A Review on AI (Artificial Intelligence) in Teaching and Learning Pharmaceutical Sciences and Medicine.

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***Abstract*—Artificial Intelligence (AI) has emerged as a transformative force in education, particularly in pharmaceutical sciences and medicine. AI-driven technologies, including machine learning, natural language processing, and intelligent tutoring systems, are reshaping traditional teaching methodologies by enhancing personalized learning, improving knowledge retention, and facilitating real-time feedback. This review explores the various applications, benefits, and challenges of AI in teaching and learning within these fields.One of the most significant contributions of AI in pharmaceutical and medical education is its ability to create adaptive learning environments. AI-powered platforms analyze students' learning patterns and tailor educational content to match individual needs, thereby improving comprehension and engagement. Virtual and augmented reality (VR/AR) applications, coupled with AI, provide immersive simulations that enhance the understanding of complex biological and pharmacological concepts. These tools allow students to practice clinical decision-making, drug formulation, and patient interactions in a risk-free setting, bridging the gap between theoretical knowledge and practical application.Moreover, AI enhances medical and pharmaceutical research education by offering predictive analytics and big data analysis. AI algorithms process vast amounts of clinical and pharmacological data, enabling students and researchers to identify patterns, predict drug interactions, and understand disease mechanisms more efficiently. AI-powered chatbots and virtual assistants also support learners by providing instant access to medical literature, answering queries, and offering explanations for complex topics, thereby improving knowledge accessibility and self-directed learning.Another promising aspect of AI in education is its role in automating assessments and providing instant, data-driven feedback. AI-driven evaluation tools help educators assess student performance more accurately, identify areas requiring improvement, and personalize remedial actions. Additionally, AI enhances peer-to-peer learning by facilitating discussion forums, intelligent tutoring systems, and collaborative research platforms, fostering a more interactive and engaging learning environment.Despite its numerous advantages, the integration of AI in pharmaceutical and medical education presents several challenges. Ethical considerations regarding data privacy, algorithm bias, and the potential reduction of human interaction in education must be carefully addressed. Additionally, the implementation of AI requires substantial investment, technical expertise, and faculty training to ensure its effective utilization. Resistance to change among educators and institutions further complicates the adoption of AI-based learning tools. AI has the potential to revolutionize teaching and learning in pharmaceutical sciences and medicine by personalizing education, improving engagement, and enhancing research capabilities. However, its successful implementation requires addressing ethical concerns, technological limitations, and institutional barriers. Future research should focus on optimizing AI-driven educational models, ensuring their accessibility, and evaluating their long-term impact on medical and pharmaceutical education. As AI continues to evolve, its integration into academia will be instrumental in shaping the future of healthcare education and practice.**

***Index Terms*—Artificial intelligence, pharmaceuticals science, Machine learning, teaching methodologies**

I. INTRODUCTION

Artificial intelligence (AI) has the potential to revolutionize the field of pharmacy education by

enhancing teaching and learning experiences. Al refers to the development of computer systems that can perform tasks that typically require human intelligence, such as learning, reasoning, and problem-solving [

In pharmacy education, Al can be used to develop personalized learning experiences, provide real-time feedback, and improve student engagement. Additionally, Al can assist in the development of curricula that are tailored to the needs of individual students, allowing for a more efficient and effective learning process. However, the integration of Al in pharmacy education also presents challenges, such as the need for faculty expertise, tool generalizability, outcome data availability, and legal and ethical considerations [2]. Despite these obstacles, the potential benefits of Al in pharmacy education are significant, and further investigation and development in this area are necessary to shape the future of healthcare through improved educational methods. Evaluation and assessment in pharmacy education focus on enhancing teaching and learning processes while maintaining accountability and competency development.[10] Key aspects of assessment in pharmacy education include:

- Various AI tools which can be use in teaching pharmacy.

