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Assessment of a Pharmacy Student–Driven Medication Awareness Initiative: Insights and Learning Outcome Attainment

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Abstract

Educational campaigns, as a type of active learning, promote student engagement, critical thinking, and professionalism. Nevertheless, evidence of their influence on knowledge acquisition and learning outcomes in pharmacy students is still limited. Therefore, this study assesses the impact of a medication safety campaign on students' perceptions of the campaign and their achievement of learning outcomes. A cross-sectional survey was carried out among fourth-year pharmacy students taking the course 'Principles of Medication Safety' in the academic years 2023 and 2024. Data on students' perceptions of the educational campaign and their self-assessed attainment of course learning outcomes were collected using a 20-item online questionnaire based on a 5-point Likert scale. Responses were summarised with descriptive statistics, while categorical variables were examined using Chi-square and Fisher's exact tests, with statistical significance set at $p < 0.05$.

One hundred pharmacy students completed the survey. The majority expressed favourable perceptions of the campaign (78%), and 82% indicated high achievement of learning outcomes, especially in areas such as communication skills, critical thinking, and problem-solving. Students who had previous experience with campaigns (24%) showed greater overall perceptions and learning outcome scores, whereas those participating for the first time (76%) reported marginally higher scores in learning outcomes. The medication safety awareness campaign led to enhanced student perceptions and self-reported learning outcomes, indicating its value as an effective active learning approach in pharmacy education. These results advocate for incorporating similar campaigns into pharmacy curricula and highlight the necessity for additional studies to evaluate their long-term effects on professional readiness.

Keywords: Saudi Arabia, Pharmacy education, Medication safety, Active learning

Introduction

Active learning (AL) is a general term that includes a variety of instructional strategies aimed at shifting away from conventional passive methods, such as lectures and didactic teaching [1–3]. AL takes place when students actively assume responsibility for their own learning through participation in group-based activities [4]. This method can manifest in multiple ways, all of which

prompt students to integrate new information with existing knowledge or real-life contexts, synthesise material, and generate novel approaches to building knowledge and comprehension [4]. Examples of AL techniques encompass case-based learning, experiential learning [5], peer problem solving [6], project-based learning [7], virtual patient simulation [8], games [9], and campaigns [10, 11].

It is important to note that genuine active learning involves collaborative, cognitive, and behavioural engagement by learners as they apply concepts to address problems and reflect on their learning experience [4, 6]. Illustrative AL strategies include project-based tasks requiring critical thinking and problem-solving, experiential activities enabling direct skill practice, collaborative case-based discussions applying theory to

practical scenarios, and simulations or campaigns that incorporate communication, reflection, and knowledge application in authentic settings [6, 8].

In recent years, health professions education, including medical and healthcare curricula, has increasingly emphasised AL [4, 12, 13]. The rigorous academic demands in health sciences can sometimes reduce student motivation [14]. Consequently, carefully designed AL sessions are vital for boosting student enthusiasm, fostering learning engagement [15–18], enriching the educational experience [4, 19, 20], encouraging peer interaction [21], and ultimately improving academic performance and satisfaction [14, 22].

One promising method for applying AL is through educational campaigns [10, 11]. This AL modality offers students chances to develop communication and critical thinking skills [14], build lasting connections with the community and stakeholders [23], and deepen their understanding of the campaign topic [10]. Although evidence is limited, studies have indicated positive effects of student-led educational campaigns on pharmacy students' preparedness and perceptions [10, 24, 25]. Prior research has revealed that pharmacy students experienced notable gains in self-confidence, sense of professional accomplishment, satisfaction, communication, critical thinking, and cultural awareness [10]. In another investigation, pharmacy students took part in a health campaign targeted at university peers within a curriculum outreach initiative; they reported high satisfaction with the campaign, demonstrated strong professional involvement, and strengthened their sense of social responsibility [11]. A further study assessed pharmacy students' satisfaction following a public education campaign on rational drug use, with most participants satisfied regarding improvements in their communication and critical thinking abilities [26]. These results underscore the capacity of AL approaches, particularly educational campaigns, to cultivate pharmacy students' communication and critical thinking competencies while supporting their professional growth as future pharmacists.

