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Sustainable Instructional Design in Pharmacy Education: A Case Study on Enhancing Student Engagement and Learning

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ABSTRACT

Designing pharmaceutical assignments in this era of AI technology requires meaningful, active student engagement to foster creativity, higher-order thinking, and effective communication skills. Conventional assessments in pharmacy education often offer limited opportunities for students to apply their knowledge and develop critical understanding. To address this gap, an instructional innovation was introduced in a pharmaceutical course through a structured activity called Formulation Fusion: From Lab to Showcase. A total of 67 Semester 3 Diploma in Pharmacy students participated in this structured activity, which required them to complete practical sessions by preparing pharmaceutical products in the laboratory, then select their two best products and design an original hypothetical formulation for evaluation. Students subsequently translated their work into digital infographics using Canva and presented their outcomes in oral sessions designed as product pitches. To promote affordability and sustainability, students were encouraged to use low-cost and readily available materials for packaging and labelling. The result showed a statistically significant improvement in post-activity score compared to pre-activity score ($Z=5.56$, $p<.001$, $r=.68$), indicating enhanced understanding of formulation concepts. Most students reported that creating infographics was an engaging way to learn about pharmaceutical formulations and recommended a similar assignment for future coursework. In conclusion, this case study demonstrates that incorporating structured, affordable, and sustainable instructional activities can enhance student engagement, foster creativity, and strengthen communication skills, thus offering a replicable model for future pharmacy education.

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1. INTRODUCTION

In pharmacy education, it is critical to produce graduates who possess both theoretical knowledge and practical competencies to adapt to fast-paced healthcare settings. The pharmacy profession today has evolved towards a more patient-centred approach, and with the recent integration of technology into healthcare, pharmacy graduates are now expected to demonstrate creativity, communication, and critical thinking skills, in addition to strong scientific knowledge (Persky et al., 2019). However, traditional assessment methods frequently limit opportunities for students to actively engage in structured activities and collaboration, creating a gap between classroom learning (knowledge recall) and professional readiness (application) (Falasi, 2024).

Active learning approaches, such as problem-based and case-based learning, have been increasingly adopted in higher education to foster student engagement and improve learning outcomes by encouraging participation, reflection, and critical thinking (Sulaiman & Abdulla, 2024). These approaches have shown positive outcomes among pharmacy graduates through activities such as patient counselling competitions and problem-based learning (Moon et al., 2024). Similar findings were reported that active learning methods improved academic performance among Malaysian students (Mohammad Hanapi et al., 2020). Hence, pharmacy educators must innovate thoroughly in assessment and curriculum design by incorporating instructional approaches that integrate both technical and transferable skills, preparing graduates for the demands of clinical and industrial practice (Steenhof, 2023).

Another critical attribute for pharmacy graduates is creativity and critical thinking, as these skills, through active learning approaches, support problem-solving in many areas, such as formulation design, patient care, and even pharmaceutical research. However, in traditional laboratory practice and assessment, these two attributes are unlikely to be applied because of a focus on practical accuracy and the production of error-free final products (Karina Mendez Cordero et al., 2025). In the context of pharmaceutics education, integrating design thinking can help students better understand formulation challenges and make evidence-based decisions, making the routine laboratory work an opportunity for students to be innovative, creative and foster a sense of right in completing their assignment (Karina Mendez Cordero et al., 2025; Pugliese et al., 2018).

Aligning with the Sustainable Development Goals (SDG) on quality education, emphasising equitable and inclusive learning, the design of instructional and active learning strategies should be affordable, resource-efficient, and accessible to various learners (Mokshein, 2018). This can be achieved through a combination of policy changes, stakeholder involvement and engagement, and the integration of technological tools (Wardat & Alali, 2025). In pharmacy education, particularly in this study, this principle is highly relevant as institutions such as Universiti Teknologi MARA (UiTM) aim to provide better learning experiences that are both impactful and resource-conscious, hence ensuring equitable access to high-quality education and training regardless of socio-economic background (Abo-Khalil, 2024; Mokshein, 2018).