Name of Al tool	Uses
1) Sendsteps.AI	Generating Presentations and Content for student understanding
2) Canva AI	It enables educators to use animation to develop unique designs. With the help of the tool's extensive collection of templates, visuals, and design tools, competent MOA understanding teachers can easily produce captivating and eye-catching presentations.
3) ChatGPT	Teachers may even use animation to create unique displays. Pharmacology MOA understanding teachers can easily produce visually stunning and captivating presentations with the use of the tool's extensive collection of templates, visuals, and creative tools. can offer ideas for exercises, activities, and subjects to address in class, assisting teachers in creating lesson plans.
4) Yuppify AI – Quiz	With Yuppify, you can easily turn any text or webpage into a quiz. A collection of questions and answers is automatically generated from the entered text and may be copied and pasted into a quiz tool or flashcard app
5) Turnitin AI - Plagiarism Scanner	An innovative artificial intelligence technology called Turnitin assists teachers in identifying possible plagiarism in student work. Turnitin generates a similarity report by comparing student contributions to a large database of scholarly sources and online publications. Additionally, it identifies new patterns of wrongdoing to alert educators to fresh approaches to plagiarism. Turnitin is regarded as the industry standard for detecting plagiarism in scholarly writing and research, guaranteeing precision and dependability for educators.

6) perplexity Ai	It will be beneficial for educational purposes, allowing us to locate references for information on medications and illnesses.
7) Hippocratic diagnosis AI	Most Effective for Improving Medical Diagnosis

A. Merits of AI in Learning and Teaching [4].

1.AI allows for easy learning experiences according to each student's needs and place

2.Immediate Feedback: AI can quickly analyze student responses and provide instantaneous feedback

3. Cost Effectiveness: AI can save time and money through automation of tasks such as grading and lesson planning

4.Virtual Reality Courses: AI supports immersive learning experiences through VR and AR technology

5.Enhanced Assessment and Feedback: AI can accurately measure student progress and provide detailed analytics

B. Disadvantages of AI in Learning and Teaching.

1) Job Displacement: AI may displace teachers due to automation of certain tasks

2) Bias: AI systems may exhibit bias, leading to unequal outcomes for different groups of students

3) Privacy Concerns: AI collects big amount of information about student, raising concerns regarding privacy

4) Overdependence on Technology: Overuse of AI may lead to excessive reliance on technology instead of independent thought and creativity

C. Future scope as an AI instructor in pharma and biotech sales representative E- Learning

In the rapidly evolving landscape of organizational training and development, the concept of self-paced learning has emerged as a game changer. Self-learning modules, often referred to as e-modules or e-learning modules, play a pivotal role in helping employees acquire new skills and knowledge. However, these modules have faced several limitations, including one-way teaching, predestined content, and Limited interactivity. The solution to these challenges lies in embracing our Al Instructor, a strong use case of Show & Tell Al in the realm of training and development. Developed by RX. Prism Inc. Al Instructor is poised to revolutionize the way organizations approach employee training, transforming static modules into dynamic, engaging, and interactive learning experiences

Consider a future in which Al can create new medications. Discover a novel medication combination. Complete clinical trials in a matter of minutes. Drugs are evaluated on virtual models designed to replicate the physiology of organs rather than on actual people or animals. Robots assist in both the production and delivery of pharmaceuticals. Drug counterfeiting becomes nearly impossible.

All of the distribution channels are secured by blockchain technology. Local chemists can 3D print customized medications in any shape and dosage.

D. Challenges of Traditional Self-Placed Training Modules

1. One-Way Teaching: Conventional e-modules primarily offer one-way teaching. They present information in a predefined manner, limiting employees' active engagement with the content.[6]

2. Predefined Content: These modules contain predefined content, leaving little room for customization of adaptation to individual employees' unique needs.

3. Motivation Gap: Many employees struggle to stay motivated when faced with static content. This lack of engagement often results in reduced Interest and a higher likelihood of disengagement from the learning processes

The future of self-paced training modules is closely intertwined with our Al Instructor, a prime example of Show & Teil Al's potential in the field of learning and development. Integrating our Al Instructor into existing e-modules can provide numerous benefits, effectively addressing the limitations mentioned earlier [7]

1. Two-Way Communication

One of the most significant advantages of our Al instructor is its ability to facilitate two-way communication Unlike traditional modules, employees can interact with our Al Instructor ask questions, seek clarification, and engage in meaningful conversations.