In the present study, the term 'educational campaign' denotes a organised, student-directed health promotion initiative aimed at a targeted audience to increase awareness of medication safety. Comparable to "health promotion campaigns" or "public health awareness initiatives" used in the US or UK, such activities typically involve creating educational resources (e.g., posters, brochures, and information stands) and engaging interactively with peers or the public to encourage awareness and safe behaviours [10, 24]. These activities are increasingly recognised as active learning tools because they promote social responsibility and require students to utilise professional knowledge in real communication contexts [25]. Educational campaigns represent one of several AL methods implemented in the 'Principles of Medication Safety' course at a pharmacy college in Saudi Arabia. In Saudi Arabia, pharmacy education consists of a 5-year Bachelor of Pharmacy or a 6-year Doctor of Pharmacy (PharmD) programme, including five years of coursework followed by a mandatory one-year internship. Both programmes integrate clinical and pharmaceutical sciences in alignment with national healthcare priorities and global standards. Medication safety is a key element of pharmacy practice, focusing on preventing medication errors and optimising patient outcomes. Conventional instruction in this area depends on lectures and case-based problem solving. Although this establishes a solid base, it may not fully capture real-world challenges or the nuances of public health communication. Thus, this study seeks to investigate pharmacy students' satisfaction and perceived attainment of course learning outcomes after engaging in a medication safety awareness campaign.

Materials and Methods

Research approach

A cross-sectional approach was implemented, incorporating a digital questionnaire to obtain feedback from senior-level (fourth-year) undergraduate students pursuing pharmacy degrees at a university located in Saudi Arabia. The focus was on individuals registered in the 'Principles of Medication Safety' module across the autumn terms of 2023 and 2024. This confidential web-based instrument aimed to collect participants' opinions about the medication safety initiative and their personal evaluation of attained educational objectives, with emphasis placed on the pedagogical benefits of the initiative rather than attitudes toward particular themes (such as campaigns against tobacco use or proper vitamin consumption). To encourage high participation, the questionnaire hyperlink was emailed to potential respondents, supplemented by three follow-up notifications spaced one week apart. Participation was entirely voluntary, with no rewards provided. The investigation complied with the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) protocols for

digital surveys and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for documenting observational research [27, 28].

Instrument development
The questionnaire was constructed via the REDCap platform (Research Electronic Data Capture; version 7.3.6; Vanderbilt University, Nashville, TN, USA), a protected internet-based system. It consisted of 20 items scored on a five-point Likert format (ranging from "strongly agree = 5" to "strongly disagree = 1"). These items were categorized into two primary domains: 11 items explored participants' views on the initiative, whereas the remaining nine evaluated their perceived mastery of educational goals.

Sample selection and enrollment process
Eligible individuals included fourth-year pharmacy students taking the 'Principles of Medication Safety' module during the autumn sessions of 2023 and 2024. Voluntary completion of the instrument was requested following the initiative's wrap-up in the 2023 autumn term. Early in the module, learners were familiarized with the specified educational objectives. Subsequently, they were assigned to teams, where each team was responsible for brainstorming a theme linked to promoting safe medication practices that addressed a relevant societal concern, along with defining the intended recipients and venue for execution. Upon theme approval, teams developed instructional resources like display boards and graphical elements, focusing on highlighting medication-associated risks and guidance for addressing them. Every resource, including boards and graphics, was examined and endorsed by module facilitators to verify the precision of safety-related details, appropriateness for the designated group, and effective communication of key points. The workflow of the initiative is depicted in **Figure 1**.
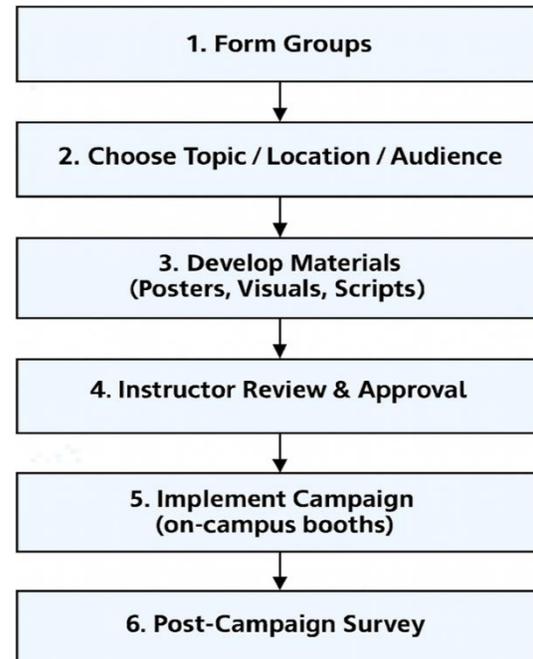

