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Current Approaches in Medical Pharmacology Education

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Abstract

The development of technology, the spread of online education and generally updated information in educational science also contribute to the development of medical education. Medical Pharmacology is seen as the basic discipline of health-related undergraduate and graduate departments, especially the preclinical period of medical faculties. Current research has shown that medical and health profession graduates (pharmacy, nursing, veterinary, biomedical, etc.) have difficulties in basic pharmacology knowledge and in their ability to apply what they have learned in pharmacology classes in practice. Also, factors such as the development of the science of pharmacology every year, the addition of new drugs to the curriculum, and the constant change of treatment guidelines make learning pharmacology difficult. In addition, pharmacology educators play an active role at the undergraduate and graduate levels at the intersection of clinical and preclinical. Therefore, it is increasingly important for pharmacology educators to make lessons active and understandable. Academicians who advocate the necessity of a current change in pharmacology education are conducting various studies on this subject. In this review, studies carried out in recent years to improve pharmacology education and expert opinions are brought together.

Keywords: Pharmacology, medicine, education

1. Introduction

Pharmacology is a branch of science with a broad field of study, such as the physical and chemical properties of drugs, their effects on the body, and their interactions with other drugs (Rivera & Gilman, 2011). Therefore, knowledge and practice of pharmacology has a unique role in the safe prescribing and administration of medications (Fasinu & Wilborn, 2024). Pharmacology is one of the basic courses of medicine and health-related branches, and with its structure that changes and develops day by day, it is a difficult but necessary course to learn. Lecturer-based learning (LBL) has been applied in pharmacology, as in every subject, for many years. Today, the most frequently used method in medical faculties around the world is the classical LBL. However, it has been observed that learning progressing through classical lectures in the classroom environment is insufficient (Fu et al., 2022; Zeng et al., 2020). Because pharmacology is a branch where new information is added to the curriculum every year with its constantly changing and active structure. Developments in the pharmaceutical industry reveal new active ingredients and treatment methods. It also includes microscopic concepts such as receptors, interaction of cells with drugs, and molecular chemical structures. In this sense, the constant change and the increase in the subjects to be learned, as well as the difficulty of learning the subjects, have forced educators and researchers to search for new learning methods. With the development of technology, new teaching methods applied in all fields of educational sciences have also begun to take place in pharmacology. The aim of new methods should be to learn how to learn, not just to memorize the subjects (Guilding et al., 2023). In addition, these methods can be applied in combination rather than alone, so that each student can find his or her own unique method (Xiao et al., 2023). Our aim in this study is to compile and guide the newly produced learning methods and related research. Our research problem is "What are the current approaches in teaching pharmacology?".

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2. Method

We implemented the method as document analysis. PubMed which a free search engine that accesses the most widely used and well-known medical, biomedical and life sciences databases in the world has been used. All randomized controlled studies, reviews and meta-analyses covering the topics of "Pharmacology" and "Education" published between 2019 and 2024 has been evaluated. We found 18,458 studies. There were records excluded after abstract screening. There are many different topics related to "education" in the medical literature. For example, since it is possible for a cell to differentiate into another cell or "learn" to fight infection/cancer by training it with drugs or genetics, we excluded such content. We only found studies that included topics related to pharmacology education at undergraduate and graduate levels. When studies that meet our criteria are selected, team-based learning (TBL), problem-based learning (PBL), personalized learning (PL), integrative technologies (IT), case-based learning (CBL) and flipped classroom (FC) methods contribute to the development of pharmacology education. These methods were used in combination from time to time and had been in the official curriculum for a while. Gamification and artificial intelligence (AI) have been in the spotlight over the last decade (Figure 1).