Based on these principles, the Formulation Fusion: From Lab to Showcase instructional innovation design was developed and implemented in one of the pharmaceutics courses, PHD211: Semi-Solid Dosage Forms, in the Diploma in Pharmacy program at UiTM Cawangan Pulau Pinang, Bertam Campus. This innovation was designed to transform routine laboratory work into an engaging, creative, and sustainable instructional activity. The main objective of this project was to enhance student engagement and learning by integrating hands-on, practical compounding sessions with creative elements such as infographic design and oral product presentations. Furthermore, this study aimed to evaluate the effectiveness of the structured instructional innovation in improving students' understanding of pharmaceutical formulation concepts and identifying key competencies developed through participation in the activity.

2. METHODOLOGY

2.1 Study Design and Settings

This study employed a quantitative cross-sectional design to evaluate the effectiveness of a structured instructional design learning innovation in enhancing student engagement and learning. All Semester 3 Diploma in Pharmacy students who enrolled into PHD211 course during the October 2024 to February 2025 academic session were invited to participate in this study. The minimum sample size was determined to be 63 using the Raosoft sample size calculator, with a 5% margin of error and a 95% confidence level. This sample size was deemed appropriate for representing the study population and providing meaningful insights into the effectiveness of the instructional design innovation.

This innovation is designed as part of their group assignment, in which students were organised into groups of three to four members and participated in a three-phase activity (Fig. 1). The first phase is in the laboratory practical compounding, where students conducted a standard compounding session following the laboratory manual and subsequently selected the best two of the product preparations for showcase. Next, each group designed an original hypothetical formulation, created digital infographics in Canva to present it, and prepared packaging and labelling using low-cost, readily available materials such as recycled paper and boxes. The final phase culminated in oral presentation sessions styled as product pitches, where students presented their work to judges role-playing as investors.

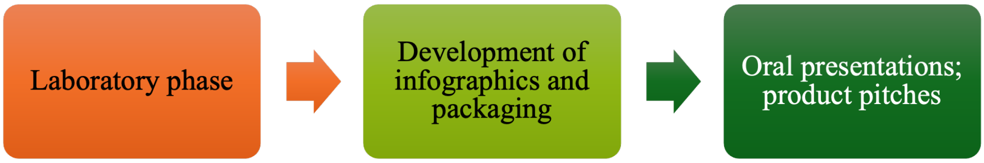

Fig. 1 *Summary of structured instructional innovation design*

2.2 Data Collection

Data were collected using a structured questionnaire distributed to all participants to gather their perspectives on the structured instructional design learning. The data collection was conducted in two phases. The first phase (pre-activity) took place at the beginning of the semester during the group assignment briefing, while the second phase (post- activity) was carried out after the students had completed their oral presentations. The questionnaire comprised several items to capture key information and employed a Likert-type scale ranging from strongly disagree to strongly agree and from not at all to a lot. The first section of the questionnaire collected participants' demographic information, including age, gender, and group. The second section of it comprised items aimed at capturing students' knowledge and understanding before (pre-activity) and after (post-activity) participating in this structured, innovative design learning activity. The final section, included only during the second phase of data collection, contained general questions to assess students' overall perceptions of the skills developed, their level of engagement and collaboration, and the effectiveness of structured instructional design. All responses were collected anonymously via a Google Form and distributed via WhatsApp.

2.3 Data Analysis

All data collected were analysed using IBM SPSS version 30. Quantitative data were analysed using descriptive statistics, including frequencies, percentages, mean and standard deviations to summarise the demographic characteristics and perception responses. A Wilcoxon signed-rank test was conducted to determine the difference in knowledge before and after the structured instructional activity. The null hypothesis was established, that there is no significant difference between the before and after activity score, with statistical significance set at $p < 0.05$. Additionally, a Mann-Whitney U test was conducted to compare students' perception scores between male and female students. Lastly, Chi-square tests of independence were performed to examine whether improvements in perceived skills (such as communication, teamwork, presentation, infographic design, and formulation design competency) differed across demographic variables, gender and age group.

3. RESULT AND DISCUSSIONS

3.1 Demographic of Participants

Table 1 displays demographic characteristics of the 67 students who participated in this study. The majority (82.1%) were female, aged between 19 and 22, with an average age of 20 years (64.2%). Participants were distributed across four groups: A1 (25.4%), B1 (23.9%), C1 (28.4%) and D1 (22.4%).