Figure 1. Process diagram illustrating the workflow for the student-organized medication safety initiative

Inclusion requirements
Only learners fulfilling the specified conditions were included in the investigation:
1. Individuals needed to be registered in the 'Principles of Medication Safety' module during the autumn terms of 2023 or 2024.
2. Learners were required to have taken an active role in the mandatory campaign component of the module.
3. Respondents had to submit electronic informed consent prior to accessing the digital questionnaire.
4. Completed responses needed to cover a minimum of 80% of the items, encompassing all essential queries.

Statistical processing
Data processing was performed with SPSS (Statistical Package for the Social Sciences) software, version 28.0 (IBM Corp., Armonk, NY, USA). Frequency counts and proportions were used to report descriptive findings for nominal variables. Associations between nominal variables were tested via Chi-square tests or Fisher's exact tests as appropriate. Continuous data were assessed for distribution normality and summarised as means accompanied by standard deviations; group differences were evaluated using independent t-tests. Statistical significance was defined at $p < 0.05$. Regarding

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aggregated scores for campaign perceptions and learning outcome (LO) attainment, individual item responses were totalled, yielding potential maximums of 55 for perceptions and 40 or 45 for LOs (depending on the section).

Responses rated as neutral on the Likert continuum were assigned the central value of 3 and included unchanged. Categorisation of total scores relied on direct summation without merging neutral ratings into favourable or unfavourable groups. Overall campaign perceptions and self-evaluated LO mastery were dichotomised as "favourable" or "unfavourable" employing a 60% benchmark, aligned with Bloom's criterion [29], a standard frequently applied in educational assessment and attitudinal research [30, 31]. Scores reaching or exceeding 60% of the possible maximum were interpreted as reflecting adequate or favourable views/high LO accomplishment (upper category), whereas those falling below were viewed as indicating insufficient or unfavourable views/low LO accomplishment (lower category). In line with Bloom's framework for differentiating inadequate, fair, and strong achievement or attitudes [29], this benchmark provides an equitable standard for detecting substantial agreement while avoiding overly rigorous thresholds.

To confirm the instrument's dependability and soundness, dual psychometric evaluations were applied.

Assessment of internal consistency

The Cronbach's alpha statistic was computed to evaluate the coherence among questionnaire components. This coefficient varies from 0 to 1, with elevated figures signifying stronger reliability. Interpretation thresholds followed the criteria outlined by George and Mallery (2003): ≥ 0.9 denotes "excellent," 0.8–0.9 "good," 0.7–0.8 "acceptable," 0.6–0.7 "questionable," 0.5–0.6 "poor," and < 0.5 "unacceptable" **(Table 1)**.

Table 1. Internal consistency reliability of survey sections

	No. of items	Cronbach's alpha	Interpretation
Students' perception of the campaign	11	0.987	Excellent
Perceived acquisition of learning outcomes	9	0.989	Excellent

Construct validity

To evaluate the construct validity of the instrument and determine how effectively the items captured the intended latent constructs, confirmatory factor analysis (CFA) was performed. Standardized factor loadings of 0.70 or higher were regarded as evidence of robust convergent validity, indicating strong alignment among items measuring the same concept; all items satisfied this standard [32]. Loadings were reported in standardized form to allow direct comparison between items, whereas unstandardized values—though calculated—were omitted because they vary with scale metrics. The analysis was carried out with AMOS software (version 26), which revealed two distinct factors accounting for a combined 90.2% of the overall variance **(Tables 2 and 3)**.

Table 2. Factor loadings for students' perception of the campaign

Question	Factor Loading
Q2 – Campaign participation enabled me to design strategies for minimizing medication safety risks.	0.961
Q6 – I am highly satisfied with my experience in the awareness campaign.	0.960
Q9 – Peer and audience interactions encouraged reflection on key medication safety issues.	0.955
Q3 – Engaging in the campaign is relevant to my future pharmacist role.	0.954
Q5 – I enjoyed actively taking part in the campaign activities.	0.953
Q8 – I would like to join similar campaigns in the future.	0.944
Q11 – The campaign helped me develop independent learning skills.	0.944
Q1 – Participation improved my understanding of medication safety challenges.	0.938
Q4 – The campaign clarified expectations for my role as a PharmD student and future pharmacist.	0.924
Q10 – The experience served as preparation for my professional career.	0.909
Q7 – Medication safety campaigns should be integrated more broadly into the curriculum.	0.899