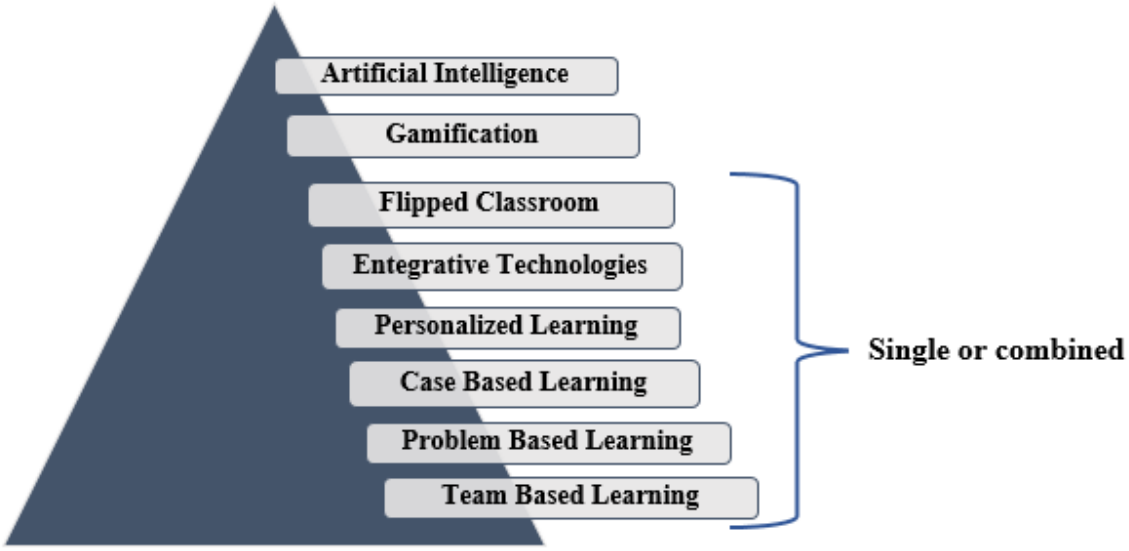

Figure 1. New training methods in pharmacology

3. Findings

As in every discipline, revision has been needed in pharmacology education over time. With the constant renewal of existing information and the difficulty of keeping up with developing technology, learning models have also changed and traditional LBL has become outdated and inadequate. For this reason, modern learning methods such as TBL, PBL, PL, IT, CBL and FC that contribute to the development of pharmacology education, attract attention. We took these methods, which started to take their place in the curriculum and are sometimes applied in combination, as a single title and examined gamification and AI, which have come to popular in recent years, separately.

3.1 Some modern learning methods

TBL has been first designed as an effective method based on teamwork by Dr. Larry Michaelsen for use at the University of Oklahoma (Michaelsen, 2004). In this method, firstly, the students has been individually familiarized to subject with lectures given by instructors, literature reviews, books and other materials. Then, the information is reinforced by applying a pre-test. Finally, they are given the opportunity to solve problems, reinforce their knowledge, and discuss the issues they defend in small groups. This method has been frequently applied in pharmacology education and according to studies it has been observed that effective learning is provided. Positive results has been obtained, especially when the test achievements of low-performing students were compared before and after TBL (Carrasco et al., 2021). For a course as dynamic and broad as Pharmacology, TBL provides a collaborative environment for team members to grasps drug names, mechanisms, and adverse effects that may be difficult to learn individually. Through several studies, TBL has been shown to be as effective and sometimes better than traditional pharmacology (Dunaway, 2005).

PBL is a method of learning by identifying a problem, conducting appropriate research, reasoning, and discussing information in groups, as in TBL. The most important distinguishing feature of PBL is that it not only teaches students a certain subject but also provides them with general problem-solving competence. According to studies, PBL has also yielded positive results in the field of pharmacology, has increased interest in learning, has strengthened team spirit, providing effective communication and improving students' problem analysis and problem-solving skills (Liu et al., 2019).

Another innovative learning method was PL. As it is known, the traditional classroom structure is a uniform system that forces each student to adapt. In PL, the aim is to provide education to the student according to his/her own interests and learning speed by using various technologies and simulations in the classroom. PL, which can also be used as a tool in the medical curriculum, is a method that facilitates learning drug names, mechanisms of action, clinical applications, etc., and provides time and location flexibility (Fidalgo-Neto et al., 2014).

In IT, there is a connection to a central unit via computer or mobile devices and support from video clips, e-books and online quizzes. There are studies in the field of pharmacology showing that it is beneficial to use it especially to make the contents attractive (Gudadappanavar et al., 2021).