Table 1
Participants' demographic characteristics (n=67)

Demographic		Frequency (n)	Percentage (%)
Gender	Male	12	17.9
	Female	55	82.1
Age (years)	19	8	11.9
	20	43	64.2
	21	12	17.9
	22	4	6.0
Group	A1	17	25.4
	B1	16	23.9
	C1	19	28.4
	D1	15	22.4

3.2 Students' Perceptions of The Instructional Innovation Activity

Table 2 summarises students' perceptions of the instructional activity in the pharmaceutics course. Overall, students' perceptions were highly positive, with most students (98.5%) agreeing that the structure of the group assignment deepened their understanding of the formulation design. In addition, 95.5% perceived that creating an infographic was an engaging way to learn about pharmaceutical formulations. This finding is in line with a study conducted among Pakistani undergraduate medical students, which reported similarly positive perceptions that infographics simplify information, enhance understanding and bridge theory and clinical practice (Subaveerapandiyan et al., 2024). Furthermore, the majority of them (91%) would recommend similar assignments for future coursework, supporting the findings from Okoro and Hedima that structured group assignments are more favourable among students in pharmacy education (Okoro & Hedima, 2022). Notably, about 22.4% of students lacked confidence in presenting scientific information both visually and verbally, suggesting that many students still require additional support. This finding warrants action by educators or teaching assistants to pay closer attention to affective barriers, such as confidence and clarity, when designing assignments, particularly those involving visual communication, which is not formally taught in the syllabus (Leone & French, 2022).

The five general perception items demonstrated good internal consistency (Cronbach's $\alpha = 0.82$). The Mann–Whitney U test revealed no significant difference between genders ($U = 217.50$, $Z = -1.86$, $p = .062$). This finding suggests a slight tendency for one gender group to report higher perception scores than the other. Male students have a higher mean rank (M=43.38) compared to female students (M=31.95), suggesting marginally higher perception scores among males. This finding reinforces the conclusion that the structured assignment was well received across genders, with only minimal individual variation.

Table 2
Students' perceptions of instructional innovation activity

Perception item	Frequency, n (%)			Mean ± SD	p value*
	A little	Somewhat	A lot		
Creating an infographic is an engaging way to learn about pharmaceutical formulations.	3 (4.5)	21 (31.3)	43 (64.2)	3.58 ± 0.63	0.062
I feel confident in presenting scientific information visually and verbally.	15 (22.4)	37 (55.2)	15 (22.4)	2.94 ± 0.80	
This assignment has deepened my understanding of excipient formulation and its role.	1 (1.5)	29 (43.3)	37 (55.2)	3.52 ± 0.59	
The skills I develop during this group assignment will benefit me in future academic or professional tasks.	3 (4.5)	20 (29.9)	44 (65.7)	3.60 ± 0.63	
I would recommend similar assignments for future coursework.	6 (8)	24 (35.8)	37 (55.2)	3.45 ± 0.70	

* Mann-Whitney U test, significant when p <0.05

3.3 Impact on Student Learning and Engagement

Fig. 2 shows a clear upward shift in the median post-activity score (4.1) compared to the pre-activity score (3.8), indicating notable improvement following the structured instructional activity. The significant increase in post-activity scores provides strong empirical support for the Formulation Fusion: From Lab to Showcase model's ability to promote a deeper understanding of the topics and enhance students' confidence in scientific communication (Armstrong et al., 2024). These findings align with previous studies that reported that structured, affordable, and sustainable instructional design can enhance students' engagement and learning in pharmaceutical education (Armstrong et al., 2024; Arnab et al., 2025). Similarly, a study among undergraduate medical students found that integrating a flipped classroom and team- based learning discussions within laboratory instruction significantly improved conceptual understanding and performance, favouring the continued use of the model in the near future (Qu et al., 2024).