Table 3. Factor loadings for perceived acquisition of learning outcomes

Question	Factor Loading
Q17 – The campaign enhanced my ability to resolve medication safety problems.	0.878
Q15 – Participation empowered me to actively promote safe medication use in the community.	0.858
Q12 – The campaign strengthened my knowledge of causes and prevention of medication safety issues.	0.853
Q14 – I was able to apply theoretical knowledge in practical settings through the campaign.	0.851
Q18 – My communication skills improved as a result of the campaign.	0.847
Q20 – The campaign increased my confidence and awareness regarding safe medication practices.	0.837
Q16 – I was able to assess and interpret information to propose strategies for preventing medication safety problems.	0.836
Q13 – The campaign inspired further interest in learning about medication safety risk factors.	0.820
Q19 – My critical thinking skills were enhanced through participation.	0.817

Results and Discussion

Demographic profile

Of the 140 pharmacy students enrolled in the course, 100 (71%) completed the survey and were included in the study analysis. For most participants (76%), this represented their first engagement in a medication safety awareness campaign, whereas 24% had prior experience with similar initiatives.

Students organized and conducted campaigns addressing key medication safety topics, including "Safe Use of Vitamins" (focusing on risks from excessive doses), "Safe Use of Psychotropics" (highlighting adherence and dependency concerns), and "Safe Use of Analgesics" (covering misuse and abuse of NSAIDs and opioids). Campaign activities were carried out in high-traffic areas on campus using information booths to reach a broad student audience.

Students' perceptions of the campaign

Overall, students reported a positive experience with the campaign and recognized its educational value. The mean perception score was 42.7 ± 14.3, equating to a perception rate of 77.7% ± 25.9%, with scores ranging from 20 to 100 and a median of 25.9. Applying a threshold of 60 to categorize responses, the majority of participants demonstrated strong positive perceptions, with only 22% indicating a less favorable view.

Looking at individual items, most students acknowledged tangible benefits from their participation. Specifically, 73% felt their understanding of medication safety had increased, 72% noted the campaign helped them develop strategies to prevent or mitigate safety issues, and 68% recognized its relevance to their future pharmacist role, particularly regarding practical application. **Table 4** presents a detailed breakdown of responses, reflecting how students perceived the campaign's contribution to their educational experience.

Table 4. Students' perception of the medication safety awareness campaign

Students' perception of the campaign	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Q1 Participation improved my understanding of medication safety challenges.	54 (54)	19 (19)	7 (7)	6 (6)	14 (14)
Q2 Campaign participation enabled me to design strategies for minimizing medication safety risks.	48 (48)	24 (24)	12 (12)	7 (7)	9 (9)
Q3 Engaging in the campaign is relevant to my future pharmacist role.	52 (52)	16 (16)	14 (14)	4 (4)	14 (14)
Q4 The campaign clarified expectations for my role as a PharmD student and future pharmacist.	51 (51)	18 (18)	16 (16)	6 (6)	9 (9)
Q5 I enjoyed actively taking part in the campaign activities.	51 (51)	22 (22)	10 (10)	7 (7)	10 (10)
Q6 I am highly satisfied with my experience in the awareness campaign.	49 (49)	20 (20)	15 (15)	4 (4)	12 (12)

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Q7 Medication safety campaigns should be integrated more broadly into the curriculum.	47 (47)	29 (29)	7 (7)	6 (6)	11 (11)
Q8 I would like to join similar campaigns in the future.	44 (44)	24 (24)	13 (13)	6 (6)	13 (13)
Q9 Peer and audience interactions encouraged reflection on key medication safety issues.	43 (43)	27 (27)	15 (15)	2 (2)	13 (13)
Q10 The experience served as preparation for my professional career.	40 (40)	29 (29)	13 (13)	3 (3)	15 (15)
Q11 The campaign helped me develop independent learning skills.	47 (47)	22 (22)	11 (11)	5 (5)	15 (15)

Perceived acquisition of learning outcomes

Students reported notable gains in their learning outcomes, with an average score of 34.6 ± 11.5, equivalent to $77\% \pm 25.5\%$ of the maximum possible score. Individual scores ranged from 20 to 100, with a median of 25.5. Using a benchmark of 60 to indicate sufficient perceived learning, 82% of students exceeded this threshold, while 18% scored below it.

