A Review on Novel Methods of Pharmacology Teaching Concerning Iranian Academic Context

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Abstract- Pharmacology is the cornerstone of health science courses the same as biomedical programs in educational setting. New educational intuitions and methodical progresses in teaching and learning, as well as recent findings in pharmacology research, can help pharmacology educators reconsider and regulate their teaching approaches. Thus, the aim of this article is to review existing studies on the different methods of teaching pharmacology and investigate different outcomes in this regard. In the present investigation, recent articles in the databases of Web of Science, PubMed, Scopus, Embase, Google Scholar, IranDoc and Scientific Information Database (SID) were examined, and the delegated documents were reviewed. The gathered data showed that students' cognitive, metacognitive, and cooperative learning besides collaborative skills are effective factors for teaching. Additionally, application of blended learning or flipped instruction via technologies such as computer ameliorates the process of teaching and learning pharmacology in academic setting. Consequently, to overcome the difficulties in managing the data overload, it sounds necessary to introduce new teaching methods in academic context. Therefore, the current investigation is useful for practitioners, curriculum designers and educational administrators in medical and paramedical educational context.

Introduction

Pharmacology which is highly needed by different groups of medical graduates for both therapeutic activities and research programs, has been defined as studying the effects of various compounds on the activity of the organs throughout the body. Because of the importance of this knowledge to target groups, pharmacology instruction happens in a diversity of contexts designed for the students at the faculties, such as pharmacy, medicine, paramedicine, nursing and dentistry. Also, the instructive notion of pedagogical content knowledge has been the topic of several investigations in this arena (1-5). Medical students study this course after rudimentary disciplines and before experimental disciplines. In this realm, the effect of learning can be partial for students who have not studied clinical disciplines such as internal science. Besides, the overload of content and resources may be considered as a challenge for learning pharmacology course in university context (6). In this regard, new instructive perceptions and scientific advances in pharmacology research motivate instructors to regularly adjust their teaching strategies (7).

Pharmacology instructors should be scholastically well-qualified in their profession, and they should have general knowledge of teaching methodology. Based on the literature (8), a major difference has been found between knowing about a topic or the content awareness and knowledge of teaching the content. According to the

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definite context, the purposes and applications of pharmacology teaching vary considerably (7,9,10).

In educational realm, students are the emphasis of the instructive innovativeness; thus, their cognitive and affective learning involvements direct all verdicts in academic setting (11). This viewpoint highlights the rudimentary notion of modern curricula which emphasis learner-centered teaching rather than teacher-centered classes (11-13). Traditional programs, which were based on lecture and test styles education, recently are substituted by programs in which learners select what they will learn and to what extent, how, and how they will assess their own learning (12). In such a context learner-centered instruction attentions to skills and practices that qualify permanent learning and self-regulating problem-solving (11-13).

Reviewing the literature indicates that, the corresponding instructional approaches include problem-based teaching, case-based teaching, and outcome-based one, which can be implemented based on collaborative and self-directed learning activities. In learner-centered classes the teacher will act as an organizer or facilitator who helps and encourages students' participation. The pharmacology instructor should be well equipped to accomplish this role thorough understanding of subject matter and he/she should have academic expertise too (13).

Theoretical framework for teaching

Different theoretical frameworks such as metacognitive knowledge, cognitive theory, cooperative learning and collaborative theory have been suggested for teaching in this realm. John Flavell suggested metacognition theory in 1970s. He distinguished metacognition as an awareness strategy that attentions or controls any part of cognitive deed (14). Besides, he introduced two common parts of metacognition as knowledge and experience. Regarding this issue, we can explain metacognitive knowledge by emphasizing dissimilarities between static and strategic knowledge. According to the study by Baker and Brown (15), static knowledge refers to what students are able to express about cognition; however, strategic knowledge includes the tactics that students implement to control cognitive signs. These strategies comprise planning, figuring out how to begin or endure a process, foreseeing and guessing how much will be recalled or understood or how much time it will take to complete a particular cognitive task. In this domain, guessing, visualizing response before accomplishment of cognitive account, observing and defining how well cognitive goals are accomplished have

been reflected as students' crucial strategic knowledge.

