



A New Approach to Teaching - Learning Human Anatomy and Physiology



Edith Mary Beltran Mill*, Layra Barrios Martin and Durvys Rose Vazquez Perez

University of Sancti Spiritus "José Martí Pérez", Cuba

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*Corresponding author: Edith Mary Beltran Mill, University of Sancti Spiritus "José Martí Pérez", Cuba

E-mail: ebeltran@uniss.edu.cu

Abstract

The present This article is related to the importance of the explanatory-integrative approach, which presupposes the relationship structure-property-function-operation (EPPF) as the central axis of knowledge, specifically in the teaching-learning process of Human Anatomy and Physiology, a discipline that It is taught in the bachelor's degree in education Biology. In the development of the work, obstacles are needed that prevent the successful establishment of said relationship; a critical reflection is made about the concept of these categories and didactic procedures are proposed that guide how to establish it; this will promote a more organized study, the development of skills and therefore better results.

Keywords: Didactic procedures; Structure-property-function-operation relationship; Human Anatomy and Physiology

Introduction

The Study Plan "E" of the Graduate in Education Career, specializing in Biology, has been designed in order to improve the training and development of the modes of action of future professionals, capable of determining, analyzing, and solving complex problems in their professional pedagogical activity and respond to the demands of the end of education and the objectives of the Cuban school.

The curricular design is structured in four years and consists of twenty-five disciplines, grouped into ten common disciplines with thirty-two subjects and fifteen disciplines with thirty subjects corresponding to biological and chemical contents (including the so-called Basic Sciences), which make up the plan of the teaching process. It has been conceived with a systemic character, in which each discipline plays an important role in the training of the professional.

In its base curriculum it has Human Anatomy and Physiology, it is included in the study plan for the training of Biology teachers with the aim of consolidating and deepening their basic knowledge, since its object of study is the structure and function of the organs of each one of the systems that make up the human organism, physiological mechanisms that allow vitality, personal and collective hygiene, contents that support the development of

other disciplines of the study plan and that serve as a theoretical-practical foundation for the professional work that future graduates will perform.

The subjects taught in this discipline contribute to the development of the dialectical-materialist conception of the world in students and find wide application in different subjects of General Polytechnic and Labor Education, in daily life and in the knowledge and conservation of the environment. Therefore, it constitutes a basic discipline for the training of Biology teachers in basic secondary and pre-university education. From the third improvement of the National Education System, guidelines were established in the selection of biological contents, among them: the explanatory-integrative approach which presupposes the structure-property-function-functioning relationship as the central axis of knowledge, thus declared in the theoretical model where the general conception of the teaching of Biology is established [1] for secondary and pre-university and applicable to all disciplines of the Biology Career. This relationship implies the comprehensive study of biotic phenomena, analyzing the causes in a systemic and gradual manner, taking into account the different levels of organization that will allow emphasizing biological integrity.

Currently, the teaching and learning of Human Anatomy and Physiology of the Bachelor of Education, Biology specialty has great challenges that must be overcome: students are overwhelmed by a large amount of information; generally learning is based on memory; It is difficult to establish the structure-property-function-operation relationship due to the lack of methods that allow the development of this explanatory-integrative approach and a basic text aimed at the specialty. This constitutes a great challenge for the professors of said career since it constitutes a complex subject that requires the constant improvement of didactic tools that provide elements for the student to acquire knowledge, develop intellectual capacities, without which it will be possible to train critical professionals, creative and autonomous.

The integration from Anatomy and Physiology is a problem that must be solved by the special didactics of this discipline; must be updated periodically, to match social development. Taking into account the changes assumed in the third improvement, the importance of the explanatory-integrative approach in the teaching-learning process of the discipline as well as the limitations detected, it is decided to carry out this investigation that proposes to offer didactic procedures that allow establishing the relationship not only of the structure and the function, but also the property and operation categories are included, being defined as the relationship structure-property-function-operation (EPFF).

Development

Limitations to establish the EPFF relationship in the teaching-learning process of Human Anatomy and Physiology

a) In the development of the work, obstacles were investigated that prevent students who are studying the degree from successfully establishing said relationship, which is specified below.

b) The bibliography that is available to the teacher and the students is specialized in one of these branches of Biological Sciences, that is, Anatomy independent of Physiology.

c) The Human Anatomy and Physiology discipline does not have a textbook, so students must use different reference books that show this limitation in the approach to knowledge.

d) A reference book used by students consistently is Human Anatomy [2]; in its generalities, the manifestation of the structure-function relationship is indicated with precision; in the development of each topic, he explains the morphological aspects and defines the function of each organ belonging to the corresponding system, but in most cases he does not go deep into the histological elements, a level at which essential links of this relationship can be found.

e) Another work that should be used by students and teachers is Treatise on Medical Physiology, [3]. This text has an

essentially physiological approach, due to its specialization in medical sciences, it does not reach the dialectical treatment of the categories that are being analyzed. The same occurs with the books on Cellular Physiology and Control Systems [4] and Physiology of the Internal Environment [5].

f) In the Biology 3 book for ninth grade [6] published in the third educational improvement, in most cases the morphological elements are explained separately from the physiological ones and although some processes that occur in the organism are explained, they are not explained. the structure-property-function-operation relationship is exemplified, the links are not established, the dialectical character is lost; The same occurs with the biology 5 book for the eleventh grade [7] in which this relationship is only exemplified when studying the cytoplasmic membrane and the male genital organs, not being the case with the rest of the organ systems.

g) Another text widely consulted by students of the career for containing a little more information in correspondence with the program of the discipline is Fundamentals of Anatomy and Physiology for teachers [8] in which the function and processes are addressed. basic physiological conditions of the human organism, and since it is designed for Early Childhood Education teachers, especially for those who work with children who have special educational needs with or without disabilities, it emphasizes the most frequent pathologies in the students of these centers, in the measures hygienic as well as in the neurophysiological processes of the psychic processes.

