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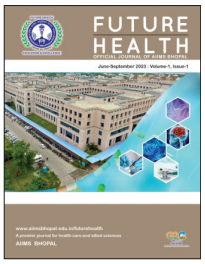

Review Article

Beyond the lecture hall: The power of museums in pharmacology education

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Received: 04 February 2025

Accepted: 26 March 2025

Epub Ahead of Print: 06 June 2025

Published: ***

DOI:
10.25259/FH_17_2025

Quick Response Code

ABSTRACT

Pharmacology education plays a pivotal role in enhancing medical knowledge and improving healthcare outcomes. However, traditional teaching methods often struggle to engage students deeply and foster long-term retention. This article explores the potential of museum-based learning to revolutionize pharmacology education by offering immersive and interactive experiences. Museums, with their historical artifacts, medicinal plant specimens, and old pharmaceutical tools, provide students with tangible connections to the evolution of pharmacology. Museum exhibits not only allow students to explore the history of drug discovery but also bridge the gap between traditional healing practices and modern medical advancements. By incorporating hands-on learning, museums foster critical thinking, curiosity, and collaboration, enriching students' understanding of pharmacology in a multidisciplinary context. Furthermore, museums offer valuable insights into the ethical and regulatory aspects of drug development, allowing students to examine past challenges and the evolution of drug safety. The integration of advanced technologies, such as virtual and augmented reality and artificial intelligence (AI), further enhances the learning experience by providing interactive simulations of pharmacological concepts. Despite challenges like financial constraints and accessibility, museum-based pharmacology education has the potential to engage students more effectively and promote a deeper understanding of pharmacological sciences. Future efforts should focus on integrating museums into the curriculum, conducting research on their effectiveness, and developing innovative teaching methods to optimize learning outcomes in pharmacology education.

Keywords: Educational museums, Historical pharmacology, Interactive learning, Museum-based teaching, Pharmacology curriculum

INTRODUCTION

Pharmacology education is a fundamental part of health sciences, playing a crucial role in enhancing pharmacotherapy outcomes and improving quality of life.[1] Despite its importance, pharmacology can be particularly challenging for students because it requires a deep understanding of the intricate relationships between biochemical, physiological, and clinical factors.[2] The traditional lecture-based approach, while essential, often struggles to engage students in ways that foster deeper comprehension and long-term retention.[3] Even advanced teaching approaches like problem-based learning (PBL) and virtual simulations offer interactive experiences but tend to fall short in providing a comprehensive historical and contextual perspective.[4] As a result, students may miss the historical evolution, key discoveries, and ethical influences that have shaped current pharmacological practices. Museums, often overlooked in medical education, hold the potential to revolutionize pharmacology teaching through immersive and interactive learning experiences.[5] Museums contain historical artifacts, medicinal plants, old pharmaceutical tools, and rare books, offering students a tangible way to explore the evolution of pharmacology.[6]

These exhibits provide an opportunity to connect abstract pharmacological concepts with their historical and real-world applications, making them more accessible and memorable. The power of museum-based learning lies in its ability to integrate historical, cultural, and scientific aspects of pharmacology into the learning experience.[7] Students can develop a deeper understanding of pharmacological sciences by examining the history of drug discovery, traditional healing methods, and major scientific advancements. Museums preserve insights into past ethical challenges in pharmacology, offering valuable context for modern drug development and regulation.

Moreover, museums enhance education through hands-on learning, fostering critical thinking, collaboration, and curiosity.[8] Guided exhibits, interactive displays, and hands-on activities help students explore pharmacology's complexities and link historical practices to modern advancements. This interactive and contextual learning approach enhances both understanding and retention, enabling students to grasp the full significance of pharmacology within the broader context of medical science and history.[9]

