MICROTEACHING IN PHARMACEUTICAL CHEMISTRY

Meena Chandran*[1], **K. Krishnakumar[1]**

[1] Department of Pharmaceutical Chemistry, St James College of Pharmaceutical Sciences and St James Hospital Trust Pharmaceutical Research centre (DSIR recognised), Chalakudy, Thrissur, Kerala, India-680307.

Affiliated to Kerala University of Health Sciences, Thrissur, Kerala, India.

ABSTRACT

In such a rapidly specialized and fast area of pharmaceutical chemistry, it is challenging to teach complex themes such as design, synthesis, and quality control for drugs. Teachers of chemistry, besides scoring well in a chosen area of chemistry, should be aware of sophisticated ideas that may be conveyed excitingly and appropriately to the lives of students. Preparation of the instructor with high concentration and deliberation, like in microteaching, has proven to be particularly helpful especially in those aspects mentioned. Peer and student real-time assessments ensure that the teacher is continually refining and improving teaching methods, which is why microteaching is effective in terms of feedback. Further, microteaching enables instructors to break down complex pharmaceutical topics into nondigestible mouthfuls students could digest. Although the student-and teacher-education could be comprehension-based on concepts, practical applications, or both, the beauty of microteaching is that it gives the possibility of enriching both student and teacher pharmaceutical education. The incorporation of molecular models and simulations to supplement a visual perspective along with lab data, enable the instructor to demonstrate in class how chemical theory influences drug design and assessment. This active and iterative approach to learning not only ensures better communication skills on the part of educators but what is learned directly applies to real-world pharmaceutical scenarios. Microteaching is, in the end, a useful tool for teaching pharmaceutical chemistry since it encourages active learning, improves teaching strategies, and allows students to eventually learn the thorough understanding of this complex science that underpins drug development and quality assurance.

KEY WORDS: Microteaching, Pharmaceutical Chemistry

INTRODUCTION: [1,2]

Teaching is a process intended for learning by inducing a behavioural change in the taught. It is an art of communicating a message with impact on audience. Pedagogy is an art or profession of teaching. Teaching creates knowledge, awareness and feelings in the taught and brings about behavioural change.

The art of teaching is actually something that teaches something to a student; however, learning is influenced and facilitated by that process. The quality of that teacher is reflected in the good amount of learning students have about the teacher. Basic techniques of teaching cannot be learnt during classes. The biggest challenge which the medical education programs face is training medical teachers in particular teaching techniques. The only way through which the pedagogic skill for teaching can be gathered is by making faculty training methods less expensive and more disciplined. It was fifty years ago that the then emerging technique of micro-teaching filled up a gap in techniques for scientifically validated and efficacious teacher training programs.

The paper aims to uphold the cause of using microteaching techniques proper more often and effectively with minimal possible facilities. For this purpose, a systematic literature search of research articles and reviews was made from various educational databases. In addition, reference lists of published articles, books available were reviewed.

MICROTEACHING [3,4]

Microteaching is a teaching technique used to improve teaching skills by offering a practice opportunity for brief lessons to be delivered to a few peers or students. The short lessons typically are 5-10 minutes long and focus on a particular skill or method of teaching. After the video or live delivery, the specific recommended changes are communicated to tailor the techniques of a teacher. This approach gives a focused, controlled setting in which educators have the opportunity to design and refine their strategies of teaching in a real-life low-stakes situation.

MICROTEACHING IN PHARMACEUTICAL CHEMISTRY: [5,6,7]

The much dynamic and complex area of Pharmaceutical Chemistry requires explanations of complex topics such as drug design, reaction mechanisms, and analytical techniques. Hence, a content expert with facilitation and good communicative skills, high demand is there during teaching. Microteaching is considered the best approach for pharmaceutical scientists educators because it helps in developing teaching skills. In a nutshell, focused lessons hold the promise of allowing teachers the chance to teach some of the more important ideas they are expected to communicate, receive constructive criticism, and then continue the process of honing their craft. Such kind of learning leaves the students with much clearer and more compelling experiences, where in learning an interactive, well-structured lesson closes the gap between theoretical knowledge and real-world application in drug development and quality control.