2. Contextual Learning.
Our Al Instructor excels at providing context-specific explanations and examples. It adapts to the employee's level of understanding and tailors its responses to match the context of the employee's query. This feature fosters. deeper comprehension and retention.

3. Instant Feedback
With our Al Instructor, employees receive Immediate responses to their questions. This instant feedback not only keeps employees engaged but also ensures that may grasp concepts effectively

4. Enhanced Motivation
Interactive online training experience driven by our Al Instructor boosts employee motivation. Engaging content and prompt answers to queries sustain high motivation levels, making the learning journey more enjoyable and productive
5. Integration Flexibility Our Al Instructor can be seamlessly integrated into various authoring tools making it easy for organizations to adopt this technology. This adaptability ensures that our Al instructor can enhance a wide range of self-paced training modules

E. Revolutionizing Pharmacovigilance with Large Language Models: A Pharma Perspective
In the ever-evolving landscape of pharmacovigilance (PV), the quest for Innovative solutions to ensure drug safety and efficacy is unending. As an experienced manager deeply entrenched In the PV industry, my journey has taken an exciting turn with the advent of Large Language Models (LLMs) like GPT-3 and its successors. These advanced AI tools are not just technological marvels; they are on the brink of transforming pharmacovigilance from the ground up. promising a future where drug safety processes are more efficient, accurate, and proactive than ever before.[7]

F. The Promise of LLMs in Pharmacovigilance
At its core, pharmacovigilance is about data-collecting, analyzing, and interpreting vast amounts of information to detect, assess, understand, and prevent adverse effects or any other drug-related problems. This is where LLM shine. With their unparalleled ability to understand and generate human-like text, LLMs can sift through mountains of data, identifying patterns and insights that might elude even the most experienced professionals. [8]

G. Streamlining Adverse Event Reporting
One of the most time-consuming aspects of PV is the manual processing of adverse event reports. LLMs can automate this process, accurately extracting relevant information from unstructured data sources such as social media, healthcare forums, and narrative reports. This not only speeds up the reporting process but also enhances the detection of potential safety signals, ensuring faster response times [9]

H. AI -Driven pharmacy education
artificial intelligence (AI)is a modern tool in pharmacy education it helps the next generation to prepare as a healthcare professionals Personalized learning experiences adaptive curricula AI powered systems ensures that each learner and student gets effective materials, course content, proper guidance and also analyses student learning data. [10]

I. Intelligent Tutoring
it provides guidInce, natural language processing, machine learning.
Skill assessments- it analyses students' practical abilities and their skill development, grading, devising for clinical practice. [11]

J. Objective assessments
having proper accuracy and consistency for case study.
Timely feedback- provides students with immediate insights.
Workload reduction-it helps to focus more on personalized coaching and student interactions.
AI powered virtual environmental students to allow students to practice clinical skills, setting, case study of patients.

Scenario -based learning this learning prepares students for diverse challenges that they will face in real world. Intelligent Tutoring system- adjust a difficulty and complexity based on student performance. Personalized guidance- estimate strategies based on strength, weakness, learning preferences. [12]

K. Predictive analytics for students' success
1)data collection-access Student data which analyze different level, learning behaviors, complexity etc.
2) Predictive modelling-prediction about students' activity either struggling or falling to succeed.
3) Targeted interventions-helps to achieve their goals provides timely support. Privacy safe guiding Student data and ensuring personal information about education settings.
algorithmic bias faculty and administrators must be vigilant in identifying and mitigating any biases that present in AI used for assessment. seamless integration estimate experience for faculty and students by streamline learning manage learning platforms.