KEY FEATURES OF MUSEUM-BASED LEARNING

Historical perspective

Museums provide a unique opportunity to explore the evolution of pharmacology, tracing drug development from ancient remedies to modern pharmaceuticals.[10] Studying ancient medical texts, early drug preparations, and historical case studies allows students to better understand the evolution of medicinal practices [Figure 1]. Building on this understanding, integrating ancient healing traditions with modern medicine can expand treatment options, enhance patient care, and contribute to a more holistic and inclusive healthcare system.[11] This historical insight helps bridge the gap between past and present, illustrating how traditional knowledge has influenced modern drug discoveries and therapeutic approaches. One of the earliest and most significant pharmaceutical documents from ancient times is the Ebers Papyrus, dating back to around 1500 B.C. and later named after George Ebers, who discovered it [Figure 2].[12]

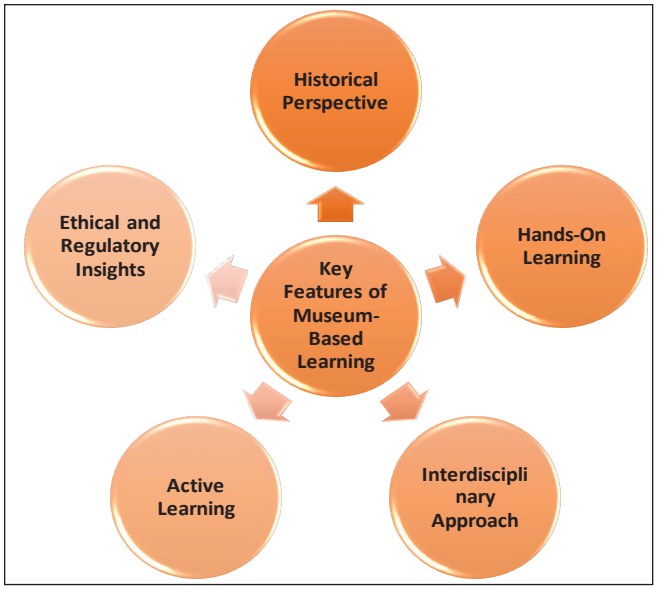

Figure 1: Key features of museum-based learning.

Figure 2: Ebers Papyrus (1500 B.C.): Earliest known pharmaceutical record, named by George Ebers.

Hands-on learning

Unlike conventional classroom learning, museums allow students to interact with physical objects that represent key moments in medicine history.[13] Exposure to medicinal plants, old pharmacopoeias, and antique drug formulations provides a tangible connection to pharmacology's roots.[14] Handling preserved medicinal specimens or analyzing historical prescriptions enhances comprehension and retention, making abstract pharmacological concepts more relatable and memorable. Retention plays a crucial role in learning, as it determines how well knowledge and skills gained during the learning process can be recalled and utilized in real-life scenarios later on [Figure 3].[15,16]

Interdisciplinary approach

Pharmacology is deeply interconnected with various scientific and social disciplines.[17] Museum-based learning facilitates multidisciplinary exploration by integrating elements from various fields.[18] For example, exhibits on traditional healing practices emphasize the cultural importance of indigenous medicine, while displays showcasing the early synthesis of drugs highlight the critical role of chemistry in the development of pharmaceuticals. This interdisciplinary approach fosters a more holistic understanding of drug development and its broader implications.

Figure 3: Pharmacopoeia by Adolphus Occo, 1574 (left), Codex Medicamentarius, 1818 (right). Retention plays a crucial role in learning, as it determines how well knowledge and skills gained during the learning process can be recalled and utilized in real-life scenarios later on. The figure reference is instead included in text in Hands on learning session.

Active learning

Museum-based education promotes an interactive and student-centered learning environment.[19] By engaging with interactive displays, students can critically analyze historical and contemporary issues in pharmacology, such as drug regulation, ethical dilemmas, and the socio-economic impact of pharmaceuticals. This active learning approach enhances critical thinking, problem-solving skills, and intellectual curiosity. By incorporating these key features, museums serve as powerful educational tools that enrich pharmacology learning, making it more immersive, engaging, and historically informed.[20]

Ethical and regulatory insights

Museums provide a platform for understanding the ethical and regulatory evolution of pharmacology.[21] Exhibits featuring historical drug trials, significant legal cases, and ethical discussions surrounding medical experimentation allow students to better understand the complexities involved in the drug development and approval processes. By examining past challenges such as the thalidomide tragedy or early vaccine trials, students can critically analyze the role of regulations in ensuring drug safety and efficacy [Figure 4].[22] This awareness fosters a sense of responsibility and ethical consciousness in future healthcare professionals.[23]