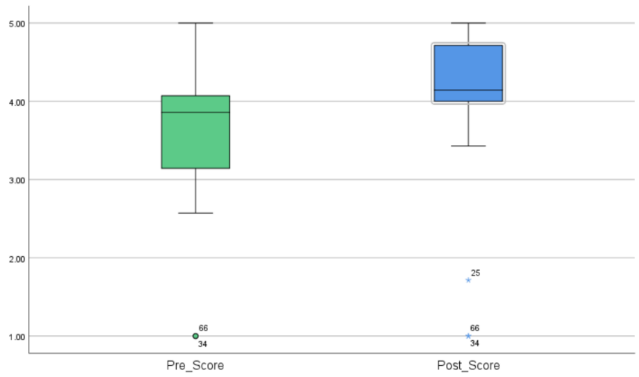

***Fig. 2** Median score for pre- and post-instructional innovation activity*

A Wilcoxon Signed-Rank Test (Table 3) was conducted to examine the difference in students' scores before and after the implementation of the structured instructional innovation activity. The results indicated a statistically significant increase in post-activity scores compared to pre-activity scores ($Z = 5.56$, $p < .001$), with a large effect size ($r = .68$). Of 67 participants, 45 recorded higher post-activity scores, 7 showed a decrease, and 15 had no change. The higher number of positive ranks suggests that the instructional intervention effectively enhanced students' understanding and engagement with the learning material (Arnab et al., 2025). In summary, by combining practical compounding, creative design through Canva, and oral pitching, this instructional activity effectively simulated real-world pharmacy practice that required both technical and communication skills.

Table 2
Students' perceptions of instructional innovation activity

Statistic	Pre-Test	Post-Test
Median (IQR)	3.86 (1.00)	4.14 (0.71)
Mean ± SD	3.65 ± 0.75	4.20 ± 0.79
Rank type	**n**	**Mean Rank**
Negative Rank (Post < Pre)	7	11.36
Positive Ranks (Post > Pre)	45	28.86
Ties (Post=Pre)	15	-
	Parameter	**Value**
Test statistics	Wilcoxon Test Statistics (T)	1298.50
	Standardised Test Statistics (Z)	5.561
	Asymptomatic Significant (2-tailed)	<.001a
	Effect size (r= Z/√N)	0.68

Significant when $p < 0.05$

3.4 Students' Perceived Skills Development

Most students reported developing and improving several skills following the structured instructional activity (Fig. 3). The most frequently cited skill gained was formulation design competency (89.6%), followed by communication skills (88.5%) and presentation skills (74.6%). This finding is supported by a recent study that reported improvement in interpersonal and communication skills among pharmacy students through the structured curriculum interventions (Koh-Knox Sharp et al., 2024). Even though the findings are promising, it is empirically safe to note that not all instructional design activities consistently outperform traditional methods; in some cases, these design activities yield comparable outcomes. In short, these findings suggest that the activity can successfully enhance both technical knowledge and transferable skills relevant to pharmaceutical education (Foucault-Fruchard et al., 2024).

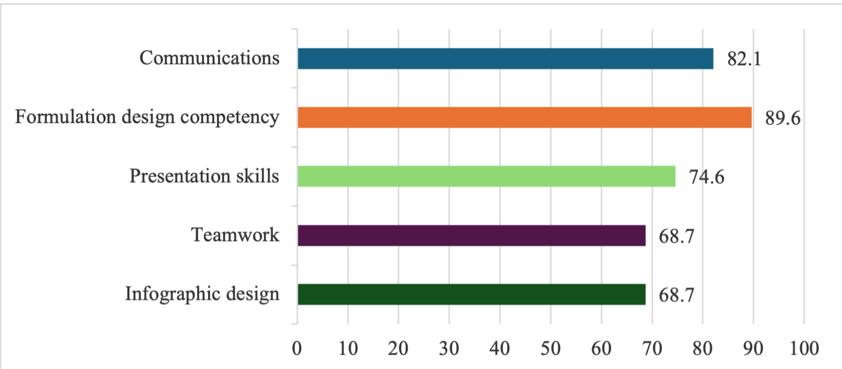

Fig. 3 *Students' perceived skills development*

3.5 The influence of gender and age on perceived skills

A series of Chi-square tests was conducted to examine the influence of gender and age on students' perceived skill following the structured instructional activity. As shown in Table 4, no statistically significant associations were found between either gender or age and any of the measured skills ($p > 0.05$). This finding highlights the inclusivity of the learning design, in which all students, regardless of age or gender, were able to develop the necessary competencies such as communication, teamwork, and design formulation. To conclude, this result is coherent with the universal design for learning frameworks, which promotes inclusivity and equitable access to education through accessible teaching strategies (Priyadharsini & Sahaya Mary, 2024).

