Agrisost | Vol. 25, No. 2, May-August 2019: 1-6

ISSN-e: 1025-0247

The Teaching-Learning Process of Organic Chemistry in Agronomy Studies from an Interdisciplinary Perspective

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Citation: García González, M., Varela de Moya, H., Rodríguez Saldaña, M., & Pérez Torres, E. (2019). The Teaching-Learning Process of Organic Chemistry in Agronomy Studies from an Interdisciplinary Perspective. *Agrisost*, *25*(2), 1-6. Recuperado a partir de https://revistas.reduc.edu.cu/index.php/agrisost/article/view/e3047

Received: April 29, 2019 Accepted: July 9, 2019 Published: July 10, 2019

Funding source: undeclared.

Conflicts of interest: no conflict of interest has been declared

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Abstract

Context: The education of an agronomy engineer largely depends on Organic Chemistry, since it offers essential knowledge to develop modern and sustainable agriculture. Therefore, this subject should be linked to the professional training and practice of agronomy engineers.
Objective: The aim of this paper was to set up an interdisciplinary-professional algorithm for teaching and learning Organic Chemistry in the first year of Agronomy studies.
Methods: A transversal descriptive study was performed in the period comprising February-March 2018, at the Faculty of Agricultural Sciences. The empirical methods used were document review, survey to teachers of the subject, as well as discussion group.
Results: The main results show that the didactical system of the curriculum of subjects Organic Phemistry and Plant Health lack a suitable interdisciplinary approach; teachers refer to extra-class activities as the space for interdisciplinary work, which can be integrative, interdisciplinary, and professional.
Conclusions: The teachers deemed it adequate to use the interdisciplinary-professional algorithm to prepare extra-class activities; hence students could link the contents of Organic Chemistry to topics of Plant Health, thus contributing with a more professional approach to Organic Chemistry within Agronomy studies.

Palabras clave: interdisciplinary-professional algorithm, agronomy, organic chemistry.

Introduction

Agronomy is the oldest agricultural university course, which was officially approved on June 30, 1900. It conceived a professional with knowledge of rural engineering, and capable of running the then newly-established food processing industry.

Engineering in agronomy was one of the first university studies implemented in the University of Camagüey, on November 6, 1967. Then, the School of Agronomy was created, whose role was to train higher level specialists, who were able to plan, organize, and run the agricultural programs of the province. Initially, Martha Abreu Central University was in charge of the methodological advisory

(Fernández, de Laosa, Díaz, Medrano & Fernández, 2010).

The education of an Agronomy engineer largely depends on Organic Chemistry, since it offers essential knowledge to develop modern and sustainable agriculture, and meet the food demands of humans and the animals used in human nutrition.

Hence, it is not possible to achieve this goal with professionals lacking mastery of chemistry, or without searching for new techniques that help increase productions with less resources (natural or man-made), as well as effective use of all available spaces.

The skill acquisition process of engineers in agronomy requires several other subjects to provide the tools for developing vocational skills in the students, which will motivate them, creating the need of improved services based on the social needs and interests (Escobar & Pérez, 2015).

In syllabus E of Agronomy Studies, the discipline Chemistry comprises subjects General and Analytical Chemistry, Organic Chemistry, and Biochemistry, which provide the skills necessary to take further disciplines that are the backbone of the course.

The discipline chemistry provides knowledge of plant physiology, the soil, plant nutrition, animal nutrition, pesticide use, and rational control of water use, through different irrigation methods that may be utilized under certain conditions, evaluation and protection of the environment (Ministerio de Educación Superior, 2017).

The object of study of this discipline moves within the chemical structure and properties of elements and compounds associated to agricultural ecosystems, and the metabolic processes where essential biomolecules intervene in plant and animal development. Also included are the bases and applications of most commonly used analytical methods of chemical-physical characterization of ecosystems, and the evaluation of the nutritional state of species (Ministerio de Educación Superior, 2017).

