (Cohen's d = 0.959) indicative of a substantial positive shift in student attitudes. This underscores the potential of role-play as an active learning methodology to enhance student engagement and perceptions of pharmacology. This aligns with findings that role-play enhances communication skills and promotes a positive attitude towards the subject [24].

Our results align with prior research emphasizing the value of active and contextualized learning approaches in pharmacology education [2, 12]. These approaches, particularly role-play, can address the common perception of pharmacology as abstract and difficult due to its early placement in medical curricula and perceived limited clinical relevance [7]. The positive experience with our clinical pharmacology internship supports the effectiveness of case-based learning in enhancing engagement and relevance [45]. The challenge often lies in the density of information and the need to grasp core concepts [46, 47]. Consistent with our findings, Palappallil & Retnayyan [23] demonstrated a positive perception of role-plays in learning the P-drug concept, while also noting the limitation of unequal participation. However, in our study, all students participating in the internship actively experienced role-play at least once, ensuring equal participation. This highlights a crucial point: attitudes towards pharmacology can be negatively influenced by a perception of rote memorization, rather than meaningful understanding [15]. Role-play offers a solution by moving beyond traditional methods [48], embedding pharmacology instruction within clinically relevant scenarios that simulate real-life therapeutic decisions, and aligning with experiential learning principles. By actively engaging students and allowing them to apply knowledge and develop critical thinking skills in realistic situations [2], role-play fosters a positive educational environment and enhances learning.

The observed attitudinal improvements align with previous findings, where role-play interventions enhanced students' prescription competencies, enthusiasm, and perceived relevance of pharmacology [23]. Simulation and role-play improve communication skills [19] and build connectivity between knowledge and clinical application [49]. Our qualitative data substantiates these outcomes, revealing that students valued the realism and interactivity of role-play, felt more responsible in their decision-making, and expressed a newfound appreciation for the risks and ethical dimensions of prescribing—key components of rational drug use education. As Gotardelo et al. [2] observed, role-play promotes active participation and helps students develop professional attributes for future practice. Simulation-based learning offers a safe environment to practice and refine skills without jeopardizing patient safety [50], enabling repeated practice to achieve proficiency. Additionally, role-play has been shown to strengthen communication skills [19] critical for effective medication counselling and improving patient adherence [51]. This method also promotes confidence and thoughtful prescribing by providing a structured opportunity for repeated, supervised practice. Incorporating simulation and role-play into medical education reflects a growing emphasis on experiential learning that better prepares students for modern clinical practice. To be effective, however, these methods must be thoughtfully embedded within the curriculum. While Ahmed et al. [52] reported that some students still value lectures, our focus group findings revealed mixed attitudes. Many participants appreciated the realism and practical benefits of role-play, yet some continued to view pharmacology as overly focused on memorization, which they linked to anxiety. This concern has also been reported in earlier studies [15]. These findings highlight the need to support active learning methods with

curricular changes that integrate pharmacology throughout all phases of medical education.

Focus group results further indicated a diversity of opinions among students, reflecting both appreciation and hesitation toward pharmacology. While many students appreciated the realism and practical value of role-play sessions, some continued to perceive pharmacology as a memorization-heavy and anxiety-inducing subject-echoing sentiments found in earlier research using an established attitude scale [15]. Highlighting the relevance of attitudes, it directly connects the concept of attitude to the goals of medical education, emphasizing its impact on student behaviour and future practice [26]. Several studies have demonstrated that a student's attitude towards a subject directly influences their engagement, learning outcomes, and future professional behaviour [13, 15, 27]. This highlights the need not only for active methodologies but also for longitudinal curriculum reforms that integrate pharmacology meaningfully across clinical rotations [53]. This study demonstrates a significant improvement in students' attitudes; however, these positive attitude changes cannot be directly linked to pharmacology knowledge or prescribing competence. Future longitudinal studies are needed to assess whether attitude gains persist over time and how they translate into rational prescribing skills. Furthermore, integrating role-playing and similar experiential learning methods into different modules of pharmacology education, rather than simply as one-time interventions, can reinforce the clinical context, reduce learning anxiety, and promote deep learning. Although general attitudes toward pharmacology have improved, high scores for statements such as "Just hearing the name of the pharmacology drives me crazy" and "I would like to prevent the pharmacology course from being taught in its current form" indicate that feelings of anxiety and resistance persist in some students. This finding highlights the need for a holistic teaching approach that requires interventions not only at the cognitive but also at the emotional level. The attitude scale used in this study allowed us to capture both positive (e.g., "Pharmacology makes me feel like a doctor") and negative (e.g., "Pharmacology drives me crazy") sentiments. This dual-factor structure helped reveal the nuanced impact of role-play interventions on both enthusiasm and anxiety. Furthermore, the study by Tekeş & Toraman [16] showed that using student-generated flashcards improved both academic performance and attitudes towards pharmacology, suggesting that active learning strategies can positively impact student engagement and achievement. Gupta et al. [54] found that while students generally found active learning methods useful, some methods were preferred over others -further supporting the idea that the type and format of active learning activity can significantly influence its effectiveness.