The CBL method is another efficient way of learning. Its effectiveness as both a traditional and integrative learning method has been demonstrated in many studies. CBL is based on solving scripted cases by discussing and facilitates learning in a wide range of areas, from the pathophysiology of the disease to its symptoms, pharmacotherapy and side effect profile, and provides the student with problem-solving skills, as in PBL (Özdener et al., 2020; Tayem, 2013).

Another learning method that has attracted attention in recent years is FC. In this method, first of all, by taking advantage of technological developments, the student studies the subject with videos and materials before the lesson. Then, assignments are given as in the traditional method, and these assignments are done individually or as a team in the classroom. In this way, the educator teaches and assigns homework as in the traditional method, and the student is enabled to understand the lesson in his own way by making use of technology. The biggest difference here is that the lesson is learned outside the classroom and the homework is done in the classroom under the control of the educator. There are studies showing that it is used alone or in combination with other methods in medical and pharmacology education and increases test success (Lockman et al., 2017; Zhang et al., 2019).

3.2 Gamification

Another method that can be used to make learning attractive is gamification (Morris et al., 2013). In recent years, interest in LBL has decreased as students benefit from different learning methods. Especially with the impact of the pandemic period, the rapid advancement of computer and interactive technologies in education has been opened. The use of game elements (e.g., points, leaderboards, rewards) in non-game contexts is called gamification or “gamified learning” (van Gaalen et al., 2021).

The tournament called "Pharmacotrophy" held at the Paris Faculty of Pharmacy in 2021-2022 is a good example of this. In 2021-2022, students' exam results were evaluated with online and face-to-face races using Kahoot. Questions were prepared from various subjects in the pharmacology curriculum, aiming to both understand the subjects and motivate learning through competition. After the tournament, the effectiveness of the method was tried to be measured by collecting feedback from students and educators with an online survey. In particular, students emphasized that this method is motivating and supports teamwork. In addition, among the students who received similar exam success scores in previous years, those who participated in the tournament received 20.1% higher scores than those who did not participate (Delage et al., 2024).

3.3 The role of Artificial Intelligence (AI) in medicine and pharmacology education

Today, the impact and rapid progress of Artificial Intelligence (AI) is indisputable. The use of AI is supported in medical science and education, as in every field. It has consolidated its place in higher education, especially since the launch of ChatGPT in November 2022. For this reason, the potential benefits and challenges of using ChatGPT in medical education continue to be investigated. First of all, medicine and pharmacology education is a challenging discipline that requires memorizing a large amount of information in a short time and staying up to date. At this point, with ChatGPT, students can easily and quickly search for information on any subject, allowing them to better understand complex concepts. Additionally, ChatGPT offers a personalized learning experience by analyzing the student's learning style and individual needs. In addition, through clinical simulations, it also provides the opportunity to benefit from the experiences of others and receive real-time feedback about the decisions they will make when they step into the profession (Feng & Shen, 2023).

But what is important is when and how students and faculty will use it rather than whether they will benefit from it. Although AI has the potential to revolutionize medical education, it should be noted that it cannot replace human expertise and interpretation ability. It should be aimed that students do not dull their critical thinking and idea generation abilities while completing assigned assignments, and faculty members must maintain honesty and professionalism. Additionally, legal liabilities such as producing biased content and copyright issues should be

avoided. It is suggested that AI should only become a tool that makes teaching easier and more interesting. As a result, medical educators can leverage the power of ChatGPT to create innovative and effective learning experiences for the next generation of medical students (Patel et al., 2023).

In a study conducted in 2024, various examination systems in medical pharmacology education were tested and learning objectives were determined by using three AI platform named Sage Poe, Claude-Instant and ChatGPT. Accordingly, it was designed to generate questions, administer tests and evaluate exam results to measure students' knowledge about hypertension. It was observed that the artificial intelligence platforms in this study produced quality test items suitable for different evaluation purposes and achieved similar results except for minor changes. In this way, it is thought that artificial intelligence tools can be valuable in terms of quickly creating quality exam methods and time management (Sridharan & Sequeira, 2024). However, some of the data obtained were found to contain errors. Considering that artificial intelligence tools can also reach incorrect or biased information, test results still need to be checked by an expert. As a result, with advancing technology, it has been suggested that artificial intelligence be integrated into the medical curriculum to support both students and educators.