Abstract concepts can be shown in class to students using tools like the molecular model, digital simulation, and lab demonstrations. The microteaching process promotes one aspect of reflection as well as peer feedback towards continuous improvement in the teaching process. Given that pharmaceutical education needs to shift upwards to cater to increased production, a framework such as microteaching can only benefit both teachers and learners to be more than appropriately prepared for whatever will see the industry through.

Pharmaceutical chemistry microteaching can be delivered by illustrating subject-matter knowledge, teaching strategies, and relevant practical applications based on the discipline. A step-by-step process for setting up pharmaceutical chemistry microteaching sessions is as follows: [8,9,10,11,12,13,14]

1. **Selecting/ Identifying a Topic and Establishing/Defining the Objectives**

   a. **Selecting/identifying a core topic:**

   Pharmaceutical chemistry is a vast area, so the objective is to choose a topic that is crucial but achievable in the setting of microteaching. Some commonly opted topics may be:

   - Mechanism of Drug Synthesis and Reactions.
   - Analytical techniques such as chromatography (HPLC, TLC), spectroscopy (UV, NMR) and mass spectrometry.
   - Drug stability, degradation pathways and formulation science.
   - Structure-activity relationships (SAR) in drug development.
   - Physicochemical properties of molecules.
   - Drug design techniques

b. **Establishing/Defining the Objectives:**

State clearly what the students should be able to understand or demonstrate at the end of the lesson. If you are lecturing on drug synthesis, for example you can divide the material into two parts or you can formulate the objectives as:

- To investigate various Organic Reaction Mechanisms.
- To elaborate on the function of intermediates in drug synthesis.
- To illustrate how a single synthetic procedure can be used to demonstrate.

2. Designing the Micro Lesson Plan

Design a five-to-ten-minute class that concentrates on a specific subject. Given the short time, the lecture should emphasize precision, simplicity, clarity, and engagement. Make sure the pupils grasp the main ideas as well. The lesson plan's format is as follows:

a. **Introduction (1-2 minutes):**

Briefly introduce the concept and its relevance to pharmaceutical filed. For example, we will study the idea of CADD today, along with its use in contemporary drug discovery.

Present a fact or question to the class right away, such as, "Can anyone think of a drug that was discovered using computational tools?"

b. **Core Content (3-5 minutes):**

Explain the subject using both theory and real-world examples.

- When discussing theoretical subjects (like drug synthesis), use diagrams, molecular models, or multimedia presentations to explain a critical reaction and the mechanism in detail. Describe the context underlying the use of a certain reaction in the synthesis of a given medication.
- More applied subjects or practically oriented, such as analytical chemistry, describe the process and have a demo of how to interpret data. For example, take a chromatogram, explain what to look for in terms of peaks in an HPLC to determine purity of the compound.

c. **Practical Example or Demonstration (2-3 minutes):**

Provide an example or diagram-for instance, draw chemical structures, use models, demonstrate instrument data, or in a synthetic chemistry lesson, illustrate a reaction setup using lab glassware, reaction mechanisms, or simulations.

d. **Interactive Element (2-3 minutes):**

Ask a question or present a problem related to the lesson. For Example:

- What is the impact of a rise in polarity of the mobile phase on component separation in HPLC for drugs?
- "What would happen if this reaction intermediate, during the synthetic process of a drug, came into contact with moisture?"

Ask the students briefly to discuss or provide answers to the problem. The activity becomes more interactive and will allow them to retain that target learning objective.

e. **Conclusion (1 minute):**

Summarize the learning points and relate them to real-world pharmaceutical applications.

For example: "In conclusion, CADD and more specifically molecular docking remains a very potent tool in the early stages of drug discovery. This allows for a prediction of the interaction between a drug and its target during the selection of compounds to be further tested in experiments. In other words, this drastically shortens the time and cost component involved in the process of drug development."

