





Memos Adoption in Basic Medical Science Education as a Successful Learning Model: A Mixed Method Quasi-Experimental Study

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Purpose: Basic medical sciences are of a solid abstract nature. *Pharmacology* is a challenging discipline delivered in all healthcare-related curricula with different aims and goals. Memes are one of aiding instructional designs proved to surge students' performance and satisfaction with the educational process. Apart from assessing medical students' and faculty's perception of meme use in pharmacology learning, the current study aimed to explore the criteria of preferences and factors associated with successful memes' adoption in this discipline as one of the most challenging basic medical sciences.

Methods: A biphasic study was conducted among second-year undergraduate medical students and faculty members. The study involved assessing the perceptions of staff and students, and thematic content analysis was performed on the narrative responses of the participants to explore factors contributing to the success of learning memes. Additionally, students' performance was also analyzed.

Results: The use of memes in pharmacology was well perceived by medical students, with a mean satisfaction rating of 4.5/5 for high-achieving students and 4.33 for low-achieving students. Memes were associated with a performance surge ($p = 0.022$). Six themes emerged as criteria for a successful learning experience of meme use: previous scientific background on the meme topic, scenario context of the meme, learning concepts tackled by memes, the simplicity of meme's message, the relevance of meme's message to practice, and the modality of meme's use in the topic of education. Regarding the perception of meme use in pharmacology learning, four themes emerged: the mode and engagement of learning experience mode, the feasibility of meme use in pharmacology learning, students' attitudes towards further meme inclusion in their study, and the perceived impact of memes on students' cognitive skills.

Conclusion: The use of memes in pharmacology yields positive learning outcomes. A careful selection of memes is required to ensure a successful learning experience.

Keywords: Memes, pharmacology education, instructional design, performance, perception

Introduction

Pharmacology teaching is integral to all healthcare-related curricula, each with different aims and goals. Effective pharmacotherapy and appropriate medication prescriptions are critical.¹ As a basic medical science, pharmacology is included in preclinical education in many medical schools.² However, these basic disciplines focus on theoretical knowledge rather than its relevance to clinical practice, resulting in a somewhat unmotivating and dull environment for students and lower engagement and satisfaction with their studies.^{3,4} Proper pharmacology education is crucial to avoiding medication errors in future practice.⁵ Therefore, engaging tools that boost students' experience in pharmacology

learning and enhance their relevance to practice need to be explored. Furthermore, few studies have reported the use of memes in pharmacology education.

Memes are humorous audiovisual tools carrying a message that rapidly spread within a large population. As defined, they are digital objects that riff on a given visual, textual or auditory form and are then appropriated, re-coded and slotted back into the internet infrastructures they came from⁶. The selfish gene theory introduced by Dawkins described memes as small cultural units that transmit similar to genes. Like genes, memes undergo modification, selection, and retention. They compete for hosts based on cultural suitability; and some become extinct.⁷

Meme use in medical education has been tried in some disciplines, including chemistry,⁸ medical terms,⁹ renal physiology,¹⁰ pharmacology,¹¹ and pathology.¹² Previous studies that aimed to adopt memes as a novel instructional design or an assessment tool proved their efficacy in influencing students' performance or perception. However, no studies have investigated the criteria for determining the success of learning memes. Finding those criteria will assist pharmacology educators in selecting effective memes for education.

The current study aimed to assess the perception and effect of using memes in pharmacology learning among medical students and faculties. Furthermore, we aimed to explore the factors associated with successful memes' use and the criteria of memes' preference in that challenging discipline. This was achieved by enrolling a sample of second-year medical students and some faculty members who were enrolled in the respiratory module held at a Saudi college of medicine over three months (February–April 2021). In the current study, we sought to answer the following questions:

- Do memes promote students' perceptions and performance in high-stakes pharmacology exams when used as guiding review tools?
- What factors are associated with successful memes' adoption from students' and faculty's perspectives?

Material and Methods

Study Setting and Context

The current study was conducted among a sample of second-year medical students who were enrolled in the respiratory module and some faculties involved in teaching that module at the College of Medicine, Dar Al-Uloom University, Riyadh, Saudi Arabia, during the period (February–April 2021). The adopted curriculum follows an integrated problem-based learning (PBL) system-wise approach. The fundamental principles of the pharmacology discipline are mainly covered during the primary phase of the undergraduate program.¹³

Study Design

The current study is a mixed-method biphasic quasi-experimental study. The quantitative component examined students' performance as well as faculty and students' perceptions. The quantitative self-administered survey was developed based on focused group discussions. The qualitative component of the study was based on the analysis of narrative responses of the participants regarding their perceptions of the meme use and criteria for success in pharmacology education.

Participants, Sampling, and Grouping

Convenience sampling was adopted, including all registered students who attended at least 75% of the course and consented to participate in the current study. Enrolled students were categorized into two groups: the control group, where students were involved in the summative evaluation without exposure to memes, and the test group, where students were exposed to memes before the evaluation. Random digital assignments determined each group of students, maintaining blinding to prevent students of both groups from recognizing their peers were in another group. Faculty members involved in teaching one or more basic medical sciences and who consented to participate were enrolled.

The students in the test group, to facilitate subgroup comparison, were categorized based on their grade point average (GPA) into high achievers (GPAs A+, A, B+, and B) and low achievers (GPAs C+, C, D+, D, and F). Moreover, faculty members were divided into seniors, including full professors and associate professors, and juniors, including assistant professors and lecturers.