Again, a recent study addressed the pros and cons of using ChatGPT in medicine, dentistry, pharmacy and public health education. For this research, various guidelines were created based on expert opinions and literature in these four disciplines. These guidelines have featured the advantages and concerns of using ChatGPT. In short, it has been accepted that the use of ChatGPT in medicine, dentistry, pharmacy and public health education has advantages in areas such as personalized learning, easier understanding of complex concepts, creating case scenarios and receiving instant feedback, data analysis and rapid literature review. In addition, it was emphasized that it is still approached with skepticism due to limitations such as data confidentiality, the risk of obtaining biased and incorrect information, and the decrease in students' critical thinking and communication skills (Sallam et al., 2023).

4. Discussion and Conclusion

As a result, pharmacology represents the fundamental discipline of health-related professions. In other words, it is not possible to be successful in professions such as medicine, nursing, pharmacy, dentistry and veterinary medicine without having accurate and complete knowledge of pharmacology. In addition, it is a fact that the classical education method is inadequate due to the fact that the science of pharmacology has a constantly changing, developing and growing content, and that it is one of the most difficult courses for students since it is already a complex field. For these reasons, a revision in pharmacology education will be inevitable. In addition to traditional methods, it is necessary to turn to technology-based methods that are suitable for each student's learning method, are interesting and facilitate memory retention. Additionally, further studies are needed to increase and develop these methods. It will make a great contribution to science if researchers interested in both pharmacology and educational sciences increase their studies in this direction and develop this field (Guilding et al., 2024).

While innovative and technological methods are being increasingly integrated into the clinical courses of medical schools, traditional methods are still mostly applied at the preclinical stage. On the other hand, using technology in pharmacology, which is an applied science, can lead us to more accurate drug prescription and treatment. Developments in technology and its reflection on education have gained importance in the last decade. Especially during the pandemic period, the necessity of technology for education has become indisputable. At this point, inequality between countries comes to the fore. In regions where there is not sufficient internet access, the quality of education decreases dramatically. Some international projects such as the Pharmacology Education Project (PEP) are needed to reach technology in these regions and ensure that students receive up-to-date pharmacology education (Faccenda et al., 2019). It is possible to apply new training methods not only alone but also in pairs or multiples. According to a study comparing training techniques, PBL and CBL combined is the method that increases test success the most. In addition, TBL and FC are methods that significantly increase both student satisfaction and course success (Xiao et al., 2023). In general, student satisfaction with new methods is higher than traditional education.

In particular, TBL provides contributions such as communication skills, critical thinking and team spirit through peer-level teaching. In a study with pharmacy students, the impact of TBL was evaluated through a post-lesson survey. Student satisfaction, comprehension and class participation increased (Attia & Mandour, 2023). In a dental school, TBL was also evaluated by both students and lecturers. Students stated that they learned faster and lecturers stated that their classroom performance increased (Chen et al., 2022). In another study, it was observed that the success of low-achieving first-year medical students increased after TBL (Kim et al., 2020). On the other hand, in a study comparing TBL and LBL, student satisfaction was higher in TBL, but there was no significant difference in terms of test success (Nguyen et al., 2016).

A structured questionnaire and prescription samples were used in a study comparing PBL and LBL. Accordingly, it was observed that with PBL, students' knowledge increased and they wrote more accurate

prescriptions (Brinkman et al., 2021). However, in another study a year later, there was no significant difference in test success between PBL and LBL, although student satisfaction was higher (Sushama et al., 2022).

In a study in which third-year medical students were surveyed about CBL, it was stated that the curriculum was quite satisfactory (Özdener et al., 2020). In parallel, many studies have shown that student satisfaction is high in CBL (Hasamnis et al., 2019; MEIRA et al., 2022). In addition, it was observed that test success increased in studies comparing CBL and LBL (Chiranjeevi et al., 2022; Tushar et al., 2020).

Additionally, there is a need for studies comparing these methods with each other in more detail. Over time, technological methods and especially AI and gamification will begin to take more part in education. It should be aimed to achieve a standard and ideal training method in medical pharmacology education by conducting more randomized controlled studies. To our knowledge, there is no study in which cost-effectiveness analysis has been conducted on this subject. Since efficiency is also important economically today, studies in this field are needed.