3. Utilizing Interactive Teaching Techniques/Elements

Interaction is the core of micro-teaching. Some ways to engage students in a pharmaceutical chemistry micro-lesson:

➢ **Questioning:** Utilize Socratic questioning to stimulate their thinking. For example:

i. Ask the students to identify the functional groups present in a molecule of a drug, or predict how a drug would behave in a stability test.

ii. "What do you think is the rationale for this solvent being chosen for this reaction?"

iii. "How would you sketch an explanation for this chromatogram outcome?"

- **Explanation:** Use short, simple prose to clarify often complex chemical content; provide analogies for challenging concepts.
- **Think-Pair-Share:** After presenting a concept, have the students pair with someone and discuss the following:

i. "Discuss with a partner how this reaction mechanism will impact the final structure of the drug."

- **Use Case Studies:** Give actual pharmaceutical case studies:

i. "These are actual pharmaceutical cases like the one on the top where a drug failed quality control due to impurities. Design how you would design an HPLC method that could detect the impurities?"

- **Group Work:** Have the students do work in groups to solve chemical problems on minimal feasible terms;

i. Give them a reaction mechanism and ask what will happen.

- **Demonstrations:** Laboratory small demonstrations that may be an explanation of the steps in a laboratory procedure or of a chemical reaction. They could use simulations, molecular models, or data from the laboratory.

4. Incorporating Visual Aids and Technology

- ✓ **3D Molecular Models:** Using molecular modelling kits, illustrate drug structures or reaction pathways. Such models give students a better feel for complicated chemistry topics they might otherwise find obscure.
- ✓ **Software’s:** Chemical drawing software, such as ChemDraw or 3D visualization software, for the creation of chemical structures, mechanisms, or analytical data - chromatograms or spectrums.
- ✓ **Videos and Animations:** Display animations of chemical reactions, synthesis pathways, or laboratory procedures. It will useful for students who learns visually.
- ✓ **Lab Simulations:** Virtual labs provide the chance to use tools such as Labster to simulate laboratory experiments whereby students can thus witness complex techniques such as HPLC or mass spectrometry.
- ✓ **Real Data:** Real laboratory results, for example chromatograms or NMR spectra can be discussed with students and related to the theory.

5. **Incorporate Pharmaceutical Case Scenarios**

Use case-based teaching to connect the principles of chemical interest with their application to real pharmaceutical problems.

• **Drug formulation:** Describe and present the development of a specific formulation for a medication, with details of the chemical reactions.

• **Quality Control:** Explain how various chemical techniques, for instance HPLC and UV-Visible spectroscopy, are involved in purity or stability determination of drugs.

• **Problem-Based Learning (PBL):** Issue the students a problem to solve that is based on pharmaceutical chemistry, such as designing a synthetic pathway for a drug or figuring out which analytical method to use for a given drug.

6. **Deliver the Micro Lesson**

- Deliver the prepared lesson to a small group of students or classmates.
- Having employed appropriate body language, eye contact, and engagement strategies, focus your thoughts on conveying your message effectively.

7. **Feedback and Assessment**

❖ **Feedback:**

✓ **Peer feedback:** Get peer or mentor to evaluate your clarity, pacing and engagement after you have delivered a microteaching session.

✓ **Student Feedback:** How well do students seem to understand the material by means of an exit ticket such as a quick quiz or conversation at the end? Their responses can help to highlight where further explanation is needed or changes need to be made in future conversations.

✓ **Self-reflection:** After receiving feedback, reflect on how the lecture went. Consider this:

- Did the students engage with the material?
- Was the information too technical or too simple?
- How useful were interactive features and the visual aid?

• Revise the lesson for repeating it in the future to add more strength into weakest which has been concluded on reflection and feedback.

❖ **Assessment:**

By the end of class time a brief assessment of how well students have grasped the topic. This may include:

a. A Quick multiple-choice review of key take-home messages for instance, "What is the primary purpose of the stationary phase in HPLC?".
b. Questions asked to students to explain a concept in their own words or to apply it to a real-world problem, such as: "Design a stability test for a new drug formulation.".
c. The results of evaluation can further be utilized to tailor your teaching strategy in such a way that sub-sequent sessions are even more potent.