L. AI's transformative impact on Pharmacy education
AI is a transferring way for pharmacy learners, tutors personalized curricula, Virtual simulation to transfer educational landscape. Personalized learning experience adaptive curricula -analyses student performance.
Virtual mentors- intelligent chat boxes provide personalized guidance and support, insights tailored to students' progress. Practice critical skill to prepare for real world pharmacy challenges. [13]

M. Instant assessment
Acknowledge the Student data and provide rapid feedback.
Personalized insight analyzed strategy to learn analyses /improve their performance.

N. Realistic environments
Virtual simulations and scenarios replicate in professional careers. Collaborative teamwork's- inter professionals, healthcare providers used for student practice.
Diverse case study- Intelligent tutoring system, adaptive learning, AI driven tutoring system tailor the learning experiences to each student's unique strength, weaknesses and knowledge gaps. [14]

O. Continuous improvement-
Provides increasing effective support for gathering more data, for predictive analytics for students' success.

P. Trade identification
Personalized recommendations suggest to help the student development for effective learning strategy.

II. ETHICS CONSIDERATION IN AI

A. Driven pharmacy education-
1) bias and fairness- do not discriminate certain student populations.
2) Primary and data security- Protect Student data and technologies.
3)Transparency and accountability - AI continues to transform the landscape of pharmacy education. It is crucial to harness its power responsibility and ethically ensuring that all students have access to personalized, engaging, effective learning experiences to prepare them for challenges in future.
B. G Protein-coupled receptor (GPCR) drug development using artificial intelligence (AI) techniques
C. Studying pharmacology
The field of applying artificial intelligence (AI) techniques to protein-coupled receptor (GPCR) drug discovery is one that is growing quickly. From helping us understand the basic functions of GPCRs to finding novel ligand-GPCR interactions or forecasting clinical reactions, artificial intelligence can be applied at several points in the drug discovery process. Here, we give a broad overview of the ideas underlying artificial intelligence, going into great detail into the machine learning subfields. [14]
D. Intelligent Systems in GPCR Drug Discovery
the GPCR has seen a steady rise in the usage of AI and machine learning. Three enquiries as
1. When may artificial intelligence be used to speed up the drug discovery process? 2. How has artificial intelligence been applied to drug discovery? What makes it possible now? 3. Does AI face new difficulties as a result of the drug discovery process that call for creative computational methods?

