Original article

The transferential method of intradisciplinary integration of the biological content in the Agronomy career

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ABSTRACTS

The insufficiencies in the application of biological contents in relation to the preparation of future agronomists limit the solution of professional situations. With the use of the Systemic-structural-functional method, the transferential didactic method of intradisciplinary integration of biological contents in the Agronomy career was designed. It has an educational, transferential, intradisciplinary integrating, fundamentalizing character and is based on the theory of developmental education, the conception of biotic integrity, with an explanatory-integrating approach. In the teaching-learning process of the Biology discipline, this method allows the understanding, generalization and concretization of the biological content in professional situations.

Keywords: Content integration; Didactic transfer; Biology teaching; Didactic method.

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Introduction

The transferential method of intradisciplinary integration of biological contents as a didactic component of the teaching-learning process of Biology, responds to the integration, transfer and intradisciplinarity of biological contents, which as a formative requirement, needs to be integrated due to its high incidence in the management of agroecosystems as biological systems.

In the theoretical systematization carried out to the integration of contents, authors such as: Mena (2010), Collazo (2016), who have contributed meanings in their epistemological and didactic treatment, stand out. These results point to the totalizing essence of integration and its importance in the training of the agronomist and the teaching-learning of sciences with an interdisciplinary perspective from the psychological and didactic aspects.

The absence of a theoretical treatment of the didactic conception of the integration of contents in the teaching-learning process of the disciplines is noticed, which evidences the need to deepen the role of intradisciplinarity in the levels of integration as a process. It is a matter of assuming intradisciplinarity as an elementary level and methodological theoretical underpinning of interdisciplinary relations, specifies Bataille (2019). The logic of content integration provided by Mena (2010) is assumed as a deconstruction, reconstruction and application to another context, that is, as a transfer but without a vision of process.

It highlights the existence of inconsistencies in the argumentation of the integration-transfer relationship; the mechanisms of transfer have been seen as an application to other contexts, but in the intradisciplinary it is insufficient. The transfer with a processual vision has been insufficiently worked didactically, it is seen as a prefabricated product according to Contreras (2015). Assuming integration and transfer as processes requires teachers to deeply master how the biological content is taught and learned, i.e., the teaching method. It expresses the internal configuration of the process, so that, according to Alvarez (1997, p. 38), "by transforming the content, the objective is reached, which is manifested through the way, the path chosen by the subject to develop it".

This requirement is ratified by the result of the theoretical systematization of the integration of contents, which corroborated a meager proposal of didactic methods for integration in general, and intradisciplinary integration in particular.

In this sense, Mena (2010) stands out, who recognizes as an integrating didactic method the investigative method, which is projected as a dynamizer of the didactic conception of integration of the contents of the basic sciences in the Agronomy career, defended by the author.

In this line of analysis, Brito (2005) presents the transversal integration method as a general way of teaching-learning in the training of the intermediate technician in Agronomy, based on the dynamics of the scientific-productive-teaching agro-ecosystem and the integration of technological, research and teaching methods. Both methods of a very general nature to enhance the intradisciplinary approach of the biological contents in the training of this professional.

With these scientific perspectives, the research carried out in the Agronomy career of the University of Guantánamo is framed, which assumes as a problem the insufficiencies in the application of biological contents by future agronomists, which is limiting their performance in the solution of professional situations.

Among the fundamental causes, we point to insufficiencies in the teaching-learning process of Biology in the career, manifested in a limited didactic-methodological conception of the articulation and contextualization of biological contents. Therefore, the objective is to propose a transferential didactic method of intradisciplinary integration of biological contents in the Agronomy career.

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It highlights the existence of inconsistencies in the argumentation of the integration-transference relationship; the mechanisms of transference have been seen as an application to other contexts, but in the intradisciplinary it is insufficient. The transfer with a processual vision has been insufficiently worked didactically, it is seen as a prefabricated product according to Contreras (2015). Assuming integration and transfer as processes requires teachers to deeply master how the biological content is taught and learned, i.e., the teaching method. It expresses the internal configuration of the process, so that, according to Alvarez (1997, p. 38), "by transforming the content, the objective is reached, which is manifested through the way, the manner chosen by the subject to develop it".