8. Iterative Teaching and Improvement

• Microteaching motivates continuous improvement of teaching skills. Present the lesson repeatedly, with every presentation using the suggestions made by others as an improvement to make the material clearer, well-paced, and well delivered.

This iterative process allows educators the ability to work toward perfecting their ability to explain concepts sometimes complex in origin from the field of pharmaceutical chemistry in a simple, interesting, and effective manner.

BENEFITS OF MICROTEACHING IN PHARMACEUTICAL CHEMISTRY:

1) **Mastery of Content:** Teachers can improve their understanding and articulation of simple chemical concepts by concentrating on one subject using microteaching.
2) **Practical Relevance:** Micro-teaching affords pharmaceutical chemistry teachers a medium whereby theoretical knowledge can be easily related to practical applications of the knowledge within the laboratory, hence students' in-depth appreciation of the subject in its relevance to practical applications.
3) **Skills Development:** The methodology improves the ability for explaining, demonstrating, and presenting-with such abilities, while teaching cumbersome subjects like pharmaceutical chemistry, constant expression through these activities is considered necessary.

4) **Targeted Feedback:** It lets the instructors receive targeted feedback about how they are presenting the material and how the students are responding to it; therefore, it ensures continuous improvement.
5) **Better Student Outcomes:** Shorter, clearer, and more engaging lessons enable the students to understand apparently intricate topics like the design and analysis of drugs.

EXAMPLE FOR MICROTEACHING IN MEDICINAL CHEMISTRY [15]

Microteaching Topic: Introduction to SAR in Drug Design

Time: 10 minutes

Targeted audience: Undergraduates or Postgraduate students in the field of Pharmaceutical Chemistry or Medicinal Chemistry.

Objective: By the end of the session, students will be able to understand the concept of SAR and how it helps in optimization of drug molecules for therapeutic purposes by the end of this microteaching session.

LESSON PLAN

1. Introduction (1 minutes)

Objective: This topic introduces the concept of Structure-Activity Relationship (SAR), which relates to medicinal chemistry.

Script: "Today we will talk about one of the most important things in medicinal chemistry: Structure-Activity Relationship or SAR. SAR helps us know which changes in a drug's chemical structure led to changes in biological activity. It is important as we modify molecules to increase potency, selectivity, and reduce side effects."

Engagement Question: "Can anybody think of any reason why altering the shape of a molecule would make it more potent as a drug?

2. Core Content: SAR Explanation (4 minutes)

Objective: Explain how SAR is used to optimize drug molecules.

Script: In medicinal chemistry, the definition of SAR is defined as a relationship between the drug's chemical structure and its observed biological activity. Small, systematic variations in the structure-including changes within the functional groups, rings, and substituents-create variable degrees of alterations in the ability of the drug to bind to its target receptor.

For example, take a more well-known drug like morphine, and give examples of its analogues, illustrating how structural change - such as the addition or subtraction of hydroxyl groups - alters its binding to opioid receptors and so the potency and the side effects.

Visual Aid: Draw diagrams or use molecular models to show structural differences in a drug, such as indomethacin that influence its interaction with COX enzymes and the disruption of COX activity and pain relief.

3. Illustration of SAR in Drug Development Optimization (2 min)

Objective: To illustrate how SAR has been utilized to develop an improved variant of a given drug.

Script: "Let's look at the history of beta-blockers. The most important beta-blockers like propranolol were actually active but nonselective, and thus they also interfered with other receptors in the lungs and led to many side effects through bronchoconstriction. SAR studies led medicinal chemists to modify the structure to develop more selective drugs like atenolol, that have a greater action on the heart with lesser side effects."

Visual Aid Example: Compare the molecular structures of propranolol and atenolol, pointing to the most important structural features that give you a clue about their improved selectivity.

4. Interactive Component: Problem Solving (2 minutes)

Objective: SAR and drug design; challenge students to think.

