

MEDICAL EDUCATION

Problem based learning (PBL) in Organic Chemistry

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ABSTRACT:

Background: PBL appears to answer many concerns regarding educational methods, encourages students to look for new solutions to relevant problems using available knowledge and resources. The process expands students' critical thinking and problem solving skills while enhancing their creative capabilities

Objective: To develop a PBL modules for teaching of organic chemistry.

Methods: This module was developed for implementation in the curriculum of Chemistry Departments in Colleges of Sciences and Education. This is an innovations to be developed for increasing the wide-ranging abilities of students. A series of strategies which are involved in PBL, concept mapping and online communications, are suggested and discussed in terms of encouraging student-centered learning.

Key words: PBL, Chemistry, Learning, Education.

Course description and goals

Organic chemistry is a compulsory course for all students in Tikrit University [TU] in the curriculums of Colleges of Science [TUCOS], Education [TUCOE], Pharmacy [TUCOP]; Dentistry [TUCOD], Medicine [TUCOM], Engineering [TUCOENG], Veterinary Medicine [TUCOVM] and Agriculture [TUCOA]. There are 18 syllabuses for organic chemistry in TU.

1. For students studying clinical medicine at TUCOM (6 years undergraduate) students.
2. Pharmacy at TUCOP (5 years undergraduate) students.
3. Chemistry Department at TUCOS (4 years undergraduate) students.
4. Biology Department at TUCOS (4 years undergraduate) students.
5. Chemistry Department at TUCOE and TUCOE (4 years undergraduate) students studying basic chemistry at college of Education.
6. Biology Departments at TUCOS, TUCOE and TUCOE (4 years undergraduate) students.
7. TUCOD (5 years undergraduate) students.
8. TUCOVM (5 years undergraduate) students.
9. TUCOA (4 years undergraduate) students.
10. TUCOENG (4 years undergraduate) students.

11. M Sc in Chemistry programs → Biochemistry [TUCOM, TUCOE, TUCOS] ; Analytical; Inorganic, Physical and Organic Chemistry [TUCOE, TUCOE, TUCOS].
12. Ph D in Chemistry programs → Biochemistry [TUCOM, TUCOE] ; Analytical Chemistry [TUCOE] and Organic Chemistry [TUCOE]
13. M Sc Biology → TUCOE, TUCOE.
14. M Sc in Agricultural Sciences... TUCOA.

In general the syllabus includes topics on alkanes, alkenes, alkynes, stereochemistry, aromatic compounds, alkyl halides, alcohols, phenols, ethers, aldehydes and ketones, carboxylic acids and their derivatives, amines, heterocyclic compounds, carbohydrates, lipids, amino acids and proteins, and nucleic acids. Student assessment is by a mid-term and a final written examination.

Objectives: To

1. Introduce the characteristics and principles of organic compounds, to provide the foundations for subsequent courses such as pharmacology, biochemistry; to provide students with strategies to solve real world organic problems, especially those relevant to life sciences, by using their acquired knowledge.
2. Enhance comprehensive abilities of analyzing, understanding and solving problems, developing in students an appreciation of the scientific method.
3. Equip students well for the skills of lifelong learning.

Modifications of teaching and learning.

Step .I.

In the 1989 Tikrit University was established with Colleges of Medicine [TUCOM], Engineering [TUCOENG] and the College of Education for Women [TUCOE]. Then the University expanded to include a new colleges. At the present there are 14 colleges, of them 9 colleges dealing with teaching of organic chemistry in their courses of undergraduate and postgraduate studies. The Ministry of Higher Education and Scientific Research [MHESR] introduced reforms committees for all disciplines [Medical (Medicine, Dentistry, Pharmacy, Nursing specialty); Engineering; Pure Science, Humanities, Agriculture and Veterinary Medicine]. These committees develop curricula for their disciplines and perform annual reforms to improve and implement new innovative educational approaches. The MHESR completed its reorientation for higher education and established its reform guidelines. As one of the nation's leading institutions of medical education is TUCOM that adopted PBL , Competency based, Student centered, Community oriented , Community based curriculum.

As a common course supplied for all the university students, Organic Chemistry is considered important and thus need to be undergoing reform for at present time.

Some innovations are discussed below.

Lectures:

New textbooks are used including some English references, more realistic and meaningful tasks related to the students' future careers are provided. Modern multimedia techniques such as *Photo Shop*, *Flash* and movies, which can explain the chemical reaction mechanisms easier than traditional teaching styles, are incorporated into lectures; *PowerPoint* files replace writing on the board, making

the course more interesting and active; a web site of online learning releases the students and professors from the constraints of space and time by offering new learning contexts. Meanwhile, the students are encouraged to join more activities, for

example, attending academic lectures being delivered by famous scientists. There are numerous famous scientists visiting Tikrit University each year, and their excellent

speeches are inspiring to the students. The more the students learn, the more they clearly understand what they know and don't know, the more they study. Other activities include short presentations by students, and role plays which illustrate chemical reaction mechanisms. A proverb says that 'interest is the best teacher', all these measures greatly increase the interest of students and make teaching more effective.

Tutorials :

Tutorials are divided into three parts.

1. The first is one-to-one tutorials scheduled one per week for all students. The students go to teachers' rooms and discuss problems with their teachers.
2. The second is two formal tutorials in one semester, the teacher will have a general review of all chapters and give the students some exercises.
3. The third tutorial is for international students only, and is aimed to help them overcome the obstacles of language and grasp the organic knowledge.

Laboratory:

New laboratory books and videos are used, and students learn more from the videos. A range of more interesting experiments are recommended, such as some drug synthesis, and the extractions of vitamins. All these experiments are related to real life and are entertaining for students. Although all these strategies have significantly improved the teaching and learning, we are still exploring new teaching methodologies in order to increase the comprehensive abilities of students.