Intervention

The current study was conducted over two phases as shown in (Figure 1). In the first phase, students were invited to attend a revision session one week before the summative evaluation. Each group attended separately with the same instructor. The revision session, which spanned an hour, involved an open discussion revisiting the theoretical contents of the module. During this session, seven selected pharmacology memes were displayed consecutively for the test group, and students were requested to reflect on their content. For the control group, instead of using memes, students engaged in a discussion wrapping up the same aspects of the curriculum. The summative evaluation consisted of ten scenario-based multiple-choice questions (MCQs) of variable difficulty. Notably, the memes did not cover the concepts of the three questions (items 7, 9, 10), while the other seven MCQs were related to scenarios described in the displayed memes.

In the second phase, three faculty members and three students from the test group were invited to participate in a focused group discussion (FGD) alongside the principal investigator and two medical education experts. FGD was extended for one hour and adhered to criteria established by Krueger.¹⁴ During FGD, the concept and methodology of using memes were discussed. After an extensive literature review based on the FGD insights, a semi-structured, self-administered questionnaire was established and validated. The proposed survey underwent piloting with ten participants (five students and five faculty members). The pilot results indicated that an estimated 8–10 minutes are needed to finalize the survey. All questions were precise and reliable, requiring no modifications.

Data Collection Instrument

Students' performance in the summative evaluation was compared, considering the overall and per-item performances. Each question was graded out of 1, and the overall performance was calculated out of 10. Two days later, students of the test group and the participating faculties were requested to complete the survey sent to them, along with the memes provided a link using the Google Forms platform. The pre-designed survey consisted of four subsections (see Appendix 1), as follows:

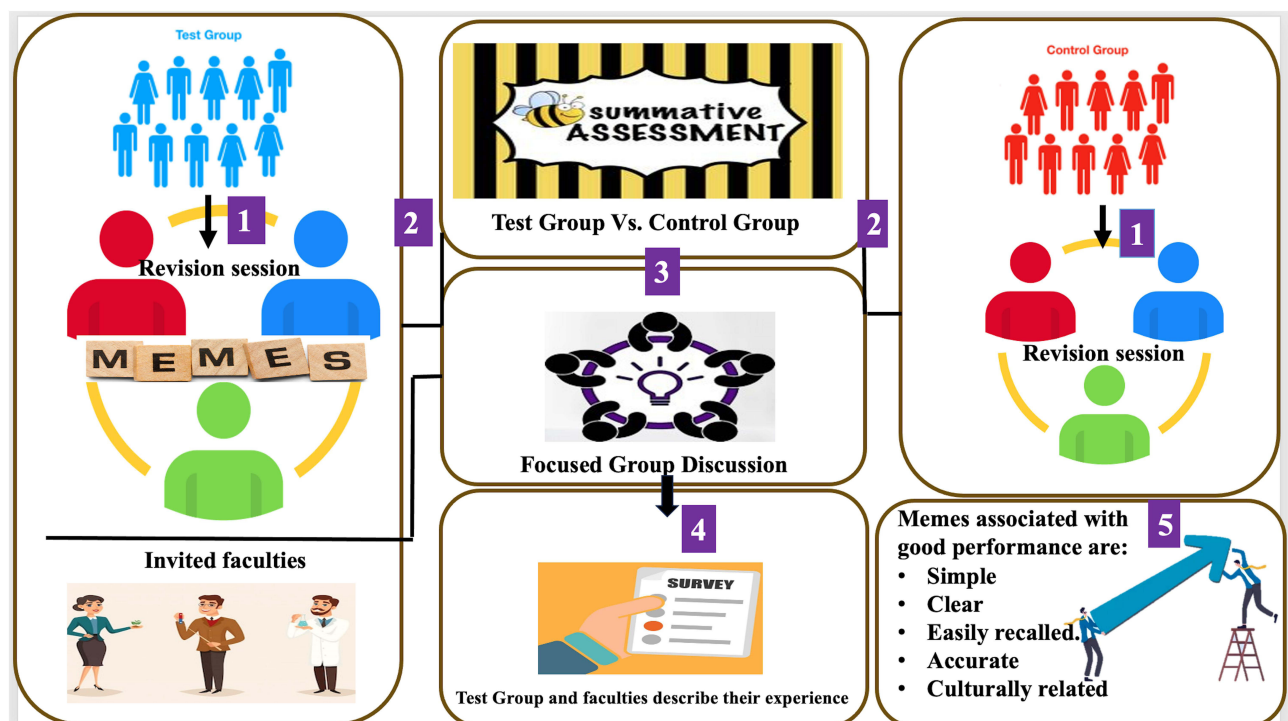


Figure 1 Conceptual framework of Memes Adoption in pharmacology learning as a successful learning model.

In the first section, participants were asked to rank the seven adopted memes on a scale of ten, where ten is the best and one is the worst. Participants also scored their overall satisfaction with memes on a five-point (1–5) Likert scale (5 = very satisfactory, and 1 = very unsatisfactory).¹⁵

In the second section, participants rated the factors influencing their preference for a specific meme on a five-point Likert scale (5 = strongly agree, and 1 = strongly disagree).¹⁵

The third section was designed for the students in the test group only, focusing on the perceived advantages of memes. The students scored the proposed advantages of memes using the Likert scale (5 = strongly agree, and 1 = strongly disagree).¹⁵

The fourth section of the survey covered the participants' intention to redesign and replicate memes. This part consisted of three questions. The first two questions were answered on the same Likert scale. In the last question, the participants chose one preferred meme-inspiring source from movies, plays, sports, songs, social events, and TikTok.