A study in 2021, focusing on pharmacology education found metacognition skills an important element for pharmacy students to improve their life-long skills and professional competence (16). On the other hand, another study by Medina and colleagues introduced metacognition as a crucial tool for critical thinking and self-regulated pharmacology learning. As we know, understanding, reasoning and subsequently problem-solving are integral parts of pharmacy practice. Interestingly, metacognition has been found the important skill for monitoring the monitoring the mentioned items so that it should be focused more on educational settings of pharmacology (17). Also in this regard, Colthorpe et al reported that, metacognitive awareness would be an encouraging factor for pharmacy students to improve their knowledge, be involved in higher-quality strategies and consecutively elevate the learning benefits (18).

The other teaching theory is collaborative learning. It is a notion that highlights a theoretical framework for teaching and learning process. It is worth pointing that the intellectual cooperation has a long history in the arena of research for education (19). The collaborative education is part of a social constructivist perspective. Here, knowledge is a course of interaction or joint construction of meaning which can be considered as a course of teaching (20). The advantages of this learning method were also tested and proved concerning pharmacological topics (21).

Besides, cognition theory plays dominant role in teaching. Based on this theory, the concept of distributed cognition does not happen inside the brain. Regularly, it is distributed across various systems, comprising communal and technological resources (22). It is important to note that several studies have been conducted on consequences of using the theory to better learning of pharmacology. Throughout the studies, preventing data overload during pharmacology courses were found the most important advantage of the theory (23-26).

Likewise, the term Cooperative Learning (CL) as a joint problem solving was introduced in the realm of teaching in 1975. According to Johnson and Johnson (27) developments in education emphasized student-student interaction as a significant element in teaching and learning process. Grounded on this outlook, the learners produce their own knowledge by cooperating with others. Here, group accomplishment is a venue for peer communication. According to a study in 2002 (28), CL is well-defined as a paradigm for supporting students work together supportively. In this realm, the Vygotskian

perspective is entwined in CL principles. Vygotsky claims that authenticity of the environment and the sympathy between students are vital for learners to help them feel part of this environment (29). The method was also tested for learning pharmacology. As an example CL (together with role-play) was very effective for improving the students' communication skills and active-learning (30).

Additional central perspective concerning teaching and learning process is related to the role of constructivism. This viewpoint has its origins in cognitive thinking. Constructivism is basically a theory based on scientific study about students' learning. Based on this perspective student conjecture his/her awareness of the world, through reflecting on his/her own practices. To this end, student asks questions, explores the answers and measures his/her understanding of the content knowledge (31). The studies have helped a lot make these concepts meaningful for both pharmacology learners and teachers during recent years (32-34).

Search strategy

In order to prepare the present review, a combination of the phrases and keywords including medical and paramedical students, cooperative and collaborative skills, cognition, metacognitive knowledge, teaching methods, traditional teaching and computer mediated teaching were explored through the popular databases such as Web of Science, Pubmed, Scopus and Embase as well as SID, IranDoc and Google Scholar. Then the selected contents were reviewed meticulously and subsequently discussed and concluded.

Literature review

Regarding undergraduate students, what has happened to teaching methods of pharmacology during the past decade, have paved the way for new technologies to enter the mentioned field which resulted in employing role plays, computer assisted learning, practice of audiovisual aids and other such techniques in the educational system. Besides, the application of electronic media has become communal at universities of medical sciences. As an example, nowadays, PowerPoint (PPT)

presentations has become a very suitable supplement for the traditional 'chalk and talk' method (10).

One of the novelties that has been focused recently regarding teaching pharmacology for the students of pharmacy, medicine and nursing is simulation. Literature review highlights a significant number of reports indicating the applications of simulation such as serious games, computer assisted learning (CAL) and high-fidelity patient simulation (HFPS) which are widely used during courses of clinical pharmacology (35).

On the other hand, several investigations have been launched to evaluate the efficiency of PPT presentation or other media in contrast to the chalkboard teaching style. In this regard, previous studies (36) revealed that students want the instructors to use audiovisual aids throughout their lectures. Similarly, Bartsch and Cobern (37) illustrated that students favored lectures with PPT over the use of traditional teaching with chalkboard. The other extensive study compared (PPT) with traditional teaching, Findings showed no difference about students' performance concerning final tests (38) whereas in another study there was noticeable development in students' examination results (39). Thus, there is a variety of outlooks based on previous studies' outcomes and it is not completely clear whether the practice of a specific lecture delivery technique is greater than the others. Consequently, this review was assumed to investigate the effectiveness of different teaching methods for teaching pharmacology courses on students' performance in academic context. Table 1 summarizes the evolution of some related studies in this regard. Strict bilateral communication, online instruction resource and software, virtual teaching, case-based learning, micro-video based flipped classroom and bullet screen are interesting keywords which were discussed through recent studies (40-46).

