

# Didactic experiences aimed at strengthening of Organic Chemistry in the training of radiochemists

Anel Hernández-Garces<sup>a1</sup>, Elizabeth Avilés Rodríguez<sup>2</sup>, Maritza Lau González<sup>2</sup>, Ulises Jáuregui Haza<sup>2,3</sup>, Irene Grueiro Cruz<sup>2</sup>, and Fernando Guzmán Martínez<sup>2</sup>

<sup>1</sup>Universidad Tecnológica de La Habana José Antonio Echeverría (CUJAE), Facultad de Ingeniería Química, Cuba

<sup>2</sup>Universidad de La Habana, Instituto Superior de Tecnologías y Ciencias Aplicadas, Cuba

<sup>3</sup>Instituto Tecnológico de Santo Domingo (INTEC), República Dominicana

*Concise review on some educational experiences in a process of strengthening the teaching of Organic Chemistry in the training of the radiochemists at InSTEC<sup>b</sup>*

The Radiochemistry specialty at the Higher Institute of Applied Technologies and Sciences (InSTEC) is structured in 63 subjects organized in 14 disciplines. One of them, the Organic Chemistry discipline, has two subjects: Organic Chemistry I and II. The analytical programs of both are extensive and include countless families of compounds, types of reactions, and mechanisms by which they occur. For this reason, these subjects are considered one of the most complex in the Radiochemistry career curriculum and therefore requiring a comprehensive interdisciplinary educational approach. No previous interdisciplinary experiences were applied at InSTEC, including other similar specialities. Here we cover some educational experiences carried out in order to strengthen the teaching and learning of the Organic Chemistry in the training of radiochemists. The educational experiences were developed for students of the 3rd year of the Radiochemistry Specialty in the InSTEC during five consecutive courses between 2010 and 2014.

## Linking Organic Chemistry and Defense

The need for linking the content of the discipline Organic Chemistry with the Preparation for the Defense, came from the general Radiochemistry syllabus that includes a brief characterization of the specialty and contains, among others, the curriculum, the general objectives and the value system, to be developed in order to ensure the Radiochemist Professional Identity [1]. In this one, the objectives for the third year declare that the design of experiments has to take into account, among other factors, the defense of the country. Two seminars were proposed in which students could identify, relate, describe, characterise, argue, and explain the organic substances of interest to the Defense. The seminars were developed with the InSTEC Department of Defense and the Executive Authority National Center for the Non-Proliferation of Chemical Weapons [2]. Students reviewed the books individually and selected the substances without the participation of the professors. A high level of independence was observed in all students regarding the organisation of visits, search

and review of information, and the results achieved in the class presentation. This experience also led to the strengthening of ties between teachers and specialists of the parts involved.

## Introducing Concept Maps

The lack of a global vision is often the main problem in undergraduate students and therefore it is difficult for them to integrate multiple and diverse relationships between carbon compounds. On the other hand, concept maps providing a visual method to help students organize their thoughts, are also useful tools in science, and help making connections between subjects. They are also tools by which various concepts and their relationships can be easily represented. As a teaching strategy to improve the understanding of concepts in Organic Chemistry contents (I and II) by the students, seminar were proposed. Throughout the seminars, students could identify and relate organic compounds, types of reactions, and mechanisms using concept maps. Moreover, the students could identify the concepts and categories establishing the relationships between Organic Chemistry I and II [3]. Some learning difficulties were observed while the students were working with the concept maps, such as the confusion among members of different chemical families, the wrong choice of different reaction mechanisms, and improper hierarchy. Overall, the seminars were successful. Despite the mistakes, the students could establish relations of the two subjects globally and included all the compound families in the maps.

## Linking Organic Chemistry and History

Radiochemist Professional Identity recommends actions to promote student participation in history forums [1], including curricular strategies. It was proposed to hold a seminar where the students had to present an individual work, with a free topic. Students could choose either subjects related to historic events in Organic Chemistry or biographies of researchers related to the relevant knowledge studied [4]. Consequently, students presented the chosen topics each

year. A high level of student independence was observed in the search and review of information, as well as a satisfactory presentation of their works. Most of the students chose biographical themes, and all consulted only digital encyclopedias on the internet. As a result, all of the works presented had a positivist and internal character.