Additionally, the students in the test group and faculty members were asked to attend interviews, and their narrative responses regarding the following points were transcribed as follows:

- What criteria can be relied on to make one meme better than others?
- What criteria can be relied on to consider one meme less successful than others?
- What experience has been gained using memes in the pharmacology course?

Data Analysis

Quantitative data were analyzed using Statistical Package of Social Sciences (SPSS) software, version 28.0 (SPSS Inc., Chicago, IL, USA). Data were presented as mean and standard Deviation (SD), Median and Interquartile Range (IQR), range, number, and percentages. Test and Control group performance was compared using the Mann–Whitney *U*-test. Moreover, the results of high- and low-achieving students and senior and junior faculty members were compared. P value was considered significant if <0.05 . Qualitative narrative responses were transcribed and analyzed using QSR NVivo version 12. Data analysis was carried out by adopting the thematic analysis approach described by Braun and Clarke.¹⁶ We used the deductive approach to interpret the data from the narrative responses and the inductive approach to generate the themes from it.¹⁷ Responses were analyzed, and the major themes and subthemes were reported. Content analysis was done back and forth until saturation.¹⁸ We used word research and codes to ensure the generated themes' internal homogeneity and external heterogeneity. Quality criteria for qualitative research were maintained.¹⁹

Rigor

We implemented the following measures to ensure the trustworthiness of the findings obtained in the current study regarding the quantitative and qualitative data: randomization and double blinding of students' responses were employed for the study design. Furthermore, the students were blindly coded before enrolling in the summative exam. The quantitative survey was established based on the FGD and piloting the survey before adopting it. The survey's stability was assessed using Cronbach's alpha, estimated at 0.89. For the qualitative analysis, all narrative responses were analyzed by two independent investigators, and no data were excluded until saturation. A coding book describing the agreed codes, themes, and subthemes was developed.²⁰ The calculation of the inter-rater reliability, assessing the consistency of analysis between the two investigators, yielded an overall good reliability of about 0.74.²¹

Ethical Approval and Consent to Participate

The current study was conducted after obtaining the Institutional Review Board (IRB) approval from the College of Medicine, Dar Al-Uloom University, Saudi Arabia (approval number: Pro22030010). The study followed the Declaration of Helsinki 1964 and its later amendments. Participants' data were handled anonymously to maintain their confidentiality. After explaining the objectives and nature of the study, informed written consent, including the approval of publishing participants' anonymized responses was obtained from every participant before inclusion in the study.

Results

One hundred thirteen students were registered in the respiratory block, and 98 students agreed to participate in the current study, resulting in a response rate of 86.7%. Among them, 78 were included, with 41 students assigned to the control group and 37 to the test group. Twenty students were excluded for various reasons, including non-compliance with the survey (thirteen students), and absence from summative evaluation (seven students). Besides, 22 faculty members were included. The mean age of students was 21 ± 3.2 years, while the ages of faculty members varied from 33 to 62 years, with a mean of 49 ± 5.2 years. Female students and faculty members outnumbered males. The GPAs of students and the ranking of faculty members are detailed in (Table 1).

Quantitative results

Students in the test group showed significantly higher performance than those in the control group, with $p = 0.022$. A detailed analysis of grades per item revealed that the test group outperformed the controls in all questions where memes were utilized. However, these variations reached statistical significance only in questions 2, 3, and 8. Students' performance in the three remaining questions, where memes were not used (questions 7, 9, and 10), showed no significant variations, as illustrated in (Figure 2).

Regarding evaluating the adopted memes as perceived by students and faculty members, the meme related to question 8 received the highest ranking of 9.45 among students and 9.77 among faculty members. This ranking is followed by the meme relating to question 3, with a ranking of 9.21 for students versus 9.59 for faculty members, and the meme of question 2, which shows a rank of 9.16 among students and 8.81 among faculty members. Some memes were significantly better perceived by students, including memes related to questions 1, 4, 5, and 6, with $p < 0.05$. Overall,

Table 1 Characteristics of the Participants Enrolled in the Current Study

Characteristics of the Participants	Students				Faculties (n=22)	
	Controls (n=41)		Test (n=37)		No.	%
	No.	%	No.	%		
Sex:						
• Female	23	56.1	21	56.8	14	63.6
• Male	18	43.9	16	43.2	8	36.4
Age (years)						
• <25	35	85.4	32	86.5	0	0.0
• 25–30	6	14.6	5	13.5	0	0.0
• >30	0	0.0	0	0.0	22	100.0
Student grade						
• A+	7	17.1	6	16.2		
• A	8	19.5	7	18.9		
• B+	4	9.8	3	8.1		
• B	11	26.8	9	24.3		
• C+	4	9.8	3	8.2		
• C	3	7.3	4	10.8		
• D+	1	2.4	1	2.7		
Faculty position						
• Assistant professor					10	45.5
• Associate professor					6	27.3
• Full professor					4	18.2
• Lecturer					2	9.1