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Development

The proposed transferential method of intradisciplinary integration of biological contents is the result of the didactic model of the transferential dynamics of intradisciplinary integration of biological contents in the Agronomy career; for this purpose, the configurations, dimensions, the system of essential relations were analyzed: Deconstruction of biological contents from associations structure-properties-functions of the organism, contextualized analogical reconstruction of biological contents in the ecosystem and the professional resignification of biological contents from its applicability with an agroecological perspective.

The method will not be exclusive to the discipline of Biology, that is, it will be used by the disciplines with biological contents in the Agronomy career, with its use students will be imbued with personal and professional values; as well as a systemic conception to understand the agricultural reality as a biological system.

This method has as its essence the conformation of a conception of biotic integrity and a professional bioagricultural sense, to enhance the application of biological contents in professional situations by agronomists in training. It is conceived as a productive, participative and activating method of the process.

The transferential didactic method of intradisciplinary integration of biological contents in the Agronomy career allows the understanding, generalization and concretion of the contents in biological and agricultural contexts.

From the **gnoseological** point of view, the method allows understanding the ways that favor the fulfillment of the demands of intradisciplinarity in the establishment of integrative relationships, from an explanatory-integrative approach.

Methodologically, it facilitates the structuring of a system of didactic procedures that make it possible to dynamize a developmental teaching-learning process, with the active participation of teachers and students.

The educational aspect of the method attends to the formation of feelings, values and attitudes towards nature, with the formation in the student of professional interests from

a sustainable agroecological perspective, thus the content becomes an essential regulating instrument of their relations with the environment.

Its **transferential** character favors the permanent and spiraling systematization of biological contents, through a transferential relationship and the interrelation of the different transfer mechanisms for the integration of biological contents.

On the other hand, its **intradisciplinary integrative** character favors a significant and totalizing learning of biological content, the restructuring of cognitive schemes of the student in an integrative relationship, which, at the same time, is a basis for the interweaving of thematic domains of biological content that transcends disciplinary boundaries in the course of their training as an agronomist.

It has a **fundamentalizing** character, as it facilitates the determination of the biological foundations of agricultural production from two major assumptions: biotic integrity from science and the conformation of the bioagricultural sense from the profession. The selection of invariant biological contents, their integrated simplification, as well as procedures that enable the internalization and application of the essential biological content are made possible. All this satisfies the logic of fundamentalization as a process.

The **applicability** of this didactic method is concretized in the organism-ecosystem-agroecosystem relationship for the integration of the biological content by means of transfer mechanisms. A didactic way is established to achieve the objectives of the programs of the different subjects. The Transferential Method of Intradisciplinary Integration of biological content is conceived as illustrated in Figure 1.

Source: Self elaboration

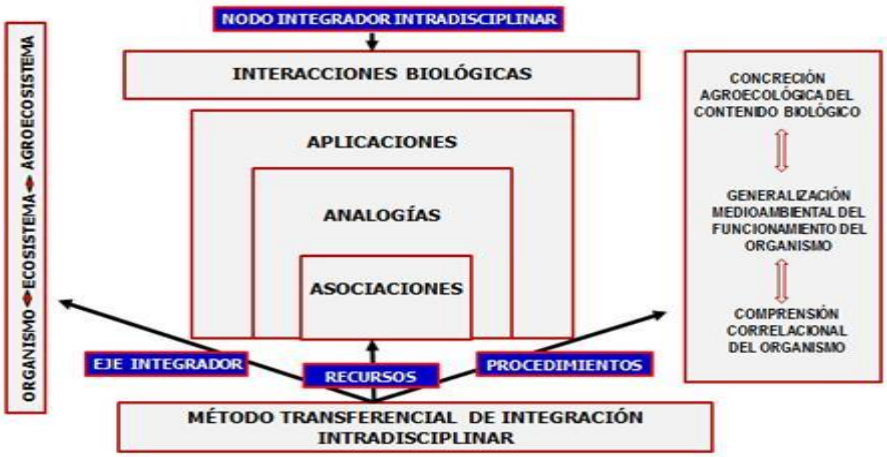

Figure 2: Its internal structure is made up of three didactic procedures and their operations shown**.**

The fundamental means that support this didactic method are the integrating tasks and exercises.