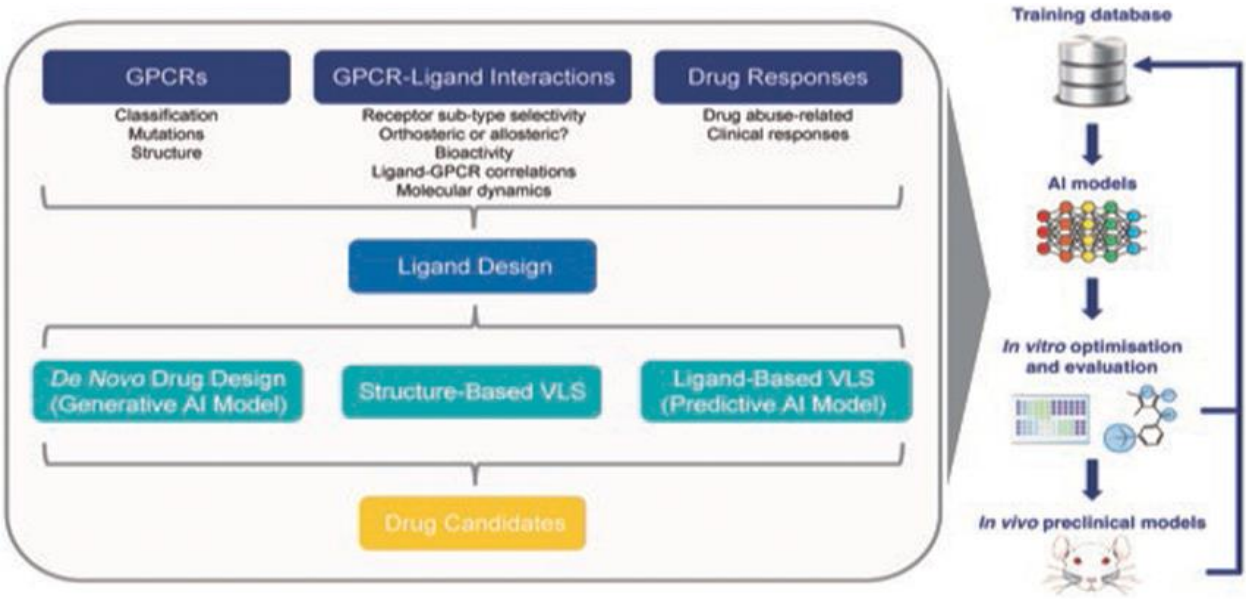

Figure- Artificial Intelligence (AI) In the GPCR Drug Discovery

SWOT analysis with AI Strengths, Weaknesses, Opportunities, and Threats, or SWOT, is a method for evaluating these four facets of your company. A SWOT analysis is a tool that can assist you in determining what your business does well at the moment and in creating a winning plan for the future. Its goal is to teach chemists the fundamentals and practical applications of

Artificial intelligence (AI) can be used in pharmacy teaching and learning in a variety of ways, including: [15]

- Simulating conversations: Students can use AI to practice conversations with physicians and other healthcare professionals.
- Topic discussions: AI can simulate discussions on novel treatment guidelines and other topics, and provide key steps to follow.
- Written communication: AI can help students develop strong written communication skills, which are important for interprofessional collaboration.
- Medicinal chemistry: AI can be used to examine SARs for drugs.
- Clinical studies: AI can analyze genetic data to select participants for clinical studies.

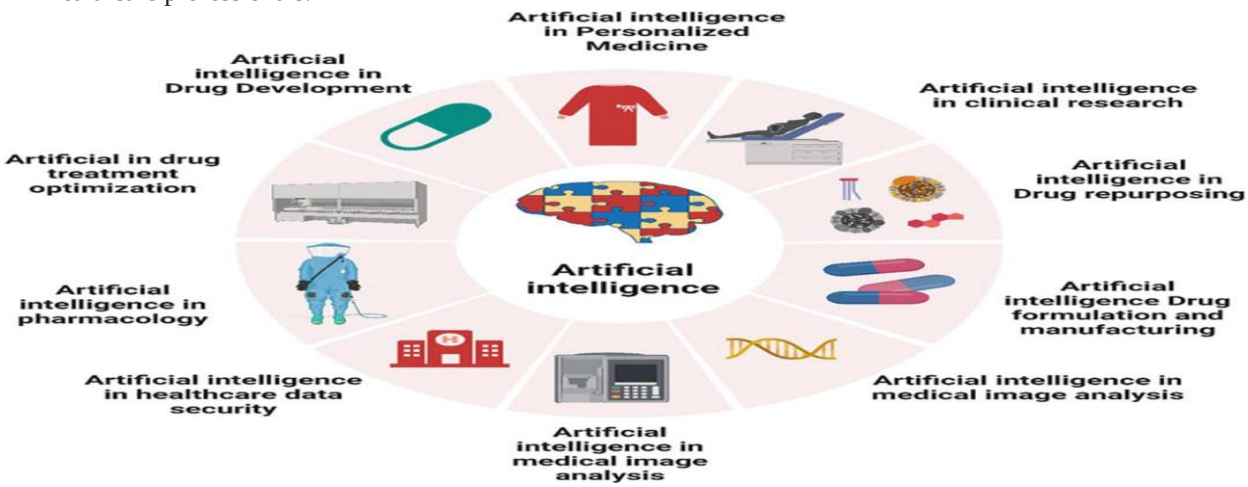

Figure 1 application of AI

III. CONCLUSION

The use of artificial intelligence (AI) and active learning techniques is becoming more and more popular in the fields of pharmaceutical sciences and medical education.AI is essential to the advancement of pharmaceutical science and medicinal chemistry, especially machine learning and deep learning algorithms.In order to improve practical skills and get pharmacy students ready for the changing demands of pharmaceutical care services, active learning techniques including case studies, role plays, and simulation exercises are being used more and more.Interactive graphics and videos are examples of visual teaching tools that have been demonstrated to enhance student learning by improving comprehension of complicated pharmaceutical science material.In order to better prepare students with the practical skills necessary for pharmaceutical care services, educational institutions around the world are modifying their curricula to include act-ive learning methodologies.