Survey responses revealed strong agreement on several aspects of the campaign. About 69% of students felt that their understanding of the main causes of medication safety problems and strategies to prevent them had improved. Moreover, 76% stated that the campaign boosted their confidence and awareness regarding medication safety issues, and 70% reported that participating helped them develop better problem-solving skills in this context. A detailed breakdown of these responses is presented in **Table 5**.

Table 5. Perceived acquisition of learning outcomes from the medication safety awareness campaign

Perceived acquisition of the learning outcomes	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Q12 The campaign strengthened my knowledge of causes and prevention of medication safety issues.	47 (47)	22 (22)	13 (13)	7 (7)	11 (11)
Q13 The campaign inspired further interest in learning about medication safety risk factors.	43 (43)	24 (24)	18 (18)	3 (3)	12 (12)
Q14 I was able to apply theoretical knowledge in practical settings through the campaign.	40 (40)	28 (28)	14 (14)	5 (5)	13 (13)
Q15 Participation empowered me to actively promote safe medication use in the community.	39 (39)	31 (31)	12 (12)	8 (8)	10 (10)
Q16 I was able to assess and interpret information to propose strategies for preventing medication safety problems.	44 (44)	23 (23)	19 (19)	4 (4)	10 (10)
Q17 The campaign enhanced my ability to resolve medication safety problems.	42 (42)	28 (28)	13 (13)	9 (9)	8 (8)
Q18 My communication skills improved as a result of the campaign.	46 (46)	23 (23)	12 (12)	8 (8)	11 (11)
Q19 My critical thinking skills were enhanced through participation.	41 (41)	29 (29)	12 (12)	8 (8)	10 (10)
Q20 The campaign increased my confidence and awareness regarding safe medication practices.	45 (45)	31 (31)	7 (7)	6 (6)	11 (11)

Campaign perceptions and learning outcomes in relation to previous experience

The relationship between students' prior involvement in educational campaigns and their reported perceptions and learning achievements was examined. At the 60-point threshold, perception scores did not show a statistically significant difference between students with and without prior campaign experience. However, those with previous exposure tended to report more favorable perceptions (87.5%) than students without such experience (75.0%).

A notable difference emerged for learning outcomes. A higher proportion of students who had participated in campaigns before (95.8%) exceeded the 60-point threshold compared to those with no prior experience

(77.6%), with this difference reaching statistical significance (p = 0.043) **(Table 6)**.

Table 6. Distribution of perceptions and learning outcomes based on prior campaign experience

Perception and Learning Outcome Thresholds		Was the medication safety awareness campaign your first experience?		
		No	*Yes*	
	Category	*n* = 24 (%)	*n* = 76 (%)	*p*-value
Perception 60	Low-negative	3 (12.5)	19 (25.0)	0.197
	High-positive	21 (87.5)	57 (75.0)	
Learning Outcome 60	Low	1 (4.2)	17 (22.4)	0.043
	High	23 (95.8)	59 (77.6)	

Overall, students who had prior experience with educational campaigns reported significantly higher mean scores in perception and learning outcomes compared to those participating in such a campaign for the first time. The mean overall perception score was 41.2 ± 15.3 for experienced participants, versus 47.7 ± 9.2 for first-time participants (p = 0.013). Likewise, the mean overall learning outcome score was higher among experienced participants (38.8 ± 8.8) than among first-time participants (33.3 ± 11.9), with a p-value of 0.020.

This study assessed pharmacy students' perceptions of a medication safety awareness campaign and their attainment of related course learning outcomes. The results demonstrate that the campaign was highly successful in generating positive perceptions, deepening students' knowledge of medication safety concerns, and developing key professional competencies. This was evidenced by approximately 70% of participants agreeing or strongly agreeing that the campaign improved their communication skills, sharpened critical thinking, and strengthened problem-solving abilities. A large majority of students also recorded high scores in achieving learning outcomes, reflecting the campaign's effectiveness in supporting knowledge gain and skill enhancement.