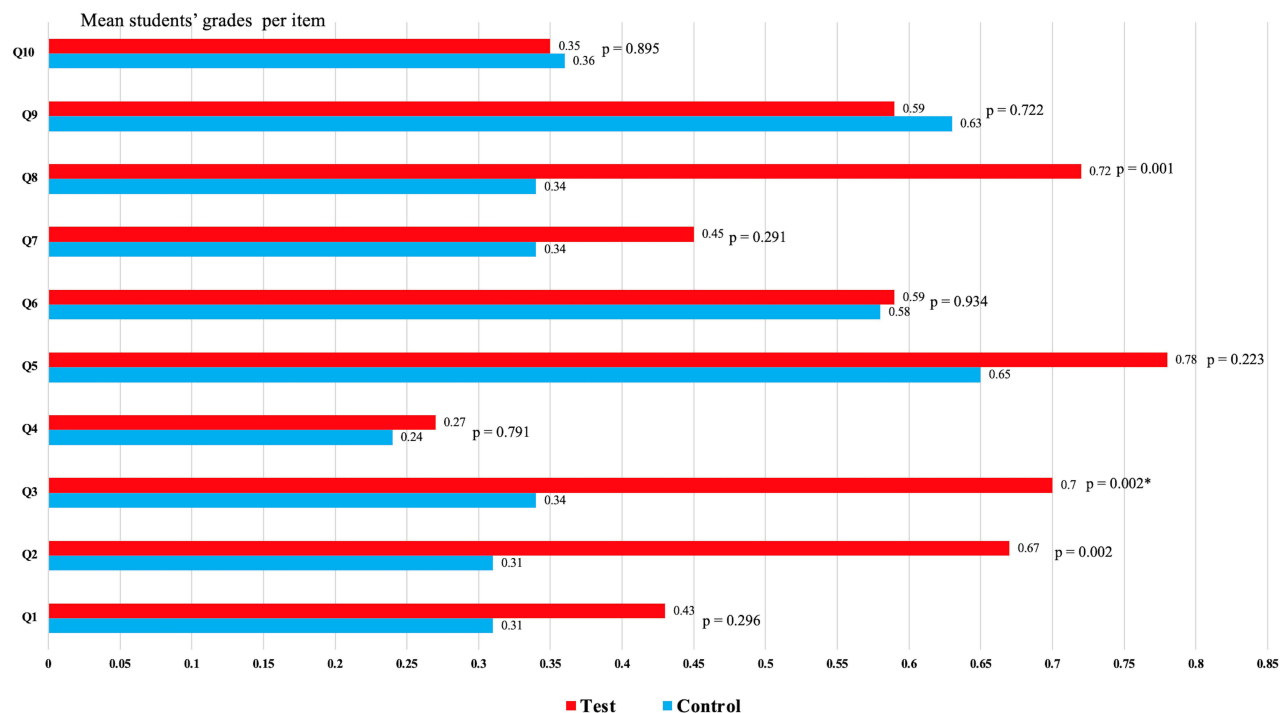


Figure 2 Mean of students' performance among the Control and Test students. *: p value < 0.05: significant.

students' satisfaction with adopting memes was significantly higher than that of faculty members (4.48 ± 0.90 vs 3.36 ± 1.29 , $p < 0.001$), as illustrated in (Table 2). There was no significant difference in meme ranking among students based on their GPAs or between faculties according to their ranking. However, junior faculty members expressed higher satisfaction with adopting memes than senior faculty members, with $p = 0.005$.

(Table 3) depicts that students prefer simple and understandable memes that reflect an international culture and memes inspired by well-known contexts compared to the faculties, who prefer distinctive novel memes associated with a relevant concrete learning concept ($p < 0.05$). The criteria mentioned above for preference were consistent among students, regardless of their GPAs, and among faculties, irrespective of their academic rank.

Regardless to their achievement, all students agreed that memes helped them solve complex case scenarios in the exam, deeply understand some concepts, and increase their focus on details as shown in (Table 4). Regarding the participants' intention to adopt memes, implement them in different learning contexts, and disseminate them through social media, students were significantly more willing to do so ($p < 0.05$). Moreover, students showed a preference for using memes inspired by movies, with 40.5% of students compared to 18.2% of faculty members. In comparison, faculties preferred memes inspired by sports with 40.9% compared to just 13.5% among students. No significant variations were noticed between students of different GPAs and faculty members of various academic ranks (Table 5).

Qualitative Narrative results for Participants' Perceptions

Criteria of Using Meme for a Successful Learning Experience

Theme I: Previous Scientific Background on the Meme Topic

Students preferred the memes that discussed topics for which they had sufficient background knowledge. Examples of students' quotes: "I liked the old female on ethambutol who was wearing glasses. I think I will never forget that adverse effect", and "Because I forgot that theophylline is a methylxanthine derivative, I could not understand that meme".