The move to learner-centred techniques highlights how crucial hands-on experiences and participation in the educational process are to building communication, decision-making, and management skills in the pharmaceutical industry. As a hypothetical model, we are developing software that can identify the disease based on the patient's medical history and information, allowing the patient to undergo the appropriate test. It helped us assess the outcomes of pharmacist project planning, find issues in practice that could help minimise errors, and talk about some important constraints.

REFERENCE

[1] Nelson S.D, Walsh C.G, Olsen, Demystifying artificial intelligence in pharmacy, *American Journal of Health-System Pharmacy* American Journal of Health-System Pharmacy, Volume 77, Issue 19, 1 October 2020, Page no- 1556–1560

[2] Hath M; Naik, Bhatia, Angat, the ties Digital health e potential implications in pharmacy practices 2012.volume 7 Page no 32-40

[3] In. stork peep leasing a competence overview of techniques taxonomy applications & research direction. 51 Computer a canto (6) 6021). Athale p420 page no 2-6

[4] B. Ngo. Nguyen D., Van Sonnenberg for and against artificial Intelligence in the medical school curriculum. Radial Arif Intel. Volume 4(5) (2022), Article e220074 page – 35-40

[5] k. Ambroziak, Ibrahim N., Marshall, V.D., Kelling, S, F., pharm teach learn, 10 (6) (2018) virtual simulation to personalize Shedont learning required pharmacy Course, pp. 400- 756.10.18

[6] Muhaimin, Habibi A. Riadgy. at Covid-19 distance and online learning a systematic literature review in Be med education 10s (1) (2) pharmacy education Article 967-page no – 112-120

[7] D.S Wijesinghe pharm Counsel AI. a new era OF interactive learning in pharmacy education via the application. large language models (open AS GPT-4). Published Jun 13, 2023. Accrued July 9 medium page no 2-4

[8] Cain J, Malcom D.R., Aungst T. D. The role of artificial intelligence in the future of pharmacy education (American Journal of pharmaceutical education) Vol 87-page no-87-112

[9] Cavner M M, Uncu.Y. T, Bulut.F. F, Chalil. E G, Tatli. An Artificial intelligence in medical education: a cross-sectional needs assessment BMC medical education page no- 2 to

[10] Callif Manag, A brief history of artificial intelligence: on the past, present, and future of artificial intelligence. Sage journel page no.7-9

[11] American Society of Health-System Pharmacists. Growth in artificial intelligence offers opportunity for health-system pharmacy. Bethesda, Maryland; 2022. Page no.4-7

[12] Turner, Murphy.M.B., Kane S. K., & Shapiro R. B. (2019). Youth learning machine learning

[13] through building models of athletic moves. Zimmermann-Niefeld, A In Proceedings of the 18th ACM international conference on interaction design and children (page no. 121–132).

[14] Balamurugan, Rohini Janaki, AL-bonsrulah, Hussein A. Z., Raja, Vijayanandh, Kumar, Lokeshkumar, Kannan, Sri Diviyalakshmi, Madasamy, Senthil Kumar, Rasheed, Raffik, Rajendran, Parvathy, & Al-Bahrani, Mohammed. (2022). Design and multiperspectivity-based performance investigations of H-Darrieus vertical

axis wind turbine through computational fluid dynamics adopted with moving reference frame approaches. International Journal of Low-Carbon Technologies, 17, 784–806

[15] Park SH, Do KH, Kim S, Park JH, Lim YS. What should medical students

[16] know about artifcial intelligence in medicine? J Educ Eval Health Prof.

[17] 2019; 16:16–21.

[18] Kern DE, Thomas PA. Hughes MT: curriculum development for medical education. A six-step-approach. 2nd ed: Johns Hopkins University Pres;

[19] 2009. page. 7-8