As the integrating axis, the organism-ecosystem-agroecosystem transferential relationship is defined as the pivot around which the interdisciplinary articulation process takes place, as the meeting and convergence point where the interrelation between the different components of the system flows. From the perspective defended, this relationship allows the unity of the biological and agronomic contexts to be signified, and their consideration as biological systems.

The proposal of biological interactions as main intradisciplinary nodes stands out, as biological contents that are distinguished "by the relevance they acquire for the professional, the degree of applicability they possess and the transcendence of the activities related to them in practice" (Álvarez, 2004, p. 8).

Source: Self elaboration

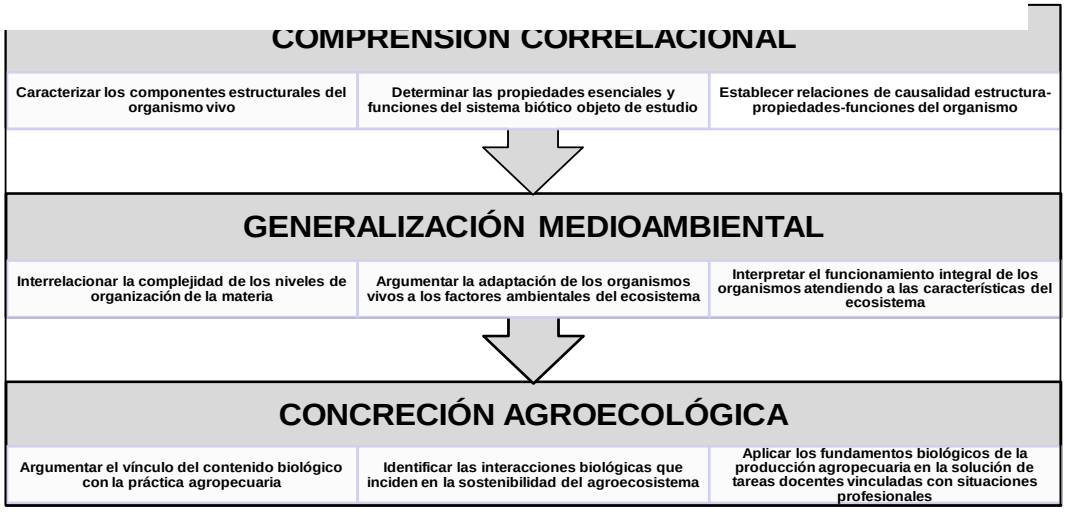

Figure 2 Structuring of the transferential method of intradisciplinary integration.

As a **didactic resource**, the method relies on transfer mechanisms: associations, analogies and applications. For the didactic treatment of the different transfer mechanisms, the following clarifications are made regarding: the operational structuring that distinguishes them, their classifications and examples that illustrate their use in the didactic proposal that is defended.

In the case of associations, it is necessary to define them as connections between ideas, images, phenomena, etc. The following is assumed as operational structure: to recognize the diversity of objects, phenomena and their relationships; to extract their regularities

from their internal and external relationships and, finally, to generalize essential common elements in the diversity and their relationships (Contreras, 2015).