These findings are consistent with earlier research emphasizing the advantages of active learning (AL) approaches, such as student-led educational campaigns, in boosting engagement and professional growth. Prior studies have shown that pharmacy student-led campaigns improve self-confidence, communication abilities, and readiness for professional practice [4, 33]. In line with this, a considerable number of students in the present study surpassed the campaign's higher threshold for positive perception. Participants particularly appreciated

the campaign's relevance to future pharmacy practice, its contribution to medication safety awareness, and its interactive learning format. These outcomes support the incorporation of educational campaigns into pharmacy curricula to increase student engagement and preparation for professional responsibilities [34, 35].

Students demonstrated robust achievement of learning outcomes, with 82% reaching high scores at the lower threshold and 68% exceeding the higher threshold. They reported notable gains in medication safety knowledge, critical thinking, problem-solving, and communication skills—competencies essential to pharmacy practice, where medication safety and patient counseling are core duties [36–39]. Furthermore, 73% of students agreed that the campaign improved their grasp of medication safety issues, and 76% supported its adoption in other pharmacy courses, underscoring its perceived lasting educational benefit.

Interestingly, prior experience with educational campaigns influenced perceptions and learning outcomes differently. Although students with previous exposure obtained higher overall scores, first-time participants slightly outperformed at lower learning thresholds. This indicates that the campaign was engaging and approachable for students irrespective of prior experience. The superior overall scores of experienced participants likely stem from accumulated learning effects and highlight the value of repeated participation in reinforcing knowledge retention and skill mastery. In contrast, the solid performance of novices at lower thresholds suggests the campaign successfully delivered foundational medication safety concepts in an accessible way. These observations align with experiential learning theories that stress the importance of practical

experiences in progressively building knowledge and abilities [40, 41].

The campaign's effectiveness highlights the promise of AL strategies in pharmacy education. By involving students in practical applications of medication safety principles, such programs help bridge the divide between theory and practice. Incorporating the campaign as an AL component promotes critical thinking, communication, and problem-solving in accordance with competency-based education models that emphasize hands-on skill building [42, 43]. Moreover, the strongly favorable student perceptions indicate that embedding similar campaigns in pharmacy curricula could markedly improve readiness for professional roles [10, 26]. Beyond immediate benefits, more than 68% of participants expressed willingness to participate in future medication safety activities, suggesting the campaign lays groundwork for ongoing engagement and fosters lifelong learning and professional growth [10, 26]. Pharmacy educators are encouraged to include educational campaigns as formal curricular elements to cultivate engagement, confidence, and competence in medication safety.

Despite these insightful findings, certain limitations must be noted. The modest sample size may restrict generalizability, and dependence on self-reported measures raises risks of social desirability or recall bias. Variations in audience interaction, venue, and topic choice across individual student campaigns could have led to differing success levels, potentially biasing some students' perceptions. The study was limited to one institution, limiting representation of varied educational environments. No pre- and post-campaign assessments were performed to measure changes in perceptions or satisfaction. The survey's heavy reliance on Likert-scale items may have limited deeper understanding of participants' views. Future investigations should examine the long-term effects of such campaigns on professional practice and patient care outcomes. Longitudinal research could determine if involvement translates to better real-world results. Multi-institutional and cross-cultural comparative studies would offer broader insights into intervention efficacy. Qualitative approaches could yield richer details on student experiences and refine best practices for AL integration in pharmacy education. Including a 'Neutral' option in categorization may have understated agreement levels, potentially introducing bias; alternative classification methods could improve interpretation in future work.

Finally, extrinsic factors like course grades or academic performance might have influenced perceptions, with higher-achieving students possibly reporting greater satisfaction, representing another potential bias source.

Conclusion

This study revealed that a medication safety awareness campaign was linked to favorable perceptions and improved self-reported learning outcome achievement among pharmacy students. The initiative effectively engaged participants, likely contributing to greater medication safety understanding and professional skill development. Both novice and experienced students derived benefits, albeit to different extents, indicating such programs are valuable and inclusive. These results provide initial evidence supporting the integration of AL strategies, including educational campaigns, into pharmacy education. Such approaches can enhance critical thinking, communication, and problem-solving abilities, thereby advancing students' professional preparedness. Future studies should investigate long-term impacts and establish optimal methods for incorporating these campaigns into pharmacy curricula.

References

1. McLaughlin K, Mandin H. A schematic approach to diagnosing and resolving lecturalgia. Med Educ. 2001;35(12):1135–42. 10.1046/j.1365-2923.2001.01090.x.

2. Mourad A, Jurjus A, Hajj Hussein I. The what or the how: a review of teaching tools and methods in medical education. Med Sci Educ. 2016;26:723–8. 10.1007/s40670-016-0323-y.