Table 2 Ranking of the Used Memes (Out of Ten) Among Study Participants

Ranking of an item ^a	Total participants (n=59)	Test Students (n=37)		Total Test Students (n=37)	P1 value	Faculties (n=22)		Total Faculties (n=22)	P2 value	P3 value
		High Achievers (n=25)	Low Achievers (n=12)			Seniors (n=10)	Juniors (n=12)			
	Mean ±SD. Median [IQR]	Mean ±SD. Median [IQR]	Mean ±SD. Median [IQR]	Mean ±SD. Median [IQR]		Mean ±SD. Median [IQR]	Mean ±SD. Median [IQR]	Mean ±SD. Median [IQR]		
Q1	7.89±2.17 8[6–10]	8.80 ±2.08 10[8.5–10]	8.75±1.95 10[8–10]	8.78 ±2.01 10[8–10]	0.957	6.90 ±1.72 6[5.75–8.25]	6.0±1.27 6[5.25–6.75]	6.40±1.52 6[5.75–8]	0.297	<0.001*
Q2	9.03±1.41 10[58–10]	9.36 ±1.11 10[8.5–10]	8.75 ±2.0 10[7.5–10]	9.16 ±1.46 10[8.5–10]	0.359	8.60 ±1.57 8.5[8–10]	9.0 ±1.12 9.5[8–10]	8.81 ±1.33 9[8–10]	0.644	0.178
Q3	9.35±1.14 10[9–10]	9.28 ±1.02 10[8.5–10]	9.08±1.78 10[8.5–10]	9.21 ±1.29 10[8.5–10]	0.661	9.60 ±0.96 10[8–10]	9.58 ±0.66 10[9.75–10]	9.59 ±0.79 10[9–10]	0.583	0.378
Q4	6.88±2.66 7[4–10]	8.96 ±1.42 10[8–10]	7.83 ±1.89 8[7–9.75]	8.59 ±1.65 9[8–10]	0.054	3.90±0.73 4[3–4.25]	4.08 ±1.24 4.5[3–5]	4.0 ±1.02 4[3–5]	0.654	<0.001*
Q5	6.33±2.28 6[5–8]	7.28 ±2.55 7[5.5–10]	6.0 ±2.79 6[3–9.25]	6.86 ±2.66 7[5–10]	0.180	5.60 ±1.17 5[5–6.25]	5.33 ±0.77 5[5–6]	5.45 ±0.96 5[5–6]	0.690	0.020*
Q6	4.91±2.89 5[2–6]	6.12 ±2.86 6[4–9.5]	5.91 ±3.05 5.5[4–9.5]	6.05 ±2.88 6[4–9.5]	0.869	2.90 ±1.72 2.5[1–5]	3.08 ±1.62 2.5[2–4]	3.0 ±1.63 2.5[2–4.25]	0.711	<0.001*
Q8	9.57±1.51 10[10–10]	9.56±1.44 10[10–10]	9.25 ±2.59 10[10–10]	9.45 ±1.86 10[10–10]	0.604	9.90 ±10.31 10[10–10]	9.66 ±0.65 10[9.25–10]	9.77 ±0.52 10[10–10]	0.351	0.716
Overall satisfaction with adopting memes in pharmacology course (out of 5)	7.89±2.17 8[6–10]	4.56 ±0.82 5[4–5]	4.33 ±1.07 5[3.25–5]	4.48 ±0.90 5[4–5]	0.615	2.50 ±1.17 3[1–3.25]	4.08 ±0.90 4[3–5]	3.36 ±1.29 3[3–4.25]	0.005*	<0.001*

Notes: High achievers are those with GPAs A, A+, B, B+ while low achievers are those with GPAs C, C+, D, D+ and F. Senior faculties include full and associate professor, while junior faculties include assistant professors and lecturers, *: p value < 0.05: significant, P1: High versus low achievers, P2: Senior versus Junior faculties, P3: Total test students versus total faculties, a: items 7, 9, and 10 were not supported by memes.

Abbreviations: Q, question, SD; Standard deviation; IQR, interquartile range.

Table 3 Distribution of Criteria of Preferences of a Certain Meme Among Study Participants

Criteria of preferences	Total participants (n=59)	Test Students (n=37)		Total Test students (n=37)	PI value	Faculties (n=22)		Total faculties (n=22)	P2 value	P3 value
		High achievers (n=25)	Low achievers (n=12)			Seniors (n=10)	Juniors (n=12)			
	Mean \pm SD. Median [IQR]	Mean \pm SD. Median [IQR]	Mean \pm SD. Median [IQR]	Mean \pm SD. Median [IQR]		Mean \pm SD. Median [IQR]	Mean \pm SD. Median [IQR]	Mean \pm SD. Median [IQR]		
I prefer direct and easily understandable meme.	4.0 \pm 0.90 4[4-5]	4.32 \pm 0.62 4[4-5]	4.0 \pm 1.12 4[4-5]	4.0 \pm 0.90 4[4-5]	0.517	3.50 \pm 1.17 4[4-5]	3.75 \pm 0.75 4[4-5]	3.63 \pm 0.95 4[3-4]	0.703	0.013*
I prefer meme that reflects my own culture.	3.45 \pm 1.13 4[3-4]	3.24 \pm 1.12 4[3-4]	3.33 \pm 1.30 3.5[3-4]	3.45 \pm 1.13 4[3-4]	0.635	4.0 \pm 0.66 4[3-4]	3.58 \pm 1.24 4[3-4]	3.77 \pm 1.02 4[3.75-4]	0.603	0.059
I prefer meme that reflects an international culture	3.50 \pm 1.33 4[2-5]	4.40 \pm 0.76 5[4-5]	3.75 \pm 1.35 4[4-4.75]	3.50 \pm 1.33 4[2-5]	0.125	2.30 \pm 1.15 2[4-5]	2.41 \pm 0.79 2[4-4.75]	2.36 \pm 0.95 2[2-3]	0.703	<0.001*
I prefer the meme inspired from a well-known context for me	4.25 \pm 0.90 5[4-5]	4.60 \pm 0.57 5[4-5]	4.50 \pm 1.16 5[4.25-5]	4.25 \pm 0.90 5[4-5]	0.607	3.50 \pm 0.70 3[4-5]	3.91 \pm 0.90 4[4.25-5]	3.72 \pm 0.82 3.5[3-4.25]	0.266	<0.001*
I prefer meme that is easy to recall.	4.47 \pm 0.72 5[4-5]	4.56 \pm 0.58 5[4-5]	4.25 \pm 1.21 5[4-5]	4.47 \pm 0.72 5[4-5]	0.695	4.40 \pm 0.61 4[4-5]	4.58 \pm 0.51 5[4-5]	4.50 \pm 0.51 4.5[4-5]	0.403	0.694
I prefer meme that is applicable to a real concrete learning concept	4.18 \pm 1.13 5[4-5]	3.92 \pm 1.18 4[3-5]	3.66 \pm 1.43 4[3-5]	4.18 \pm 1.13 5[4-5]	0.610	4.80 \pm 0.63 5[3-5]	4.75 \pm 0.4 5[3-5]	4.77 \pm 0.52 5[5-5]	0.461	0.001*
I prefer meme that is distinctive and novel. This is the first time to see that meme.	4.08 \pm 1.0 4[4-5]	3.72 \pm 1.10 4[3-4]	4.0 \pm 1.12 4[4-5]	4.08 \pm 1.0 4[4-5]	0.341	4.60 \pm 0.69 5[3-4]	4.50 \pm 0.52 4.5[4-5]	4.54 \pm 0.59 5[4-5]	0.492	0.004*