Table 4
Chi-square test results for gender and age group on perceived skill

Skill area	p -value*		Interpretation
	Gender	Age	
Infographic design	0.87	0.87	Not significant
Teamwork	0.39	0.365	Not significant
Presentation skills	0.97	0.99	Not significant
Formulation design competency	0.90	0.56	Not significant
Communications	0.19	0.39	Not significant

* Chi-Square test

3.6 Limitations of The Study

There is no doubt that this study offers valuable findings on sustainable instructional design in pharmacy education; however, several limitations should be acknowledged. The study was conducted within a single cohort of Diploma in Pharmacy students, focusing on Semester 3 participants and one pharmaceutical course, PHD 211, which may limit the generalisability of the findings to other programs or institutions. Furthermore, the evaluation relied primarily on a self-reported questionnaire assessing knowledge, understanding, and perceptions, as well as short-term post-activity assessments, which may introduce social desirability bias.

4. CONCLUSION

This study showed that integrating sustainable instructional design principles through the Formulation Fusion: From Lab to Showcase innovation effectively enhanced student engagement, skill development, and learning outcomes in pharmacy education. By transforming traditional practical laboratory routine into creative, applied, and student-centred learning experiences, the activity bridged the gap between theoretical understanding and practical application. Most students not only perceived the innovation as engaging and meaningful but also demonstrated measurable improvements in knowledge, confidence, and essential professional competencies, including formulation design, communication, teamwork, and presentation skills. The significant increase in post-activity scores confirms the educational value of this structured, affordable, and inclusive approach. Notably, the absence of demographic differences highlights the equitable nature of the learning experience, suggesting that sustainability in instructional design can be achieved without compromising educational quality. Overall, Formulation Fusion: From Lab to Showcase serves as a replicable and scalable model of sustainable instructional design that equips pharmacy students with the knowledge, creativity, and professional readiness needed to thrive in a vibrant healthcare landscape.

5. SUGGESTIONS

Given the limitations, it is recommended that this structured instructional design model be expanded and adapted for use in other pharmaceutical and pharmacy-related courses at both the diploma and bachelor's levels. Additionally, future studies should incorporate longitudinal evaluations to assess competency retention and explore the integration of digital assessment tools to further enhance student feedback and reflection. This action helps provide a stronger foundation for the full implementation of this structured instructional activity model into the pharmacy education curriculum. Lastly, it is a very encouraging step to promote inter-institutional collaboration to share best practices in sustainable teaching innovations, which could strengthen the overall quality and accessibility of pharmacy education in Malaysia and globally.

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8. CO-AUTHOR CONTRIBUTION

Author 1 (NAI) led the project conceptualisation, instructional design, formal analysis and manuscript drafting. Author 2 (WYY) contributed to the methodological design and the critical review of the manuscript. Author 3 (MNMN) helped with data collection and interpretation and reviewed the manuscript draft. Lastly, Author4 (MIO) supported the investigation during the practical sessions and provided input for the final review of the manuscript.

9. CONFLICT OF INTEREST DECLARATION

I/We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We attest that all Authors have contributed significantly to the work, the validity and legitimacy of the data, and its interpretation for submission to IJELHE.

10. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation of this work, the authors used ChatGPT 5.0 to improve readability and language. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the publication's content.

11. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

All data generated or analysed during this study are included in this published article.

12. REFERENCES

Abo-Khalil, A. G. (2024). Integrating sustainability into higher education: challenges and opportunities for universities worldwide. *Heliyon, 10*, 1–13. https://doi.org/10.1016/j.heliyon.2024.e29946

Armstrong, K. J., Hysolli, M., & Kinney, S. R. M. (2024). Implementing a longitudinal poster project to engage pharmacy students beyond the classroom in a foundational sciences course. *Pharmacy Education, 24(1)*, 79–90. https://doi.org/10.46542/pe.2024.241.7990

Arnab, S., Masters, A., Purnomo, R. A., Mahon, D., & Minoi, J. L. (2025). *Playful and frugal learning design: A value-based approach to inclusive and sustainable STEM education*. Social Sciences and Humanities Open, 12(August), 101923. https://doi.org/10.1016/j.ssaho.2025.101923

Falasi, M. (2024). *Innovative Pedagogies: A Comparative Analysis of Traditional and Modern Teaching Methods. 28(1)*, 1–2.