3. Wolff M, Wagner MJ, Poznanski S, Schiller J. Not another boring lecture: engaging learners with active learning techniques. J Emerg Med. 2015;48(1):85–93.
10.1016/j.jemermed.2014.09.010.

4. Freeman S, Eddy SL, McDonough M, Smith MK. Active learning increases student performance in science, engineering, and mathematics. Proceedings of the national academy of sciences, 2014. 111(23): pp. 8410-8415. 10.1073/pnas.1319030111

5. Palis AG, Quiros PA. Adult learning principles and presentation pearls. Middle East Afr J Ophthalmol. 2014;21(2):114–22. 10.4103/0974-9233.129748.

6. White PJ, Larson I, Styles K, Yuriev E. Adopting an active learning approach to teaching in a research-intensive higher education context transformed staff teaching attitudes and behaviours. High Educ Res Dev. 2016;35(3):619–33. 10.1080/07294360.2015.1107887

7. Bilimoria D, Wheeler JV. Learning-centered education: A guide to resources and implementation. J Manage Educ. 1995;19(3):409–28. 10.1177/105256299501900315.

8. Posel N, Mcgee JB, Fleiszer DM. Twelve tips to support the development of clinical reasoning skills using virtual patient cases. Med Teach. 2015;37(9):813–8. 10.3109/0142159X.2014.993951.

9. McCoy L, Lewis JH, Dalton D. Gamification and multimedia for medical education: a landscape review. J Osteopath Med. 2016;116(1):22–34. 10.7556/jaoa.2016.003.

10. Lee SWH. Pharmacy student-led health education campaign initiative. Curr Pharm Teach Learn. 2019;11(3):292–5. 10.1016/j.cptl.2018.12.010.

11. Lee BJ, Wang SK, So C, Chiu BG. A student-led health education initiative addressing health disparities in a Chinatown community. Am J Pharm Educ. 2015;79(9):132. 10.5688/ajpe799132.

12. Michaelsen LK, Parmelee DX, Levine RE, McMahon KK. Team-based learning for health professions education: A guide to using small groups for improving learning. Taylor & Francis; 2023.

13. Stewart DW, Brown SD, Clavier CW, Wyatt J. Active-learning processes used in US pharmacy education. Am J Pharm Educ. 2011;75(4):68. 10.5688/ajpe75468

14. Yap AXW, Er HM, Ng SH, Nadarajah VD. Community service and its learning values: perceptions of undergraduate pharmacy students. INDIAN J Pharm Educ Res. 2022;56(3):673–80. 10.5530/ijper.56.3.115.

15. Atayee RS, Singh RF, Best BM, Freedman BA. An active-learning assignment involving peer-to-peer presentations to improve pharmacy students' attitudes and knowledge of dietary supplements. Am J Pharm Educ. 2012;76(6):113. 10.5688/ajpe766113.

16. Allen RE, Copeland J, Franks AS, Karimi R. Team-based learning in US colleges and schools of pharmacy. Am J Pharm Educ. 2013;77(6):115. 10.5688/ajpe776115.

17. Gleason BL, Peeters MJ, Resman-Targoff BH, Karr S. An active-learning strategies primer for achieving ability-based educational outcomes. Am J Pharm Educ. 2011;75(9):186. 10.5688/ajpe759186.

18. McCoy L, Pettit RK, Lewis JH, Allgood JA. Evaluating medical student engagement during virtual patient simulations: a sequential, mixed methods study. BMC Med Educ. 2016;16:1–15. 10.1186/s12909-016-0530-7.

19. Chi MT, Wylie R. The ICAP framework: linking cognitive engagement to active learning outcomes. Educational Psychol. 2014;49(4):219–43. 10.1080/00461520.2014.965823.

20. Schmidt HG, Cohen-Schotanus J, Arends LR. Impact of problem-based, active learning on graduation rates for 10 generations of Dutch medical students. Med Educ. 2009;43(3):211–8. 10.1111/j.1365-2923.2008.03287.x.

21. Pettit RK, McCoy L, Kinney M. What millennial medical students say about flipped learning. Advances in medical education and practice, 2017: pp. 487-497. 10.2147/AMEP.S139569

22. Choy C, Liaw S, Goh E, See K. Impact of sepsis education for healthcare professionals and students on learning and patient outcomes: a systematic review. J Hosp Infect. 2022;122:84–95. 10.1016/j.jhin.2022.01.004.