Note: *: p value < 0.05: significant.

Abbreviations: Q, question; SD, Standard deviation; IQR, interquartile range; PI, High versus low achievers; P2, Senior versus Junior faculties; P3, Total test students versus total faculties.

Table 4 Perceived Advantages of Memes Among Students According to Their Achievement

Perceived advantages	Test Students		Total (n=37)	P value
	High achievers (n=25)	Low achievers (n=12)		
	Mean ±SD.Median [IQR]	Mean ±SD.Median [IQR]	Mean ±SD.Median [IQR]	
These memes helped me to solve complex case scenario in the exam	4.32±0.80 4[4–5]	4.58±0.66 5[4–5]	4.40±0.76 5[4–5]	0.309
These memes helped me to understand scientific concepts deeply	4.20 ±1.0 4[4–5]	4.41 ±0.79 5[4–5]	4.27±0.93 5[4–5]	0.570
These memes increased my focus on some details	4.32 ±0.94 5[3.5–5]	4.0 ±1.08 4.5[3–5]	4.24±0.98 5[3–5]	0.515

Abbreviations: Q, question; SD, Standard deviation, IQR, interquartile range.

Theme 2: Meme's Scenario Context

Students and faculty members favored the memes inspired by a known context familiar to the reader. An example of students' quotes:

"The meme of the Simpsons was my favorite. I thought the Simpson who disposed of aspirin for the asthmatic patient was a real script from the Simpson. I took time to recognize it was a joke".

Theme 3: Learning Concepts Tackled by Memes

Faculty members and students described their best memes as those that helped them solve arguments and compare similar things more easily. Most participating students preferred memes that aided recall and simplified theoretical concepts, which was evident in students' reflections on memes related to questions 2.3 and 8. Examples of students' quotes describing these memes: *"I was never able to memorize the first- and second-generation antihistamine drug classes. That meme was unique and solved that problem"*, *"I'm grateful to the meme that helped me to distinguish ethambutol from ethionamide in the exam!"* and *"I got stucked and felt unsure about the adverse effects of antibiotics until I saw the vampire meme ! Before prescribing tetracyclines, inform the patient that he will live as a vampire !"*. Examples of faculty quotes:

Examples of faculty quotes: *"I liked how that meme simplified this confusing point for the students. The door (representing the blood-brain barrier) was closed for Cinnarizine (first-generation drug) but opened for Diphenhydramine (second-generation drug)"*.

Theme 4: Meme Message Simplicity

Enrolled students preferred direct and easily understandable memes where the message could be picked up from the first look. Students disliked memes with indirect or hidden messages. Examples of students' quotes: *"I did not like that meme of ADHD. I feel it has a hidden message. Unfortunately! I could not pick it up"*. Some students had difficulty understanding the ideas for some memes. They had to consult with their colleagues or the instructor to comprehend the message behind the adopted meme. Some quotes were: *"I could not recognize the idea of that meme. I felt shy when I saw my friends laughing, but I do not know why. However, when a colleague explained it to me, it was a nice meme"*.

Theme 5: Meme's Message Relevance to Practice

Faculty members favored memes that featured accurate scientific content, were related to evidence-based medical practices, and were realistic rather than purely theoretical. An example of a faculty member quote: *"The meme discussing the adverse effects of antituberculosis drugs is an ideal example of a successful meme. The physician should be alert to the negative effects of the drug on the vision. I liked it because it is real and applicable"*.