Among the numerous studies that have been designed and implemented to improve the educational process of the student studying at universities of medical sciences in Iran (47-50), many have been conducted concerning pharmacology teaching methods. Table 2 summarizes the evolution of the related investigations concerning this issue (51-56).

Table 1. Evolution of Pharmacology Teaching Methods over the World

Authors	Year	Region	Focused titles
Seth et al.	2010	India	PowerPoint teaching compared to overhead projectors or the transparencies.
Gregson et al.	2010	USA	Integrating problem-based learning into a D.D.S. pharmacology curriculum
Chavda et al.	2011	India	Interactive classes with strict bilateral communication
Wang et al.	2012	China	Cooperative learning (together with role-play)
Kaylor	2014	USA	Cognitive load theory
Foster et al.	2017	USA	Course placement, content saturation, resources and English as a second language.
Medina et al.	2017	USA	Metacognition as a crucial tool for critical thinking and self-regulated pharmacology learning.
Colthorpe et al.	2019	Australia	Metacognitive awareness
Nicolaou & El Saifi	2020	Cyprus	Virtual patients
Andrews & Barta	2020	USA	Computer-aided learning and simulation
Carstensen et al.	2020	Denmark	Cooperative learning
Koster & Vermunt	2020	The Netherlands	Longitudinal Changes of Deep and Surface Learning in a Constructivist Pharmacy Curriculum
Gao et al.	2021	China	Online instruction resource and software
Mauldin et al.	2021	USA	Cognitive load theory
McHugh et al.	2021	USA	Promoting higher order cognition, learner-centered coaching, and constructive feedback
Martirosov	2021	USA	Metacognition skills
Garg & Bhanwra	2022	India	Case-based learning
Wu et al.	2022	China	Micro-video based flipped classroom
Chen et al.	2022	China	Bullet screen
Yiin & Chern	2023	Taiwan	effects of an active learning mechanism on cognitive load and learning achievement

Table 2. Evolution of Pharmacology Teaching Strategies in Iranian Academic Context

Author	Year	Region	Focused Titles
Najafi & Eteraf-Oskouei	2011	Tabriz	Computer simulation
Heydarpour et al.	2013	Tehran	Podcasting
Eteraf-Oskouei & Najafi	2013	Tabriz	Application of whiteboard and pharmaceutical dosage forms compared to PowerPoint Presentation.
Ataei & Panjehpour	2015	Isfahan	Cooperative teaching and interactive teaching methods
Sayyah et al.	2017	Ahvaz	Problem-based attention in comparison to blended learning methods.
Hayat et al.	2020	Shiraz	Students' self-efficacy and metacognitive learning strategies

Discussion

Teaching is considered as a developing procedure particularly in medical school. Accordingly, it requires to be promoted continuously. As discussed earlier, the main challenge for any medical university is to deliver massive amount of knowledge in contracted schedule and students must recall and interpret the acquired knowledge during the limited time of educational semester. These days, pharmacology teaching can be more stimulating and applicable by revising the schedule and revisiting the teaching procedure. It is worth noting that instructors should be familiar with students' learning style, and they have to consider the needs of analysis of undergraduate students for learning pharmacology in academic context.

In this realm students' cognitive ability and their metacognitive knowledge via providing collaborative learning context merits further attention. Besides, instructors' acquaintance with new trends of technology plays a dominant role in this realm.

The large volume of materials that can be presented in the course of pharmacology gradually led the researchers in the field of education to invent new methods for teaching (57). Detailed analysis of students' feedback is one of the main bases for directing these inventions (58). As previously mentioned, the undeniable influence of CL on the quality of education has been proved and claimed. This method of training has many advantages and can improve many aspects of learning (59). Therefore, considering the significant importance of pharmacology

knowledge for different groups of medical personnel, the necessity of entering this style of learning into the aforementioned knowledge seems logical.