ADVANTAGES OF MUSEUM-BASED PHARMACOLOGY EDUCATION

Enhancing student engagement and retention

Experiential learning has been proven to improve knowledge retention by creating meaningful, interactive experiences.[24] Museums provide a dynamic and immersive learning

Figure 4: A newborn child with Phocomelia caused by Thalidomide.

environment where students can engage with historical artifacts, medicinal plant specimens, and pharmaceutical instruments.[25] This hands-on approach activates multiple senses, making complex pharmacological concepts more tangible and easier to remember. Unlike conventional lectures, museum-based learning fosters curiosity and analytical thinking, making complex topics easier to grasp.[26]

Bridging the gap between theory and practice

Museums serve as a bridge between classroom knowledge and practical experience by showcasing real drug samples, historical prescriptions, and interactive models of drug action.[27] For example, students can observe early drug formulations, compare them with modern pharmaceuticals, and analyze how formulation techniques have evolved. These exhibits allow learners to visualize and contextualize the development of therapeutics, reinforcing their clinical significance in patient care. By making abstract concepts more concrete, museums enhance students' ability to apply pharmacological knowledge in clinical settings.[28]

Fostering interest in drug discovery and research

Museums dedicated to medical and pharmaceutical history can ignite students' curiosity about drug development and inspire them to explore careers in pharmacological research. Exhibits featuring the discovery of antibiotics, the accidental origins of major drugs, or the evolution of vaccines can stimulate interest in scientific inquiry. For example, exhibits showcasing breakthroughs like Alexander Fleming's accidental discovery of penicillin highlight the role of chance and observation in scientific progress [Figure 5].[29] By learning about the challenges faced by early pharmacologists and the breakthroughs that shaped modern medicine, students gain a broader perspective on the importance of research and innovation in drug development.[30,31]

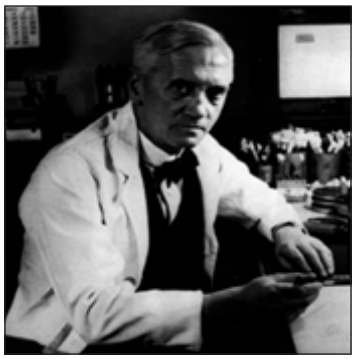

Figure 5: Picture of Sir Alexander Fleming.

Promoting ethical and rational drug use

Museums provide valuable insights into the successes and failures of medical history, highlighting both groundbreaking advancements and past mistakes. Exhibits on medical ethics, historical drug trials, and controversial treatments help students critically analyze the consequences of unethical practices.[32] By exploring case studies of drug-related tragedies and successes, students develop a stronger appreciation for responsible prescribing and the ethical principles that guide modern pharmacology.[33] For example, a museum exhibit showcasing the 1937 sulfanilamide tragedy could include preserved bottles of the toxic elixir, historical news reports, and early drug safety regulations.[34] This awareness reinforces the need for rational drug use and strengthens their commitment to evidence-based medicine.

IMPLEMENTATION STRATEGIES FOR MUSEUM-BASED PHARMACOLOGY TEACHING

Collaboration with medical and science museums

Educational institutions can form partnerships with museums specializing in medical history, pharmacy, and ethnobotany to develop specialized learning experiences for students. By working closely with museum curators and historians, faculty members can ensure that exhibits align with the pharmacology curriculum, making learning more relevant and engaging.[35]

Developing pharmacology-specific exhibits

Universities and medical schools can establish dedicated in-house pharmacology museums that showcase drug prototypes, significant case studies, and digital simulations of drug interactions.[36] Additionally, interactive exhibits, such as touchscreen displays and augmented reality features, can enhance student engagement.

Incorporating museum visits into curriculum

Structured museum visits can be formally integrated into pharmacology courses as part of experiential learning.[10] Faculty members can design pre-visit assignments that encourage students to research specific drugs or historical events before their visit. During the museum tour, students can engage in guided discussions, quizzes, or problem-solving activities to reinforce their learning.[37] Post-visit assignments, such as reflective essays, case study analyses, or presentations, can help students connect historical knowledge with contemporary pharmacological practices.