Foucault-Fruchard, L., Michelet-Barbotin, V., Leichnam, A., Tching-Sin, M., Nizet, P., Tollec, S., Nativel, F., Vene, E., Fronteau, C., & Huon, J. F. (2024). The impact of using simulation-based learning to further develop communication skills of pharmacy students and pharmacists: a systematic review. *BMC Medical Education, 24*(1). https://doi.org/10.1186/s12909-024-06338-6

Karina Mendez Cordero, Cindy Ngoc Chau, Damianne Brand, & Ayesha Rahman Ahmed. (2025). Evaluating learning methods to improve pharmacy students' retention of nonsterile compounding skills. *Advances in Biomedical and Health Sciences, 76–81*. https://doi.org/10.4103/abhs.abhs

Koh-Knox Sharp, C. P., Shepler, B. M., & Jaiswal, A. (2024). Assessing learning gains of pharmacy students in communications, ways of thinking, and intercultural skills through self-assessment. *Currents in Pharmacy Teaching and Learning, 16(4)*, 281–290. https://doi.org/10.1016/j.cptl.2023.12.025

Leone, E. A., & French, D. P. (2022). A Mixed-Methods Study of a Poster Presentation Activity, Students' Science Identity, and Science Communication Self-Efficacy under Remote Teaching Conditions. *Journal of Microbiology & Biology Education, 23(1)*, 1–15. https://doi.org/10.1128/jmbe.00262-21

Mohammad Hanapi, N., Omar, N. B., Samat, M. M. B., & Mohd Kamal, M. M. (2020). The Impact of Utilising Active Learning Methods Towards ECM366 Course Outcome. *GADING Journal of Science and Technology*, 3(September), 222–229.

Mokshein, S. E. (2018). Education for Sustainable Development (ESD) in Malaysia: Policy, Program, and Evaluation. *Advances in Social Science, Education and Humanities, 326*, 6–12.

Moon, S., Yoo, H., Hwang, H., Cho, Y. S., Kim, J. H., Kim, T. W., Kang, J., Hwang, B., Lee, Y., Shin, M., Choi, Y. J., & Shin, S. (2024). *Integrating Problem-Based Learning and Patient Counselling Competitions to Enhance Pharmacy Students' Competency in Patient Care and Communication.* 38–46.

Okoro, R. N., & Hedima, E. W. (2022). Undergraduate pharmacy students' perceived learning using a team-based debate approach. *Currents in Pharmacy Teaching and Learning, 14(5)*, 612–617. https://doi.org/10.1016/j.cptl.2022.04.017

Persky, A. M., Medina, M. S., & Castleberry, A. N. (2019). *Developing Critical Thinking Skills in Pharmacy Students. 83(2)*. https://doi.org/10.5688/ajpe8327033

Priyadharsini, V., & Sahaya Mary, R. (2024). Universal Design for Learning (UDL) in Inclusive Education: Accelerating Learning for All. *Shanlax International Journal of Arts, Science and Humanities, 11(4)*, 145–150. https://doi.org/10.34293/sijash.v11i4.7489

Pugliese, R. S., Girone, G., & Candidate, P. (2018). Design Thinking in Pharmacy Education: Inspiring Creative Problem Solving in the Next Generation of Pharmacists. *Innovations in Pharmacy, 9(2)*, 1–7.

Qu, M., Hou, Q., Li, X., Yu, C., Xia, J., & Dong, Z. (2024). Application of a flipped classroom incorporating modified team-based learning in molecular biology laboratory teaching: a mixed methods study. *BMC Medical Education, 24(1).* https://doi.org/10.1186/s12909-024-06450-7

Steenhof, N. (2023). Adaptive Expertise in Undergraduate Pharmacy Education. *Pharmacy, 11(1)*, 1–9.

Subaveerapandiyan, A., Sardar, H., & Munir, M. A. (2024). Infographics as a Learning Tool: Perceptions and Preferences of Undergraduate Medical Students. *Bulletin of Education and Research, 46(1)*, 41–65.

Sulaiman, A. H., & Abdulla, S. (2024). The Use of Active Learning Strategies to Foster Effective Teaching in Higher Education Institutions. *Zanco Journal of Human Sciences, 28(2)*, 140–157. https://doi.org/10.21271/zjhs.28.2.11

Wardat, Y., & Alali, R. (2025). Sustainability in Higher Education: Challenges, Innovations, and Research Prospects. *Educational Process: International Journal, 16*.