References

Attia, R. T., & Mandour, A. A. (2023). Team-based learning-adopted strategy in pharmacy education: pharmacology and medicinal chemistry students' perceptions. *Future Journal of Pharmaceutical Sciences*, *9*(1), 15.

Brinkman, D. J., Monteiro, T., Monteiro, E. C., Richir, M. C., van Agtmael, M. A., & Tichelaar, J. (2021). Switching from a traditional undergraduate programme in (clinical) pharmacology and therapeutics to a problem-based learning programme. *European journal of clinical pharmacology*, *77*, 421-429.

Carrasco, G. A., Behling, K. C., Gentile, M., Fischer, B. D., & Ferraro, T. N. (2021). Effectiveness of a Team-Based Learning exercise in the learning outcomes of a medical pharmacology course: insight from struggling students. *Naunyn-Schmiedeberg's Archives of Pharmacology*, *394*(9), 1941-1948.

Chen, D., Yue, H., Liu, S., Meng, L., & Yin, W. (2022). The introduction of team-based learning into the clinical pharmacology section of the endodontics clinical course. *Clinical and Experimental Pharmacology and Physiology*, *49*(9), 998-1001.

Chiranjeevi, U. K., Gedela, V., & Rao, G. H. J. (2022). A comparative study of case-based learning with conventional teaching in undergraduate training of pharmacology. *National Journal of Physiology, Pharmacy and Pharmacology*, *12*(5), 712-716.

Delage, C., Palayer, M., Lerouet, D., & Besson, V. C. (2024). "Pharmacotrophy": a playful tournament for game- and team-based learning in pharmacology education-assessing its impact on students' performance. *BMC Medical Education*, *24*(1), 219.

Dunaway, G. A. (2005). Developments: Adaption of team learning to an introductory graduate pharmacology course. *Teaching and Learning in Medicine*, *17*(1), 56-62.

Faccenda, E., Maxwell, S., & Szarek, J. L. (2019). The IUPHAR pharmacology education project. *Clinical Pharmacology and Therapeutics*, *105*(1), 45.

Fasinu, P. S., & Wilborn, T. W. (2024). Pharmacology education in the medical curriculum: Challenges and opportunities for improvement. *Pharmacology Research & Perspectives*, *12*(1), e1178.

Feng, S., & Shen, Y. (2023). ChatGPT and the future of medical education. *Academic medicine*, *98*(8), 867-868.

Fidalgo-Neto, A. A., Alberto, A. V. P., Bonavita, A. G. C., Bezerra, R. J. S., Berçot, F. F., Lopes, R. M., & Alves, L. A. (2014). PHARMAVIRTUA: educational software for teaching and learning basic pharmacology. *Advances in physiology education*, *38*(4), 368-371.

Fu, X., Wu, X., Liu, D., Zhang, C., Xie, H., Wang, Y., & Xiao, L. (2022). Practice and exploration of the" student-centered" multielement fusion teaching mode in human anatomy. *Surgical and Radiologic Anatomy*, *44*(1), 15-23.

Gudadappanavar, A. M., Benni, J. M., & Javali, S. B. (2021). Effectiveness of the game-based learning over traditional teaching–learning strategy to instruct pharmacology for Phase II medical students. *Journal of education and health promotion*, *10*(1), 91.

Guilding, C., Kelly-Laubscher, R., & White, P. (2024). The future of pharmacology education: a global outlook. In (Vol. 17, pp. 115-118): Taylor & Francis.

Guilding, C., Kelly-Laubscher, R., Netere, A., Babey, A. M., Restini, C., Cunningham, M., Kelly, J. P., Koenig, J., Karpa, K., & Hawes, M. (2023). Developing an international concept-based curriculum for pharmacology education: The promise of core concepts and concept inventories. *British Journal of Clinical Pharmacology*.

Hasamnis, A. A., Arya, A., & Patil, S. S. (2019). Case-based learning: our experience in clinical pharmacology teaching. *Journal of Pharmacy and BioAllied Sciences*, *11*(2), 187-189.