Question: Suppose you were designing an anti-inflammatory drug, in which you wanted to inhibit an enzyme involved in an inflammatory response. What structural features would you alter to make the drug more potent or selective for the enzyme?

Expected Student Answers: Hydrophobic groups can be modified to increase binding to the hydrophobic pocket of the enzyme, polar groups can be added to enhance solubility, and so on.

5. Conclusion and Summary (1 minute)

Summary: "In brief, SAR is indeed the very fundamental concept developed in medicinal chemistry that leads to understanding of how slight changes in the structure of the drugs result in significant consequences on the activity of the drug. Systematic modification of a molecule improves its therapeutic effects while keeping the side effects to the minimum."

Final Question: "What might be some challenges for medicinal chemists to overcome in using SAR as a tool for de novo generation of new medicines?

CONCLUSION:

Microteaching in pharmaceutical chemistry is very transformative since it interlocks how teaching and learning can take place. Complex scientific concepts are broken together into focused, digestible segments that improve the clarity of difficult topics such as drug synthesis, mechanism of action, and structure-activity relationships. This method offers a dynamic and interactive forum where active participation and critical thinking are encouraged towards developing a more profound understanding of theoretical principles through real-life applications.

Educators find microteaching increases pedagogical skills to enable the practitioner to adapt content delivery to real needs of students by offering constructive feedback in real time for improvement. To the students, this method provides a stimulating learning environment that eradicates the wide chasm between abstract pharmaceutical chemistry theories and their practical applications in drug development and health care services.

In this highly dynamic area of work like pharmaceutical chemistry, where the factors of accuracy, innovation, and application take over, microteaching equips a student with skills to learn the basics and yet also to perform well in practice in applying them on further research and professional practices. In sum, therefore, microteaching fosters a collaborative yet impactful educational experience that boosts the building blocks of future pharmaceutical scientists and professionals.

REFERENCE:

1. Foley RP. Microteaching for teacher training. Public Health Pap. 1974; 61:80–8.
2. Elliot J. A microteaching experiment at MEDUNSA. S Afr Med J. 1982; 62:868–70.
3. Allen Dwight William. Micro-teaching: A Description. Stanford University, School of Education. 1967: 1-128.
4. Allen, D. W. & Ryan, K. Microteaching. Addison-Wesley Publishing Company.1969: 1-151.
5. Kumar S. Microteaching: An efficient technique for learning effective teaching. Journal of Research & Method in Education, 2016; 6(1), 53-56.
6. Dandekar V. S & Raut D. M. Importance of micro-teaching for pharmacy teachers. Indian Journal of Pharmaceutical Education and Research, 2017; 51(3), 360-362.
7. Singh T & de Grave W. Microteaching revisited: A reflective approach. Medical Teacher, 2021; 43(3), 231-235.

8. Patil D. S & Mahajan N. S. Microteaching: A modern approach for effective teaching. Journal of Education and Health Promotion, 2020; 9: 297.
9. Samarasekera D. D & Gwee M. C. E. Essential steps in microteaching for clinical teaching and health sciences education. Journal of Medical Education and Curricular Development, 2020: 7.
10. Remesh A. Microteaching, an efficient technique for learning effective teaching. Journal of Research in Medical Sciences, 2013; 18(2), 158-163.
11. Patrick G. L. An Introduction to Medicinal Chemistry (6th Edition). Oxford University Press. 2017: 195-232.
12. Alan Betjeman, George Brown, Madeleine Atkins. Effective Teaching in Higher Education. British Journal of Educational Studies 1989; 37(1):86.
13. Shivakumar M & Nadarajan T. R. Active learning strategies for effective teaching in health sciences. International Journal of Academic Medicine, 2019; 5(1), 32-38.
14. Dabbagh N & Kitsantas A. Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. The Internet and Higher Education, 2012; 15(1), 3-8.
15. Silverman R. B & Holladay M. W. (2014). The Organic Chemistry of Drug Design and Drug Action (3rd Edition). Academic Press. 19-122.