Modifications of teaching and learning: Step. II.

According to the modern educational theories, there are three main teaching strategies, i.e., behaviorist, develop mentalist and constructivist, which derive many approaches such as schema, concept mapping, case studies and problem based learning (PBL). Combining these multiple teaching strategies and using them correctly will greatly improve teaching and learning. Based on those theories, and considering the reality of Tikrit University, some new ideas are considered. The most important of these is the development of problem based learning skills.

PBL is a curriculum approach which helps the learner frame experience through a series of problem solving activities and where the process of learning unfolds through the application of knowledge and skills to the solution of real world problems, often in the contexts of real practice [1]. PBL uses problems to motivate students to acquire knowledge rather than relying on the exposition of discipline knowledge [2]. PBL has been regarded as one of the most exciting and powerful education methods to have appeared in the last 40 years. Jonassen [3] argues that 'the most effective learning contexts are those which are problem or case based and activity oriented, that immerse the learner in the situation requiring him or her to acquire skills or knowledge in order to solve the problem or manipulate the solution'. A key feature of PBL is that students take greater responsibility for regulating their learning. Students' self-regulation involves planning, monitoring and evaluating learning, regulating effort, managing time and

seeking help from peers and staff [4,5]. For teachers, PBL should be designed related to: real world practice, inter-disciplinary Based knowledge, experiential knowledge/skills, skill development, values and professional behaviors. Furthermore, a PBL problem should provide context, time, place and, if possible, put the student in the role of the practitioner. The more interesting, challenging and unusual the problem, the more it will grab the attention of the students [6]. Based on the aforesaid theories, the following PBL question has been designed.

Suppose you are working in laboratory and a pediatrician refer to you a child. The child is a mentally retarded boy, unable to walk or speak, eat or drink on his own. In addition he is unable to control urination and defecation. His breath is with “mousy” odor. He has a lighter complexion than his siblings, with blond hair and blue eyes. Laboratory examinations indicated a persistent high plasma phenylalanine concentrations. Urine examination indicates a high level of phenylpyruvic acid. Further investigations prove that he is a phenylketonurea patient.

Questions :

1. What causes PKU?
2. What are the normal metabolic pathways of phenylalanine? What kind of metabolism would occur if phenylalanine accumulates in body? What kind of metabolic products' deficiency causes the above syndrome?
3. Would you be able to simulate the *in vitro* synthesis of those compounds by using chemical methods?
4. Is PKU an inherited disease? How can PKU-related conditions be reduced or prevented? How should PKU be treated?
5. PKU was first described in 1934 by a Norwegian doctor named Asbjorn Folling. He identified phenylpyruvic acid by basic chemical analysis. If you were him, what kind of tests would you use? What tests may be used to determine PKU today?
6. What kind of isomers exist *in vivo*? If you eat a racemic mixture of isomers, what will be found in your urine?

Student learning objectives are:

1. To learn the chemistry of aldehydes and ketones, carboxylic acids and their derivatives, amino acids, proteins, and nucleic acids, their function in human bodies;
2. Through the simulated synthesis of tyrosine, phenylpyruvic acid, 3,4-dihydroxyphenyl alanine (DOPA), melanin, phenyllactic acid, to recognise the multiplicative reactions among amines, carboxylic acids, alcohols, amino acids and so on;
3. Through the laboratory examination of PKU, to learn about some laboratory techniques such as chromatography, isotope techniques, etc., and to be able to identify aldehydes and ketones;
4. To review the knowledge of stereochemistry: chiral compounds;

5. To understand some gene therapy and genetic knowledge; and 6. other abilities such as the utilities of Internet sources, text books, magazines and journals. writing skills, team work.

Background :

PKU is a genetic metabolic disorder in which the body lacks a liver enzyme (phenylalanine hydroxylase) needed to process phenylalanine, an essential amino acid, into another amino acid (tyrosine) used by the body [7]. Left unconverted, excessive amounts of phenylalanine in the bloodstream are toxic to brain tissue and the central nervous system; if untreated in newborns, PKU can cause brain damage and mental retardation. Because phenylalanine is involved indirectly in the production of melanin, the pigment responsible for skin and hair color, children with phenylketonuria often have lighter complexions than their unaffected siblings. There is a characteristic 'mousy' odor that results from the accumulation of phenylacetic acid.

This odor may be detected on the breath, skin, and urine if the condition has not been treated immediately from birth or if foods containing phenylalanine are consumed. Related knowledge is shown in Figure 1. Students work in groups and search related documents in order to find possible answers. They are scheduled to attend 4.5 weeks of lectures directly related to the current problem. Finally each group would be required to give a formal paper. The teacher facilitates the students in analyzing the situation, identifying areas of learning and potential learning resources .

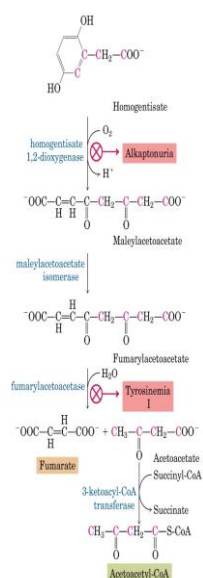


Figure (1): Chemical imbalances that produce the symptoms of PKU [6]

Conclusion:

In contemporary society, students face a world in which much of the work they will do has not as yet been imagined. Colleges need to deliver not simply specific skills and specific knowledge but also the attitudes, aptitudes and problem solving skills for lifelong learning. Undoubtedly, problem based learning is an excellent strategy, however, for successful teaching an over- dependence on one way of teaching and learning should be avoided. Combining multiple teaching styles and training students' wide-ranging abilities will gain the largest rewards.

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