Organic Chemistry is a basic subject in the education of Agronomy professionals, which is needed to interpret the chemical bases of biological processes of agricultural interest. The subject must demonstrate its contribution to comprehensive professional training since the early years, according to their behaviors, since the subject is linked the profession (Ministerio de Educación Superior, 2017).

The assumptions above justify the need to optimize the professionalization process of the contents of Organic Chemistry, based on an interdisciplinary approach, in the Agronomy studies, thus preparing students for their professional careers.

Professionalization of contents and interdisciplinary activities have been studied by several scholars in different educational systems (García & Colunga, 2004; Perera, 2004; León, 2007; Mena, 2010; Milián, 2012; González, García, García, Travieso & Puldón, 2015; Santos, Alfonso, Quintanilla, Chaviano, García & Valdés, 2017; Núñez & Escobar, 2017; García, 2017), who also treated these issues in Agronomical studies. These authors coincided in the need to train future agronomists, using a professionalized approach of all the courses delivered in the disciplines, which would contribute to reduce difficulties still present in the skill-acquisition process.

Some of the difficulties that persist throughout the training process of agronomists, corroborated by the scholars cited, reveal the following:

A predominance of instructional activities in all the subjects within each discipline.

The contents dealt with in each lesson fail to link to the profession.

The students' literature is common to all the degrees in Agricultural Sciences instead of being more customized.

The lack of student motivation toward the degree since prior to college education.

Insufficient student knowledge of Chemistry taught in high school, and the study methods used.

One of the ways Organic Chemistry has for content professionalization is the extra-class activities recommended in the curriculum, which calls for creating links to the professional practice of the engineer in agronomy, and to highlight the importance of its knowledge from an environmental point of view.

Besides from being delivered in the second term of the first year, it can contribute to the vocational education of students that chose to become agronomists.

Therefore, the aim of this paper was to set up an interdisciplinary-professional algorithm for teaching and learning Organic Chemistry in the first year of Agronomy studies, in the University of Camagüey.

Materials and Methods

A transversal descriptive study was performed in the period comprising February-March 2018, at the

Faculty of Agricultural Sciences, Ignacio Agramonte Loynaz University of Camagüey.

Theoretical, empirical, and mathematical methods were used. The theoretical and empirical methods by different researchers helped determine the practical and epistemological background during the research.

The empirical methods used were,

Document analysis, to review the syllabus and standard documents of the studies in Agronomy, in order to learn about the professional model and the curricular strategies, along with the programs of discipline Chemistry, and the Plant Health program delivered in the third year, as a way to identify the nodes of interdisciplinary articulation, and the elements of knowledge needed for extra-class activities in Organic Chemistry. Also important was the establishment of the interdisciplinary-professional algorithm.

A survey (questionnaire) was applied to the six teachers at the Department of Chemistry, University of Camagüey, who have been part of the staff of Agronomy studies for the last five years, to know about the actions or procedures for designing interdisciplinary professional teaching activities, and to investigate on the importance these teachers grant to the link between their subjects and student professional performance.

The technique known as discussion group (Domínguez, Vicente & Cohen, 2012), including ten teachers of Chemistry who work for the Agronomy studies, both in Camagüey and other municipal university facilities, was laid out to assess the proposal of the interdisciplinary-professional algorithm through which the extra-class activities are designed. The following aspects were evaluated:

1. Correspondence between the algorithm and the design of the extra-class activities based on the contents of the programs of Organic Chemistry and Plant Health.

2. Correspondence between the algorithm and delivery of the contents recommended in the extra-class activities, as to curricular strategies environmental education, technical and scientific information, and computer science, as well as subjects Agricultural Practice I and II, from the main integrating discipline.

3. Contribution to the extra-class activities to the professional model of the engineer in agronomy.

4. Logic of the contents. Relation between the contents proposed in the extra-class activities and the advancement of science and technology.