Novel demands of today's students on one hand, and the increase in the volume of learning sciences in recent years on the other hand indicate the importance of expanding CL. The product variables such as knowledge creation and higher-order thinking can be focused in research projects as well as deep understanding, in this regard (60). During pharmacology courses, the students usually need to analyze the contents (61); so that, it would be very important to consider the mentioned variables by the lecturers.

Over the years and step by step, electronic devices have played a greater role in educational systems of the world. It has been shown that, this way of education can lead to better results regarding students' learning; so that, the outcomes would improve the learners' motivation and self-direction as well as the abilities required for problem-solving (62). On the other hand, according to another study in 2020, social media has a very important place in today's education. The research found the online social media an efficient technology to help the students improve their creativity and purposefulness (63). Therefore, investing more in the research that aim to develop modern technologies in pharmacology education, which is a crucial prerequisite for therapeutics, seems very justified. In this regard, it has been suggested that, using the internet for teaching pharmacology to graduate nursing students can bring many advantages (64).

What is clear is that considering the importance of pharmacology courses in various fields of medical sciences, it is necessary to review teaching methods. Therefore, many studies have been done all over the world to update the methods. As a result of these updates, new and innovative technologies have been used, which were mentioned earlier. Each of the reviewed methods contributes to the application of pharmacology knowledge by students and this can be an effective factor in improving the health of society. Of course, the effectiveness of these methods depends on their combined and correct application. On the other hand, the correct implementation of these methods requires a skilled instructor, and this indicates the importance of holding refresher courses for professors.

Reviewing the literature showed the necessity of introducing novel techniques for teaching pharmacology to the target groups. In this regard, many efforts have been made particularly in Iran, as mentioned. Although the amount of research in this field does not meet the needs

of today's education system in universities. Therefore, designing more coherent studies to improve instructor-students' interactions and students-students' interactions during pharmacology courses seems to be necessary. The outcomes of the recent studies are credited to several aspects namely the teaching strategies, contexts of the education, contributors and students' educational level. Consequently, diversity of components affects the results of the undergraduates' attainment in an instructive context. The following proposals are suggested for future study.

a) The effect of active communications during pharmacology courses on students' performance when evaluated by final testing.
b) The effect of wiki-based cooperative learning on students' final achievement.
c) The consequence of students' metacognitive development namely tasks knowledge, person knowledge and strategic knowledge on students' final accomplishment.

As highlighted earlier, pharmacology is a difficult subject for most students. The conventional teaching relies on memorization and ignores understanding. Hence, educators should design appropriate and effective pharmacology-related learning strategies for students and using active learning mechanisms in a pharmacology course merits attention. Concerning this issue, a research finding showed that active learning requires students actively develop knowledge instead of passively receiving knowledge from the instructors (65). Accordingly, encouragement and inspiring students for further communication in class setting can enhance students' learning, and their self-efficacy (66,67). In this regard, students' direct feed-back and teachers' metalinguistic feedback plays dominant role and it helps students gain better insight concerning the gaps in their knowledge (68). Besides, the key concepts related to teaching before students' attendance in class are related to flipped instruction. All lectures would be uploaded in the form of online videos and class time will be used to engage students in active learning exercises. Likewise, the flipped instruction has been shown to be useful for pathology and pharmacology students as part of the midwifery courses in university context (69). All in all, the use of technology in teaching is an inevitable perspective in the modern education and developing interactive learning materials via digital application or blended active learning mechanism via inspiring collaborative discussion can be effective trend in teaching

pharmacology course in medical and paramedical university context.

Based on the review of related studies, computer assisted learning, cooperative learning or collaborative interactions via considering students' cognitive and metacognitive skills in comparison with traditional way of teaching pharmacology course were effective teaching methods in academic setting. It is worth noting that aforementioned teaching methods which are mostly student-centered, enhance some important aspects of students' intelligence including problem solving, critical thinking, self-confidence and self-esteem; besides, they can improve students' interest for learning in academic setting.

Reviewing the literature indicates the emphasis of the teachers and also the decision makers for medical education on these strategies for appropriate and efficient training of pharmacology course. Investigating new teaching methods and increasing the knowledge of professors seems to be the current priority of pharmacology departments. Besides, to encourage the students to elevate their cognitive abilities, employing appropriate methods of evaluation would be also very important. Although further experimental studies would be recommended to investigate standard protocols with a complete description of the teaching subject matter and assessment procedure in these regards.

Acknowledgment

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