Associations can be by similarity, by contrast, by cause and effect and by contiguity; namely:

- **Association by resemblance:** They occur when objects and phenomena, or thoughts between them actualize the memory of something similar. They also occupy an important place in deductions by analogy. For example, when working on the unity of organisms, symmetry, reproduction, type of cell, type of nutrition and respiration.
- **Association by contrast:** This associates very different phenomena such as: aerobic respiration that uses oxygen and anaerobic respiration that does not, classification into botanical and agricultural seeds, sexual and asexual reproduction, as well as the diversity of organisms.
- **Association by cause and effect:** Related phenomena are thus associated, for example, the structure-function relationship: respiration is the cause of the obtaining of energy (effect) by the organism, this energy is now the cause of the metabolic functions (effect) in the organism, the adaptive relationships of organisms such as animal appendages that enable their movement and condition their locomotion.
- **Associations by contiguity:** Events are associated when they occur in proximity in time and space, for example the representation when performing the evolutionary account of a botanical family. Another example is the analysis of concepts such as glucose, oxygen, carbon dioxide, water and energy in the process of aerobic respiration.

The treatment of analogies is based on recognizing them as comparisons between phenomena that maintain a certain similarity at a functional or structural level Oliva (2012). It is operationalized as follows:

Recognition of the parts involved in the relationship and the various aspects that each one presents.

- Identify the aspect(s) on which the relationship is focused.
- Search for correspondence: Correspondence is considered as an identification between what is taken from the known situation and what is taken from the situation

to be solved to carry out the analogy, so that it is something that the student builds supported by previous knowledge and experiences.

- Comparison of the aspects that are related in search of consequences, similarities, differences or limitations.

In establishing the consequence by analogy the central line of the structure is the analogy itself, (capital letters are used for connectors, and <...> for specific entities or statements), and then follows the consequence that is drawn from the analogy.

The outline of the structure of analogy by consequence is: "<beta> IS LIKE <alpha>" "THEN <consequences>". "Alpha and beta belong to the same category"; "beta behaves like alpha", "beta is credible".

Example: Citrus sinensis Osbeck (sweet orange) and Citrus aurantium L. (sour orange) belong to the Rutaceae family, so they can be attacked by the same pests, have the same natural enemies as well as the same nutritional and reproductive requirements.

- **"alpha explains the behavior of beta"; "other beta entities are like other alpha entities".**

Example: The planting of species belonging to families with melliferous and aromatic properties attracts pollinators, so the pollen or nectar resource is exchanged for the plant's pollen dispersal service.

In the case of similarities, the scheme of the structure on which the analogy is based reads as follows

- "<beta> IS LIKE <alpha> BECAUSE THERE ARE <entities in beta> THAT CORRESPOND IN <entities of alpha>."

Examples:

o Tomato and potato crops are mesophytic plants that have similar water control mechanisms.

o Wormwood is like dill and anise because it secretes substances that are toxic to soil insects.

For limitations read:

- "<beta> IS LIKE <alpha> CONSIDERING <limitations of correspondence> THAT PRODUCE <limitations in consequences>."

Example: o Simplified agroecosystems are like monoculture considering that genetically identical plants produce a lack of genetic diversity and can limit harvests by being vulnerable to a disease when the pathogen multiplies, destroying the entire crop.

o C3 and C4 plants perform photosynthesis considering that C4 plants have chloroplasts in the leaf mesophyll and around the conducting vessels, which makes the carbon fixation process more efficient in these plants.

A very important analogy is the one that links the results of the consequences, similarities and limitations already established. It reads:

-"THEN <consequences> BUT THERE ARE <limitations in those consequences> WHICH ARE PRODUCED BY <limitations in the correspondence>."

Example:

o The destruction of a maize crop, grown in an agro-ecosystem limited to monoculture with plants of a single variety, was caused by the intervention of a pathogenic microorganism, which advanced due to the low genetic diversity that favored its multiplication.

Finally, applications, in their didactic treatment, are understood as the degree to which a behavior is repeated in new situations, that is, it is generalized and then concretized in new situations. This requires specific knowledge in the generation of ideas that are subsequently applied in the development of new knowledge.

The operational structure of the application mechanism is elaborated on the basis of the work of important researchers on the subject Schwartz, Bransford and Sears (2005). It is operationalized as follows:

- Systematization, explanation or abstract of the content to be used.
- Reordering or new arrangements of points of view, contextualized in the new situation.
- Extrapolation of contents, generalizing and specifying effects, consequences and predictions of possible transformations in the new context.
- Concreteness in the solution of particular situations.