5. The need and usefulness of the extra-class activities for the future professional in agronomy.

6. Orientation to settle the consulted bibliography.

Results and discussion

Document review corroborated that the didactical system of programs Organic Chemistry and Plant Health lack a proper interdisciplinary approach. Therefore, to encourage interdisciplinary relationships, the interdisciplinary articulating nodes were identified, which are those included in a topic of a discipline or subject (knowledge, skills, and associated values). They set the foundation of an interdisciplinary articulation process of any university study, in order to produce more thoroughly graduate training (Fernández de Alaiza, 2000).

Moreover, the elements of knowledge defined as the portion of information with a logical sense to be learned by students, characterized by a presentation in the form of knowledge, concept, law, fact, process, principle, and skill, whose extent depends on the personological components of the teaching-learning process (Caballero, 2001; García, 2017).

After identifying the interdisciplinary nodes and the elements of knowledge, an analysis of contents was made to establish the ties among knowledge systems, skills, and values between the two subjects.

Likewise, document review facilitated the design of the interdisciplinary-professional algorithm, which was based on:

1. Review of curricular and normative documents of the course.

Analysis of the syllabus, professional model, and curricular strategies.

2. Study of programs to build interdisciplinary relationships, with emphasis on the particular contents of each science in the programs.

Plant Health topics relied on the basis of acquiring knowledge of Organic Chemistry for broader understanding. The topic chosen was pesticides.

3. Implementation of methodological work of the interdisciplinary team to carry out the proposal.

The extra-class activity is designed according to the algorithm, which directs the execution of the interdisciplinary relationship between Organic Chemistry and Plant Health.

The extra-class activity will encourage students to apply methods of scientific work. The contents of each topic are linked to the cognitive and professional interests of the students. The solution to future professional problems requires integration, generalization, and transference of knowledge.

The bibliography to be used will be managed by the students, using IT and the basic and complementary literature of Organic Chemistry and Plant Health.

4. Development and devaluation of the professional-interdisciplinary proposal.

The students will have enough time to develop the proposal, since the Organic Chemistry teacher must have already dealt with chapters on general Organic Chemistry, hydrocarbons (aliphatic and aromatic), and oxygenated compounds (alcohols, phenols, aldehydes and ketones, carboxylic acids, and functional derivatives of acids). The evaluation will be completed with the delivery of a written report and oral presentation.

All the teachers surveyed (6) coincided that the actions implemented to create interdisciplinary-professional proposals are the review of programs to check interdisciplinary relationships, identification of interdisciplinary articulation nodes and elements of knowledge.

However, the teachers did not mention the review of normative documents of the university course. The most commonly mentioned instances of design proposals were the homework assignment, as an integrative, interdisciplinary, and professional part.

In relation to the importance of linking subject contents to the profession, the aspects below were mentioned.

> The scientific conception of the world is consolidated because the academic disciplines are interrelated.
>
> It promotes the search of knowledge by the profession-driven students.
>
> It is a way to encourage interdisciplinary relationships among subjects of a discipline or among disciplines.
>
> Common links are set up among disciplines in order to achieve common goals and more professional contents.
>
> Significant learning is accomplished.

The teachers engaged in the discussion group viewed the aspects suggested as adequate, both the steps of the algorithm and its application to design the extra-class activities. As a matter of fact, the teachers highlighted its repercussion in the teaching-learning process of Organic Chemistry, as the contents of the subject are linked to the topic of pesticides, which are highly important substances to control pests in agriculture, but also have risks.

If these substances are capable of destroying pests, it is because they are toxic; therefore excessive and inappropriate use may cause pollution to the environment, food, and also harm farmers and other people. Consequently, since the first year of studies in Agronomy, students are encouraged to acquire the value of responsibility, which is required as a professional in agriculture. Besides, this professionalization of contents in Organic Chemistry helps develop the teaching-learning process.

No references concerning the implementation of interdisciplinary-professional algorithms for teaching and learning Organic Chemistry in Agronomy studies were found. However, research done by García & Colunga, 2004; Perera, 2004; León, 2007; Mena, 2010; Milián, 2012; González et al. 2015; Santos et al. 2017; Núñez & Escobar, 2017; García, 2017, provided theoretical elements for the proposal, and in consequence, helped design extra class assignment.