Our findings suggest that integrating role-play into rational pharmacotherapy education can enhance not only skill acquisition but also attitudinal alignment toward pharmacology as a clinically indispensable subject. Medical schools aiming to promote rational prescribing should consider implementing structured, scenario-based role-play sessions throughout medical training, ideally scaffolded across both preclinical and clinical phases. This is particularly important, as many graduates report feeling unprepared to start their foundation post, especially in key areas like prescribing skills [55]. Educational sessions focusing on assessing the rationality of prescriptions, coupled with student feedback [56], can also inform the design and refinement of these role-play scenarios to ensure they address the most relevant prescribing challenges. Indeed, a study using role-play in rational pharmacotherapy training [57] found that students perceived role-play as a useful tool for self-assessment and appreciated immediate feedback in simulated pharmacotherapy situations. Furthermore, research comparing traditional versus innovative learning environments [58] suggests that different classroom layouts can affect teaching and learning, with innovative environments potentially enhancing student attitudes and engagement. This supports the idea that well-designed role-play scenarios, implemented in a supportive learning environment, can positively impact student attitudes towards pharmacology. These approaches align with the principles of case-based learning, a common strategy in rational prescribing education [59]. Furthermore, integrating frameworks such as the WHO 6-step model can provide structure to these role-play scenarios, ensuring a comprehensive approach to rational drug selection [59]. In addition to technical skills, medical simulations can be used to train students in teamwork, communication, and leadership skills. Establishing a supportive educational climate is essential for improving student attitudes and maintaining motivation throughout their learning journey [15]. As demonstrated by Asanaliyar et al. [18], role-play can improve communication skills and promote a positive attitude towards the subject.

The single-institution setting and voluntary participation may limit generalizability. Furthermore, the short-term nature of the intervention doesn't allow conclusions about long-term effects. While preparation time can limit role-play's effectiveness in general [2, 7], all students in our study actively participated, ensuring equal engagement. Some students continued to view pharmacology as burdensome, highlighting the need for broader curricular reforms [60]. Future research should focus on multicentre, longitudinal studies to assess sustained attitudinal shifts and improved prescribing practices, and explore the integration of diverse active learning approaches [16, 23]. Despite these limitations, this study offers valuable

insights into the potential of role-play to enhance medical students' attitudes towards pharmacology and improve their clinical skills.

Conclusions

This study demonstrates that a one-week role-play-based clinical pharmacology internship significantly improved medical students' attitudes toward the pharmacology course. The combination of quantitative and qualitative data provides robust evidence that role-play not only enhances students' engagement and perceived relevance of pharmacology but also facilitates the development of essential clinical reasoning and communication skills by simulating real-life therapeutic decision-making. This active approach enables students to internalize pharmacological principles in a meaningful and lasting manner, aligning with broader recommendations for integrating active learning into medical curricula to improve communication skills and promote positive attitudes [10, 12, 18]. These findings underscore the importance of integrating structured, scenario-based methodologies into pharmacology curricula to foster positive attitudinal shifts and promote rational prescribing behaviours. To address persistent anxieties about pharmacology observed in some students, experiential methods such as role-play should be planned to be spread throughout the curriculum, along with longitudinal applications and emotional support strategies. Given that student attitudes are closely linked to future clinical performance, the structured implementation of role-play sessions, even within the constraints of a single-institution setting, represents a valuable step toward improving both educational outcomes and patient safety. Role-play practices integrated into the curriculum in a continuous and structured manner can play a critical role in transforming the positive attitude changes achieved in this study into long-term behavioural gains.

Abbreviations

RMSEA	Root Mean Square Error of Approximation
CFI	Comparative Fit Index
TLI	Tucker-Lewis Index

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions

ET conceived the study design and coordinated data collection. CT performed the statistical analyses. All authors contributed to data acquisition, interpretation of findings, and critical revision of the manuscript. All authors read and approved the final version of the manuscript for submission.

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Data availability

The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

Ethics approval was obtained from the Scientific Research and Publication Ethics Committee of the Graduate School of Çanakkale Onsekiz Mart University on 08.09.2023, with decision number 11/55. All participants were included in the study after obtaining the informed consent form. Our research was conducted in accordance with the Declaration of Helsinski.

Consent for publication

Not applicable.

Competing interests

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