Use of digital and virtual museums

In the era of digital education, virtual pharmacology museums can serve as an innovative tool to make museum-based learning accessible to a broader audience. Institutions can develop online platforms featuring 3D models of historical drugs, interactive timelines of discoveries, and digital reconstructions of key medical experiments.[38] These digital resources ensure that students, regardless of their location, can benefit from museum-based pharmacology education, making learning more inclusive and engaging.[39]

CHALLENGES AND FUTURE PERSPECTIVES

Financial and logistical constraints

Setting up dedicated pharmacology museums requires significant funding, infrastructure, and maintenance. Securing institutional support and external funding can help overcome these challenges, while virtual museums offer a cost-effective alternative.[40]

Accessibility and integration

Physical museum visits may not always be feasible due to geographical and scheduling constraints. An in-departmental museum can solve this issue. Integrating digital resources, virtual tours, and mobile exhibits can enhance accessibility and ensure wider participation.

Need for structured educational frameworks

For museum-based learning to be effective, it must be systematically incorporated into the pharmacology curriculum. According to the NMC 2023 guidelines, the museum must be designed to accommodate at least 50 students, ensuring that a minimum of 1.2 square meters of space is allocated per student. This provision is essential to guarantee adequate seating and comfort during museum-based learning sessions, allowing students to engage with the exhibits in a conducive environment for effective learning.[41]

Expanding research and evaluation

Although museum-based learning has been successfully implemented in other disciplines, its impact on pharmacology education remains underexplored. Further research and longitudinal studies are needed to assess its effectiveness in enhancing knowledge retention, critical thinking, and student engagement.

Future directions

The future of museum-based pharmacology education lies in the integration of advanced technologies and innovative teaching methods to enhance learning experiences. The use of virtual and augmented reality can provide immersive experiences, allowing students to explore pharmacological concepts, drug development processes, and historical contexts in an interactive digital space.[42] Furthermore, the development of specialized pharmacology exhibits that incorporate real-time data, interactive simulations, and case studies will bridge the gap between theoretical knowledge and practical application.[43] Virtual and augmented reality, in combination with AI, can provide immersive experiences, allowing students to explore pharmacological concepts in a highly interactive manner.[44] Collaborative efforts between educational institutions, museums, and industry professionals can help create a more dynamic and comprehensive learning environment that prepares students for the evolving field of pharmacology. Additionally, continued research into the effectiveness of museum-based learning will guide improvements, student engagement, retention, and professional development.

CONCLUSION

In conclusion, museum-based pharmacology education presents a transformative approach to learning, offering students a rich, immersive experience that connects historical, scientific, and ethical dimensions of pharmacology. By integrating hands-on exhibits, historical artifacts, and interactive technologies such as virtual reality and AI, museums provide a unique opportunity to bridge the gap between theoretical knowledge and real-world applications. This approach not only enhances students' understanding and retention but also fosters critical thinking, curiosity, and ethical awareness in future healthcare professionals. While challenges like financial constraints and accessibility remain, the potential benefits of museum-based learning in pharmacology education are clear. Continued innovation, collaboration, and research will be key to unlocking the full potential of museums in shaping the next generation of pharmacologists.

Author contributions: SH: Concept & manuscript preparation; SS: Literature review; AJ: Literature review; FA: Literature review; PP: Manuscript preparation; RKD: Supervision & manuscript review.