23. Begley K, Haddad AR, Christensen C, Lust E. A health education program for underserved community youth led by health professions students. Am J Pharm Educ. 2009;73(6). 10.5688/aj730698.

24. Wilbur K. Pharmacy student perceptions of public health service roles and responsibilities. Int J Pharm Pract. 2011;19(3):179–84. 10.1111/j.2042-7174.2011.00115.x.

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25. Chew C, Kapanen A, Gobis B, Reardon J. Pharmacy students' perspectives on involvement in workplace-based preventative health and wellness events. Currents Pharm Teach Learn. 2021;13(6):699–704. 10.1016/j.cptl.2021.01.038.

26. Petry I, Contri JERV, Kulkamp Guerreiro IC. Involvement of pharmacy students in a campaign on rational drug use: A Brazilian experience of active learning. Global Drugs Ther, 2021DOI: 10.31487/j.GDT.2021.01.02

27. Eysenbach G. Improving the quality of web surveys: the checklist for reporting results of internet E-Surveys (CHERRIES). Toronto, Canada: Gunther Eysenbach Centre for Global eHealth Innovation; 2004. p. e34.

28. Cuschieri S. The STROBE guidelines. Saudi J Anaesth. 2019;13(Suppl 1). 10.4103/sja.SJA_543_18. p. S31-S34

29. Bloom BS, Engelhart MD, Furst EJ, Hill WH. Taxonomy of educational objectives: the classification of educational goals. Handbook 1: cognitive domain. New York: Longman; 1956.

30. Yusof AMM, Rahman NA, Haque M. Knowledge, attitude, and practice toward food poisoning among food handlers and dietetic students in a public university in Malaysia. J Pharm Bioallied Sci. 2018;10(4):232–9.

31. Alzahrani F, Almohammadi A, Alhejaili M, Almukhlifi S. An evaluation of pharmacy students' knowledge, attitudes and risk perceptions about HIV/AIDS. Pharm Pract, 2024. 22(3).:2998. 10.18549/PharmPract.2024.3.2998.

32. Hair J, Tatham R, Anderson R, Black W. Prentice-Hall; London: 1998. Multivariate data analysis.(Ed 5).

33. Hodges LC. Student engagement in active learning classes. Active learning in college science: The case for evidence-based practice, 2020: pp. 27-41. 10.1007/978-3-030-33600-4_3

34. Garrison DR, Kanuka H. Blended learning: Uncovering its transformative potential in higher education. The Internet and Higher Education, 2004. 7(2): pp. 95-10510.1016/j.iheduc.2004.02.001

35. Prince M. Does active learning work? A review of the research. J Eng Educ. 2004;93(3):223–31. 10.1002/j.2168-9830.2004.tb00809.x. DOI.

36. Kansanaho H, Cordina M, Puumalainen I, Airaksinen M. Practicing pharmacists' patient counseling skills in the contextof reflectivity. Pharm Educ. 2005;5(1). https://pharmacyeducation.fip.org/pharmacyeducation/article/view/110.

37. Gupta S, Shaw J. Development of medication-related counselling skills in senior medical students: a checklist-based approach. BMC Med Educ. 2019;19:1–6. 10.1186/s12909-019-1773-x.

38. Bajis D, Chaar B, Basheti IA, Moles R. Pharmacy students' medication history taking competency: simulation and feedback learning intervention. Currents Pharm Teach Learn. 2019;11(10):1002–15. 10.1016/j.cptl.2019.06.007.

39. Saseen JJ, Ripley TL, Bondi D, Burke JM. ACCP clinical pharmacist competencies. Pharmacotherapy: J Hum Pharmacol Drug Therapy. 2017;37(5):630–6. 10.1002/phar.1923.

40. Kolb DA. Experiential learning: experience as the source of learning and development. FT; 2014.

41. Brown PC, Roediger HL III, McDaniel MA. Make it stick: the science of successful learning. Harvard University Press; 2014.

42. Education ACfP. Accreditation standards and key elements for the professional program in pharmacy leading to the Doctor of pharmacy degree. Accreditation Council for Pharmacy Education Chicago, IL; 2015.

43. Frenk J, Chen L, Bhutta ZA, Cohen J. Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. Lancet. 2010;376(9756):1923–58. 10.1016/S0140-6736(10)61854-5.