For the purposes of the present research, applications are classified according to the contexts, understood by Bloom (2007) from a broader perspective of meaning, purpose and location, in which the applications of the contents take shape. These can be intracontextual, intercontextual and transcontextual.

The intracontextual application is established within a biological context, in closely related contexts or in overlapping contexts, expanding the vision of students from analogical and associative connections between properties, structures, functions and operation, within the context (they relate topics, subjects in the discipline Biology and biological contents in the subjects of specific basic disciplines such as: Plant Health and Phytotechnology).

Intercontextual application takes place in different biological contexts closely related or in overlapping contexts, expanding the students' vision of Biology from situations where the fragmentation of biological content disappears, by basing solutions to professional problems on this science (they relate biological content in disciplines of professional practice).

The transcontextual application establishes the inclusion of a variety of biological contexts and the creation of new contexts, from interactions between students, biological and professional objects and processes, in which students face professional situations where the representativeness of the biological content depends on the integrating situation faced. Students confirm the need to appropriate biological contents, noting the role of Biology in their training (they relate biological contents in course and diploma works).

Finally, it should be noted that the separate treatment of the different mechanisms has been carried out only for the purpose of didactic deepening, in order to define the ways for their implementation. The proposal presented here is based on the consideration of the necessary interrelation of the three mechanisms, from a dialectic of complementarity.

In other words, in the integration process, associations are the starting point for recognition, identification and the search for correspondence, necessary for the establishment of analogies and comparisons. On the other hand, systematization, reordering and extrapolation in the development of applications is only possible through associations and analogies between ideas, processes and biological phenomena, which become contents to be generalized in new contexts.

In general, it can be stated that the transferential method of intradisciplinary integration of biological content focuses on the systematization of biological interactions and properties of biological systems in a transferential organism-ecosystem-agroecosystem

relationship mediated by the interrelation and complementarity of transfer mechanisms, which allow the understanding, generalization and concretization of biological content.

The importance of the use of different didactic methods is recognized in order to make viable the increasing incorporation of current scientific and technical content to university curricula, for the formation of a basic scientific culture and a more relevant professional training.

In the particular case of the professional training of engineers, we agree with authors such as Machín et al. (2017) on the need to establish a solid foundation, which allows them to use the contents already assimilated and integrate them in the search for technical and professional solutions to the problems in their context of action.

In the distinctive case of the Agronomy career, basic sciences such as biology, provide the scientific and technological principles that allow improving the management of agricultural production processes. To this end, it is agreed with Mena (2010) that the agronomist must learn to discern between the unified, totalizing and integral character with which agronomic nature exists and is perceived, and the incomplete, fragmented and historically conditioned nature of the scientific knowledge with which it is intended to analyze, explain and generalize its social implications, elements that must be perfected from the Didactics of Biology.

Currently, the Didactics of Biology insists on methods that demand productive cognitive activity, problematization, the optimal use of means to understand the relationships of nature, the degree of activity of the teacher and the independence of the student.

In this sense, the systematization made by Reinoso (2018) indicates that the most used methods are: traditional, deductive, inductive, experimental, problemic and scientific, which should be enriched with an integrative perspective that enables the totalizing understanding of the biological content and the holistic nature of biological systems in the training of the agronomist engineer.

Conclusions

In general, the transferential didactic method of intradisciplinary integration of biological contents constitutes a way of teaching-learning of biological contents in the

Agronomy career, so that engineers in training achieve a totalizing comprehension of biological contents and re-signify it with a professional sense of its applicability, starting from the dynamics of the agroecosystem as a biological system.

The transferential method of interdisciplinary integration of biological contents is distinguished by the assumption of biological interactions as the main intradisciplinary node, the recognition of the organism-ecosystem-agroecosystem transferential relationship as the axis of integration and, as a didactic resource, the interrelation of transferential mechanisms (associations, analogies and applications); legitimizing the dynamizing character of the transfer process in the integration of biological contents.