Ethical approval: Institutional Review Board approval is not required.
Declaration of patient consent: Patient's consent not required as there are no patients in this study.
Financial support and sponsorship: Nil.
Conflicts of interest: There are no conflicts of interest.
Use of artificial intelligence (AI)-assisted technology for manuscript preparation: The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Fasinu PS, Wilborn TW. Pharmacology education in the medical curriculum: Challenges and opportunities for improvement. Pharmacol Res Perspect 2024;12:1-11.
2. Nicolaou SA, Televantou I, Papageorgiou A, Albert AP, Hitchings AW, McCrorie P, *et al*. Factors affecting pharmacology learning in integrated PBL in diverse medical students: A mixed methods study. BMC Med Educ 2024;24.
3. Haque S, Asif F, Pandey P, Dixit RK. Revolutionizing pharmacology education : Comparing escape rooms and traditional learning on student engagement and well-being. Future Health 2025;1-7. https://doi.org/10.25259/FH_61_2024
4. Phungsuk R, Viriyavejakul C, Ratanaolarn T. Development of a problem-based learning model via a virtual learning environment. Kasetsart J Soc Sci 2017;38:297-306.
5. Kim K, Manohar S, Chisolm MS. Museum-based education in health professions learning: A 5-year retrospective. Perspect Med Educ 2024;13:585-91.
6. Jarosz K. The development of museums of pharmacy in post-soviet countries. His Phar Pharma 2020;62:135-49.
7. Todino MD, Campitiello L. Museum education. Encyclopedia 2025;5:3.
8. Abd El Wareath O. The role of educational museums in the development of education. Int J Humanit Lang Res 2022;5:36-48.
9. Khurshid F, O'Connor E, Thompson R and Hegazi I. Pedagogical interventions and their influences on university-level students learning pharmacology-a realist review. Front Educ 2023;8:1-17.
10. Parmar UI, Tripathi RK, Gajbhiye S V, Rege NN. Development and implementation of pharmacology museum as a teaching-learning tool: A prospective , interventional study. J Pharmacol Pharmacother 2018;9:147-52.
11. Elendu C. The evolution of ancient healing practices: From shamanism to Hippocratic medicine: A review. Medicine (Baltimore) 2024;103:2-16.
12. Nayab M. History of pharmacy. 2020;1-34. Available from: http://courseware.cutm.ac.in/wp-content/uploads/2020/06/3-history-or-evolution-of-pharmacy.pdf. [Last accessed on 2024 Apr 28].
13. Parry MS. Chapter 11: Getting to grips with difficult histories in medical museums. In: Kador T, Chatterjee H, editors. Object-