Kim, D.-H., Lee, J.-H., & Kim, S. A. (2020). The pharmacology course for preclinical students using team-based learning. *Korean journal of medical education*, *32*(1), 35.

Liu, L., Du, X., Zhang, Z., & Zhou, J. (2019). Effect of problem-based learning in pharmacology education: A meta-analysis. *Studies in educational evaluation*, *60*, 43-58.

Lockman, K., Haines, S. T., & McPherson, M. L. (2017). Improved learning outcomes after flipping a therapeutics module: results of a controlled trial. *Academic medicine*, *92*(12), 1786-1793.

MEIRA, M. B., MAIOLI, E. C., SOUZA, R. M., CAMARGO, M. S., & MISTRO, S. (2022). Case-based learning for teaching pharmacology to pharmacy students. *Revista Brasileira de Farmácia Hospitalar e Serviços de Saúde*, *13*(3), 775-775.

Michaelsen, L. K. (2004). Getting started with team-based learning. In *Team-based learning* (pp. 27-50). Routledge.

Morris, B. J., Croker, S., Zimmerman, C., Gill, D., & Romig, C. (2013). Gaming science: the "Gamification" of scientific thinking. *Frontiers in psychology*, *4*, 607.

Nguyen, T., Wong, E., & Pham, A. (2016). Incorporating team-based learning into a physician assistant clinical pharmacology course. *The Journal of Physician Assistant Education*, *27*(1), 28-31.

Özdener, F., Özbaykuş, A. C., Yavuz, M., Sürsal, A., Narter, F., & Koç, D. (2020). Case Based Learning Versus Conventional Lecture in Clinical Pharmacology Education and its Relation to Learning Styles. *Southern Clinics of Istanbul Eurasia*, *31*(3).

Patel, S. B., Lam, K., & Liebrenz, M. (2023). ChatGPT: friend or foe. *Lancet Digit Health*, *5*(3), e102.

Rivera, S. M., & Gilman, A. G. (2011). Drug invention and the pharmaceutical industry. *Goodman & Gilman's the pharmacological basis of therapeutics*, 3-16.

Sallam, M., Salim, N. A., Barakat, M., & Ala'a, B. (2023). ChatGPT applications in medical, dental, pharmacy, and public health education: A descriptive study highlighting the advantages and limitations. *Narra J*, *3*(1).

Sridharan, K., & Sequeira, R. P. (2024). Artificial intelligence and medical education: application in classroom instruction and student assessment using a pharmacology & therapeutics case study. *BMC Medical Education*, *24*(1), 431.

Sushama, J., Palappallil, D. S., & Thomas, S. P. (2022). Comparison of the effectiveness between problem-based learning and lecture class in pharmacology for medical undergraduates. *J Evid Based Med Healthc*, *9*(11), 48.

Tayem, Y. I. (2013). The impact of small group case-based learning on traditional pharmacology teaching. *Sultan Qaboos University Medical Journal*, *13*(1), 115.

Tushar, B. C., Gajanan, D., Gaurav, C., & Vishal, K. (2020). Student perception and effectiveness of case based learning in pharmacology.

van Gaalen, A. E., Brouwer, J., Schönrock-Adema, J., Bouwkamp-Timmer, T., Jaarsma, A. D. C., & Georgiadis, J. R. (2021). Gamification of health professions education: a systematic review. *Advances in Health Sciences Education*, *26*(2), 683-711.

Xiao, C.-L., Ren, H., Chen, H.-Q., Liu, W.-H., Luo, Z.-Y., Li, W.-R., & Luo, J.-Q. (2023). Multidimensional evaluation of teaching strategies for pharmacology based on a comprehensive analysis involving 21,269 students. *Frontiers in Pharmacology*, *14*, 1145456.

Zeng, H. L., Chen, D. X., Li, Q., & Wang, X. Y. (2020). Effects of seminar teaching method versus lecture-based learning in medical education: a meta-analysis of randomized controlled trials. *Medical teacher*, *42*(12), 1343-1349.

Zhang, X.-M., Yu, J.-Y., Yang, Y., Feng, C.-P., Lyu, J., & Xu, S.-L. (2019). A flipped classroom method based on a small private online course in physiology. *Advances in physiology education*, *43*(3), 345-349.