### Computer skills in organic chemistry

The need to link the content of the Organic Chemistry discipline with those of Informatics and Computing, in the Radiochemistry specialty, arises from the Professional Identity [1]. Therefore, computer science became an inherent part of professional training. Extra class exercises were arranged. A list with the name of organic compounds was given to the students. Each student had to choose only one compound from the list. The content of the report was made with the following issues: the image with the structure of the compound using the CHEMWINDOW software, a second image with the optimized construction including the compound's properties obtained using the HYPERCHEM program; and the image of the 3D structure and the table with the partial charges calculated using SPARTAN program [5]. As a result, the students presented the reports accurately and clearly, having understood the different types of structures and how to use softwares and programs.

### Teaching strategy in pedagogical training students

The pedagogical training students (PTE) are those with high teaching achievement who are distinguished by showing faster assimilation of knowledge and good aptitudes for learning. They are undergraduate students who excel in the domain of specific academic disciplines and participate in the development of teaching activities in the lower years of the specialty, under a tutor's guidance. This PTE carries out complementary tasks to their study plan to receive additional training, such as preparing laboratory practice jobs, giving solution of exercises previous to the practical classes, and the compilation of information for a seminar, among others. In that sense, at InSTEC there is a strong experience with pedagogical training students. To contribute to it, an educational strategy was applied in order to raise the educational preparation necessary in the PTE for teaching through lectures. It was proposed conferences prepared and given by the PTE while taking the course. To develop the activity, some topics were distributed to those who prepared the conference independently, including presenting their work in class for evaluation [6]. The presentations were straightforward; explanations showed some logical reasoning, and PTE employed illustrative conversation and showed experiments in the classroom. In all cases, the PTE achieved the highest rating in the lectures.

### Conclusions

Satisfactory results were achieved during the five years experiences aiming at strengthening the teaching of Organic Chemistry for radiochemists. The students chose the appropriate substances for their presentations and demonstrated an understanding of the difference between a chemical weapon and its precursors. It was possible to motivate the students to give importance to the Defense Preparation discipline subjects, showing them the link it has with the subjects of the curriculum of the specialty. In the second activity, despite the mistakes, the students could establish relations of the subjects globally and included in the concept maps all the interrelated compounds' families. So, global vision was improved. In the next one, it was possible to link the teaching of the Organic Chemistry discipline with history. In all cases, the students were right to locate their event in the historical periods of chemistry development. The students presented the requested structures and properties accurately in the report and clearly showed that they had understood the different types of structures and softwares in the activity related to Informatics and Computing. Finally, PTE students taught their classes satisfactorily, and the knowledge imparted was appropriately assimilated as a contribution to their educational preparation. Overall the interdisciplinary links were achieved between Organic Chemistry and other disciplines of Radiochemistry specialty.

### Notes

- a. Email: anel@quimica.cujae.edu.cu
- b. Original version of this article is Ref. [6]

### References

- [1] INSTEC (2006). Modelo Profesional de la Carrera Radioquímica. <https://www.instec.cu/FCTN/index.php/es/radioquimica/licenciatura>
- [2] Hernández-Garcés, A., Avilés-Rodríguez, E., Jáuregui-Haza, U., Guzmán-Martínez, F. *Pedagogía Universitaria*, 20:4(2015) 99-105.
- [3] Hernández-Garcés, A., Lau-González, M., Grueiro-Cruz, I., Avilés-Rodríguez, E., Jáuregui-Haza, U., Guzmán-Martínez, F., *Revista Cubana de Química*, 28:2(2016) 572-578.
- [4] Hernández-Garcés, A., Avilés-Rodríguez, E., *Ciencias Pedagógicas*, 1(2017) 92-99
- [5] Hernández-Garcés, A., Avilés-Rodríguez, E., *Mérida*, 17:2(2019) 254-263.
- [6] Hernández-Garcés, A., Avilés-Rodríguez, E., Jáuregui-Haza, U., Lau-González, M., *Maestro y Sociedad*, 17:1(2020) 79-86.