Table 5 The Intention of Participants to Adopt and Disseminate Memes Through the Social Media Among Study Participants

The intention of participants to adopt memes	Total participants (n=59)		Test Students (n=37)				Total Test students (n=37)	P1 value	Faculties (n=22)				Total participants (n=22)	P2 value	P3 value					
			High achievers (n=25)		Low achievers (n=12)				Seniors (n=10)		Juniors (n=12)									
	Mean ±SD. Median [IQR]		Mean ±SD. Median [IQR]		Mean ±SD. Median [IQR]				Mean ±SD. Median [IQR]		Mean ±SD. Median [IQR]									
I would like to design my own memes and publish them to my colleagues and my tutors	3.49±1.02 3 [3–4]		3.68±1.14 4 [3–5]		4.08±0.90 4 [3–5]		3.81±1.07 4 [3–5]		0.331		3.10 ±0.56 3 [3–3.25]		2.83 ±0.71 3 [3–3]		2.95±0.65 3 [3–3]		0.539		0.001*	
I would like to share these memes with my colleagues, and on social media	3.73 ±1.19 4 [3–5]		4.20 ±1.0 4 [4–5]		4.33 ±1.07 5 [3.25–5]		4.24 ±1.01 5 [4–5]		0.520		2.80 ±0.78 3 [2.75–3]		2.91 ±1.08 3 [2–3.75]		3.86 ±0.94 3 [2–3]		0.914		<0.001*	
I like the memes inspired from:	n	%	n	%	n	%	n	%		n	%	n	%	n	%					
● Movies	19	32.2	12	48.0	3	25.0	15	40.5	0.604 ^{MC}	2	20.0	2	16.7	4	18.2	0.658 ^{MC}	0.017 ^{MC}			
● Plays	2	3.4	1	4.0	1	8.3	2	5.4		0	0.0	0	0.0	0	0.0					
● Social events	13	22.0	5	20.0	3	25.0	8	21.6		2	20.0	3	25.0	5	22.7					
● Songs	6	10.2	1	2.0	1	8.3	2	5.4		3	30.0	1	8.3	4	18.2					
● Sports	14	23.7	2	8.0	3	25.0	5	13.5		3	30.0	6	50.0	9	40.9					
● Tik Tok	5	8.5	4	16.0	1	8.3	5	13.5		0	0.0	0	0.0	0	0.0					

Note: *: p value < 0.05: significant.

Abbreviations: P1, High versus low achievers; P2 Senior versus Junior faculties; P3, Total test students versus total faculties; MC, Monte Carlo test.

Theme 6: The Modality of Using the Meme on the Topic of Education

A few students expressed concern about missing crucial information not addressed in the memes. They recommended using them for revision rather than the traditional explanation. A student's quote: *"I was unsure if memes were sufficient; I was concerned if the tutor should explain some other important points. We can use them as a review tool but not replace the traditional lecture"*.

Perception of Participants of Using the Meme in Pharmacology Learning

Theme 1: Learning Experience Mode and Engagement

Most students reported enjoying the use of memes and engaging in discussions about the content of memes. They expressed reduced boredom and a lighter burden than in traditional sessions. Moreover, they felt motivated and engaged with their colleagues, leading to the preparation, and sharing of other new memes. Examples of quotes: *"I felt so excited and enjoyed the session. These memes were realistic and full of humor"*, and *"This is the first time I did not feel bored"*.

Faculty members also conveyed similar opinions, describing the meme-based sessions as untraditional and highly enjoyable. They expressed feeling closer to students and friendlier. Examples of faculty quotes: *"Students were surprised. They said, Oh doctor, you have seen that movie! It is incredible"* and *"I was expecting that students might dislike the idea; surprisingly, they got the idea easily and were eager to understand the message behind the memes"*.

Theme 2: Feasibility of Using the Meme in Pharmacology Learning

The faculty perceived the adopted memes as practical, cost-effective, easy-to-use, and helpful learning tools. Some examples of faculty quotes: *"Students got the idea quickly, and there was no need for special costing, preparations, or resources"*.

Theme 3: Students' Attitude Towards Exploring Further Meme Inclusion in Their Study

Students utilized memes to reflect on various pharmacology topics. Moreover, they conveyed their willingness to create and disseminate their own. Examples of quotes: *"My colleagues and I were motivated to search many websites to find memes related to our study, and we have shared them"*. In the same context, here is a quote from faculty: *"Some students designed their own"*.

Theme 4: Perceived Impact of Using the Memes on Students' Cognitive Skills

Students reported faster memorization of information, particularly during the exam. Moreover, some students noted that using memes improved their critical appraisal skills, as they had to explain some memes to colleagues who did not initially understand the humor. Furthermore, the enrolled students described how memes enhanced their curiosity, creativity, and motivation to create novel, attractive, and simple memes. Most students expressed satisfaction in finding a way to simplify understanding a complex subject, such as pharmacology.

An example quote: *"A question in the exam required identifying which drug does a particular action. Fortunately, memes saved me! I recognized the correct answer once I recalled the related meme"*. Students mentioned their ability to study independently, often reviewing the text repeatedly to design a new meme. A quote exemplifies this dedication: *"I studied very hard; I wanted to produce the best memes"*.

Discussion

The current study investigated how adopting memes in teaching pharmacology affects the students' perceptions and performance. Notably, the present work aimed to explore the reasons behind the positive perception of memes and provided insights into the criteria of successful meme adoption in medical education. The current study revealed that using memes in pharmacology is well-received and associated with a performance surge. The criteria for successful memes include simplicity, clarity, scientific accuracy, easy understandability, and recall. Moreover, essential features include relevance to clinical practice, a familiar context, and a previous scientific background.