In 2004, Perera defined the interdisciplinary-professional principle for teacher training, and applied an interdisciplinary-professional methodology to train science teachers. According to the author of this paper, the interdisciplinary-professional principle is the one directing the teaching-learning process aiming to professional education that makes professionals capable of transferring contents to provide holistic solutions to future professional problems. (Perera, 2004, p. 86)

García & Colunga (2004) conducted research on professional and technical education in terms of professionalization of basic subjects. They came to the conclusion that professionalizing a basic subject is equal to organizing this subject in a way that provides better student education, with a closer approach to problems they will face in the technical subject cycle and their practice as graduates. (García & Colunga, p. 66)

In that sense, other researchers have dealt with this topic in the teaching-learning process of Chemistry or the basic sciences throughout the formation of technicians in agronomy, and as university graduates. This assessment was considered because the didactical conceptions to optimize content professionalization in Chemistry were dealt with,

following an interdisciplinary or basic science approach centered on the content integration of studies in Agronomy, and the importance of General Chemistry for the professional training of engineers in Agronomy (Escobar & Pérez, 2015; Mena, 2010; Milián, 2012).

Accordingly, the general objective of the extra-class activities is to link Organic Chemistry to the professional practice of agronomists, with especial emphasis on its relation to the environment.

Pesticides is the topic of choice, due to the importance they have in modern agriculture. Pesticides are chemical inorganic, natural inorganic, or synthetic inorganic products used to kill every harmful organism, or organisms that compete with humans in the consumption of crops, either in the crop fields or in storage (Faz and Fernández de Cossio, 1983).

The topics suggested comprise the study of pesticides according to their specific action (pesticides, fungicides, herbicides, rodenticides, acaricides, nematicides, and sprays), and their chemical components, especially the organic ones (organochlorine, organophosphoric, carbamate, chinonic derivatives, nitrobenzene derivatives, urea derivatives, and others) (Faz and Fernández de Cossio, 1983; Morales, 2017).

Another aspect is the environmental effects of pesticides, their toxicity, and applications. Generally, when a new pesticide is used, the results are favorable, controlling pests with minimum amounts of the product; however, after a while, the usefulness of the product declines, and new pesticides are needed.

The above is justified by the environmental effects of these chemicals, which cause changes in the ecosystems, accumulate in the trophic chain, move around in the environment (in the water, soil, and the air), sometimes for long distances, and possibly harm humans under certain circumstances.

One specificity of extra-class activities is the possibility given to the student of managing accessible information; information technologies facilitate search of new knowledge in a creative way, using non-linear forms of information search.

Therefore, students must conduct information search online, such as consulting literature and journals of scientific interest. That way, students should strengthen their abilities in information management, verbal and written presentations, and the capacity to summarize, which will contribute to improved professional training.

From a general educational perspective, it contributes to the transformation of student personality, which will allow them to acquire broader professional training, optimize their time, and be immersed in modern information search systems.

Conclusions

An interdisciplinary-professional algorithm for teaching-learning of Organic Chemistry was implemented in the Agronomy Studies at the University.

The teachers deemed it adequate to use the interdisciplinary-professional algorithm and its application in the design of extra-class activities.

This kind of activities allows students to link the contents of Organic Chemistry to topics of Plant Health, thus contributing to a more professionalized Organic Chemistry within the syllabus.

Author contribution

Mercedes Caridad García González: research planning, analysis of results, manuscript redaction, final review.

Humberto Silvio Varela de Moya: data collection, analysis and interpretation of results, redaction of the final manuscript, final review.

Manuel Rodríguez Saldaña: data collection, analysis and interpretation of results, redaction of the final manuscript, final review.

Ernesto Juniors Pérez Torres: data collection, analysis and interpretation of results, redaction of the final manuscript, final review.

Conflicts of interest

The authors declare the existence of no conflicts of interests

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