Based Learning for Health and Wellbeing: Exploring Material Connections, 1st edition; Routledge, 2020; pp. 173-82.
14. Medica M. Assembling the cure: Materia medica and the culture of healing in late imperial China. 2014 [Last accessed 2024 Jul 28]. Available from: http://nrs.harvard.edu/urn-3:HUL.InstRepos:12269850
15. Ginting D, Woods RM, Barella Y, Limanta LS, Madkur A, How HE. The effects of digital storytelling on the retention and transferability of student knowledge. Sage Open 2024;14.
16. Lafont O. A stroll through the collections of pharmacopoeias of the order of pharmacists in Paris. 2007. Available from: https://www.histpharm.org/ISHPWG%20France.pdf [Last accessed on 2024 Apr 28].
17. Papadopulos JS, Mentis A fotios A, Liapi C. Social pharmacology as an underappreciated field in medical education: A single medical school's experience. Front Pharmacol 2021;12:1-6.
18. Ambarwati DRS, Wulandari D, Isa B, Astuti EP, Suardana IW. Museum-based learning for creativity: Indonesian and museum-based learning for creativity: Indonesian and Malaysian teachers. Humanit Arts Soc Sci Stud 2023;316-26.
19. Weber KE. The role of museums in educational pedagogy and community engagement. College of Education Theses and Dissertations, 2022; 254.
20. Shehade M, Stylianou-Lambert T. Virtual reality in museums: Exploring the experiences of museum professionals. Appl Sci 2020;10:4031.
21. Masic I, Skrbo A, Catic T, Sukal A. History of pharmacy described in the books and articles stored in libraries, museums and scientific databases. Int J Biomed Heal 2022;10:101-20.
22. Vargesson N. Thalidomide-induced teratogenesis: History and mechanisms. Birth Defects Res C Embryo Today 2015;105: 140-56.
23. Liu Q, Zhu H. The importance of effective regulatory control in the pharmaceutical industry in China. Adv Econ Bus Manag Res 2021;203:462-8.
24. Kong Y. The role of experiential learning on students' motivation and classroom engagement. Front Psychol 2021;12:10-3.
25. Bamberger Y, Tal T. The learning environment of natural history museums: Multiple ways to capture students' views. Learn Env Res 2014;12:115-29
26. Acar OA, Tuncdogan A. Using the inquiry-based learning approach to enhance student innovativeness: A conceptual model. Teach High Educ 2019;24:895-909.
27. Escribano-Miralles A, Serrano-Pastor FJ. Perceptions of educational agents regarding the use of school visits to museums for the teaching of history. Sustainability 2021;13:4915.
28. Perthes BWM, Watson BC, Education A, Barnes T. Art, well-being and medicine at the Barnes foundation. Historical Perspectives in Art 2024.
29. Tan SY, Tatsumura Y. Alexander Fleming (1881–1955): Discoverer of penicillin. Singapore Med J 2015;56:366-7.
30. Fasinu PS, Wilborn TW. Pharmacology education in the medical curriculum: Challenges and opportunities for improvement. Pharmacol Res Perspect. 2024;12:e1178
31. Gerberi D. Alexander Fleming: A second look. J Med Libr Assoc 2024;112:55-9.
32. Kontoghiorghes GJ. Ethics in medicines: Exposing unethical practices and corruption in all sectors of medicines is essential for improving global public health and saving patients' lives. Medicines 2021;8:10-3.
33. Orayj K, Alahmari K, Alasiri M. The concept of pharmacy ethics and the examples of ethical dilemmas encountered by pharmacists in the Asir region, Saudi Arabia: A qualitative study. Int J Gen Med 2022;15:4985-96.
34. Rendina NR. Pharmaceuticals and the nature of American childbirths. 2020;1900–70.
35. Museums LA. Academic Museums & Galleries. Professional practices for academic museums & galleries. 2017. Published with the support of the Samuel H. Kress Foundation.
36. MacDonald S, Nyst N, Weber C, editor. University Museums and Collections Journal, Volume 3. Proceedings of the 9th Conference of the International Committee of ICOM for University Museums and Collections (UMAC), Berkeley, USA, 10th–13th September 2009.
37. Tuffy J. The learning trip: Using the museum field trip experience as a teaching resource to enhance curriculum and student engagement. Submitted in Partial Fulfillment of the Requirements for the Degree Master of Science in Education. School of Education and Counseling Psychology, Dominican University of California, San Rafael, CA, 2011. Available from: https://files.eric.ed.gov/fulltext/ED517713.pdf [Last accessed on 2024 Apr 28].
38. Micoli LL, Caruso G, Guidi G. Design of digital interaction for complex museum collections. Multimodal Technol Interact 2020;4:31.
39. Network of European Museum Organisations (NEMO). A Nemo Report by Lem the Learning Museum Working Group. Digital learning and education in museums: Innovative approaches and insights. Available from: https://www.bmitpglobalnetwork.org/wp-content/uploads/2024/01/NEMO_Working_Group_LEM_Report_Digital_Learning_and_Education_in_Museums_12.2022.pdf
40. Lindqvist K. Museum finances: Challenges beyond economic crises. *Museum Management and Curatorship* 2022;27:1-15
41. NMC. Gqzette of Swdio. 2023.
42. Coyne L, Merritt TA, Parmentier BL, Sharpton RA, Takemoto JK. The past, present, and future of virtual reality in pharmacy education. Am J Pharm Educ 2019;83:7456.
43. Andrews LB, Barta L. Simulation as a tool to illustrate clinical pharmacology concepts to healthcare program learners. Curr Pharmacol Rep 2020;6:182-91.
44. Oseni VE, Matthew UO, Oladipupo MA, Onyedibe ON, Akpan EE, Andrew-Vitalis N, *et al*. Healthcare applications of augmented reality (AR) and virtual reality (VR): Immersive simulation in medical-clinical education. In: Creating immersive learning experiences through virtual reality (VR), edited by Hussain SM, Hakro AN, IGI Global, 2025, pp. 201-238.

How to cite this article: Haque S, Sindhu S, Jain Ayush, Asif F, Pandey P, Dixit RK. Beyond the lecture hall: The power of museums in pharmacology education. Future Health. doi: 10.25259/FH_17_2025