The use of memes in education is grounded in the fundamental pillars of many learning theories. In the context of andragogy learning theory, adult learners demonstrate a need to comprehend the purpose of their learning and possess an

independent self-concept for self-directed learning. Besides, they seek to accumulate a wealth of experience as a valuable learning resource, and their learning needs intertwine with developmental tasks in social roles. Furthermore, they engage in problem-centered learning, focusing on immediate knowledge application, and are primarily motivated by internal factors like self-esteem rather than external influences.²² In addition, Mayer's cognitive theory for effective multimedia designs states that the brain's limited capacity can be expanded by actively processing information using dual channels. Therefore, engaging students in the active learning mode and providing visual stimuli and precise, well-prepared learning material is expected to enhance working memory, recall, and performance.²³

The effectiveness of memes is grounded in the theory of natural selection, which describes three main conditions: variations, replication, and differential fitness. Differential fitness is the degree of alignment between an element's features and the environment in which it spreads.²⁴

Memes also function as a model of experiential education. The relationship between meme use in learning and experiential education resides in their potential to enhance learning through engaging, reflective, and immersive experiences.^{25,26} Memes can serve as a tool to create a more experiential and engaging learning environment, given that they are rooted in current cultural trends, represent a form of informal communication and learning, require critical thinking to convey a message effectively, are based on social interaction through online platforms, are designed to enhance memorization, and promote reflection and discussion.²⁷

Our study revealed that meme adoption is well perceived by students, regardless of their achievement level, and is associated with higher student performance. These results align with previous studies.^{8,10,12,28,29} Brown attributed the improved performance, facilitated by illustrations, to the stimulation of multilevel cognitive functions in terms of visualization, observation, recall, and interpretation.²⁸ In line with previous studies' findings, participants described their meme learning experience as funny and enjoyable, converting learning into less boring and interesting ones.^{8-10,12,28}

The current study demonstrated that students identified successful memes as being direct and easily understandable. Both students and faculty members considered the memes successful when they could be quickly recalled. Vague memes with indirect or unclear messages were disliked, which might overwhelm the students when interpreting the idea. This aligns with the general criteria of good memes used in social contexts; simplicity was a key attribute. Good memes have six qualities, including a focus on ordinary people, humor, simplicity, flawed masculinity, replicability, and whimsical content.³⁰ A simple meme could be easily stored and recalled.³¹

To successfully adopt memes, our students preferred having a sufficient scientific background beforehand. Memes are almost effectively used as a complementary tool, aiding students in filling the gaps after reaching a reasonable level of learning.³² Previous studies have adopted memes as a reviewing tool⁸ in a project-based learning format¹² or as an additive teaching method.¹⁰

Learning from memes inspired by familiar contexts, such as movies, sports, and social events, was appreciated by our students. Successful memes, we found, should have a solid cultural foundation. Possessing cultural competence to adopt memes related to specific community norms and traditions ensures the usefulness and longevity of memes. However, the rapidly changing dynamics of social culture present a unique challenge.³³

In our study, faculty members preferred applicable memes relevant to clinical practices. Moreover, they considered the scientific accuracy of the memes to be one of the primary factors in ensuring successful memes. Meticulous meme revision, considering scientific, linguistic, and grammatical aspects, is crucial to reflect a proper scientific context and positively impact the meme's value.³³ Similarly, Knobel and Lankshear proposed fidelity, fecundity, and longevity as the components of a successful meme framework.³⁴

Moreover, memes that address scientific confusion were established as criteria for successful adoption that were agreed upon by students and faculty members. Speculating the memes number 2.3 and 8 conveys essential findings. Students perceived these three memes well (showed the highest mean of satisfaction > 9). Students owed that to their ability to solve a scientific argument or common confusion, like comparing two drug generations, two drugs possessing the same therapeutic use, or a group of medications sharing adverse effects. Interestingly, these memes were the best perceived by participating faculties, too. Besides, these were the only items where student performance variations showed statistical significance. This positive impact of memes on students' performances was attributed to their ability to promote high-order cognitive skills, aligning with a surge in students' competencies and perceptions,³⁵ similar to our study results.

Strength and Limitations

The current study was the first to explore the criteria for successful meme adoption in medical education. Including faculties of different ranks and students with varying achievement levels addresses a significant knowledge gap and allows the generalization of the obtained findings. However, the study is limited; it was conducted within one institution and focused on one student's academic level. We recommend future studies that explore the factors contributing to the successful replication of the meme in other disciplines of medical education.

Conclusion

The current study revealed that using memes in pharmacology is well-received and associated with a performance surge. The criteria for successful memes include simplicity, clarity, scientific accuracy, easy understandability, and recall. Moreover, essential features include relevance to clinical practice, a familiar context, and a previous scientific background.

Abbreviations

FGD, focused group discussion, GPA, grade point average, MCQ, multiple-choice questions, PBL, problem-based learning, SPSS, Statistical Package of Social Sciences.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of College of Medicine, Dar Al-Uloom University, Riyadh, Saudi Arabia (protocol code Pro22030010).

Data Sharing Statement

The data analyzed in the current study are available upon reasonable request from the corresponding author.

Informed Consent Statement

Written informed consent was obtained from every participant prior to their inclusion in the current study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no competing interests (financial or non-financial) related to this work.

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