The limitations indicated in the bibliography constitute an obstacle for the treatment of the central axis of the teaching of Biology in ninth and eleventh grades, as well as the objectives and skills of the Human Anatomy and Physiology discipline.

This has been corroborated by the author during her professional performance in which she verified the following regularities in the third-year students of the Biology major after completing the study of the subject Human Anatomy and Physiology I:

a) The students do not determine the histological features of the structures, which would favor determining the properties.

b) They define concepts of structures, physiological processes, but do not establish the links between them.

c) When explaining the functioning of an organ or an organ system, they only refer to its function.

d) They have limitations when explaining biological integrity, applying the contents to new situations.

In discussions held with secondary and pre-university teachers, it was found that they recognize the explanatory-integrative approach that should prevail in the Biology subject, but many fail to explain the reason for this, most do not adequately

define the concepts of structure, property, function, operation, do not interrelate them and have not created an algorithm for the treatment of this approach. They all agree that the methodological orientations do not offer them the necessary indications for the work of these categories with a dialectical approach.

In a group interview with professors of Human Anatomy and Physiology from the different Universities of the country, it was possible to confirm limitations in the methodological work related to the integration of said category with this important skill of the discipline, to explain the relationship structure-property-function-operation. Among the main limitations detected are the fact that only the structure and function are explained independently, without establishing the links, so the potential of this for the scientific-materialist training of students is wasted; there is no methodology by which teachers work on this skill.

The review of the subject of this research has allowed us to verify that it has not been studied previously, only with regard to the structure-function relationship. It is known that it constitutes a line of methodological work in the groups of the Human Anatomy and Physiology discipline, so due to the relevance of the topic and its importance, the authors have considered it necessary to address it.

Reflection on the EPFF relationship

Next, we reflect on the four essential categories that are addressed in this work: structure, property, function, operation, since their meaning will allow us to understand their relationship. A study of the definition of the concept and basic ideas of the structure category offered by various texts has been carried out. In the provisional textbook of Biology 3 of the ninth grade for the new improvement, structure is defined as, "Element, part or component present in every living organism" [6]. The dictionary of biological terms defines it as "... distribution and order of the parts of an organism." [9].

In these definitions only the elements that make up the organism are taken into account, they do not refer to the possible changes that occur internally, in addition, they limit the concept to the level of the organism, no mention is made of the sublevels: cells, tissues, organs and organ systems. The same is appreciated in the definition given in the dictionary Meanings.com (2013-2020) where it is stated that: "The structure is the distribution of the parts of a body..." where mention is made of the arrangement and order of the parts within a whole.

In the eleventh grade Biology 5 provisional textbook, structure is defined as: "interrelations between the components of a system, their combinations and arrangements in space, the shape they take, among other details of their spatial configuration" [7]. Already in this definition reference is made to the components of

a system and the relationship that exists between them depending on the conditions in which it is found.

[10] (sf) defines structure as, "A set of organized and independent elements; its analysis, therefore, cannot be limited to that of the elements that make it up but also to the relationships that link them and based on which they acquire meaning. The term has displaced the system. "Ways in which the elements, parts or characteristics of a whole are organized, distributed and worked..." "Grijalbo, Great Illustrated Encyclopedic Dictionary". In this definition you can see the approach to the structure of life. The general definition that in the dictionary of Philosophy is made of structure, "Inner form of organization of the system, which constitutes a unit of stable connections between its elements, as well as the laws that govern these connections" [11], expresses the dynamic nature of the category and is presented in a broad dimension, so that it can be applied to all levels of organization in which life exists. Consider the relationship between cells, tissues, organs, and organ systems, as well as the elements that make that relationship possible.

The authors of this research consider that the structure of the human organism must be studied taking into account all the levels that allow its formation from the atomic to the organ system; this will allow us to understand even more the functioning of the organ or system under study; For example: Living beings are made up of 98% by elements such as C, H, O, N, P and S; (The remaining 2% is represented by elements such as Fe, Ca, Na, K, Cu, Mg, I, Cl. etc.) The combination of these six elements can lead to the formation of millions of different molecules; the compounds in whose composition carbon intervenes are called organic compounds; Within this group we can mention monosaccharides, polysaccharides, amino acids, proteins, lipids, nucleotides and nucleic acids, among others. These are organized in a particular and precise way and interact with each other to establish the cellular structure; cells are the bricks with which tissues are built, tissues to organs and these to organ systems or apparatus.

Now, if we want to determine the structure of a particular organ, we must study it not only from the macroscopic point of view but also from the microscopic point of view, determining which are the types of cells and types of tissues that are part of its constitution; For example: the stomach is an organ of the digestive system, made up of principal or zymogen cells (they produce pepsinogen (I and II); oxytic or parietal cells (they secrete hydrochloric acid and gastric intrinsic factor or Castle's intrinsic factor); neck mucous cells (secrete alkaline mucus), endocrine cells (secrete gastrin, somatostatin, serotonin, etc). Main tissues of the stomach: epithelial tissue, support, muscle tissue. Knowledge of the types of tissues that make up the organ or organ system will allow us to know the properties of the organ, which constitutes another category.

The Latin term *proprietas* is where the etymological origin of the property concept is found, which we are going to analyze in depth below. A word that is formed from the union of three clearly delimited parts: the prefix *pro* - which is equivalent to “forward movement”, the adjective *privus* which means “of only one” and the suffix *-tas* which indicates “quality” [12]. According to the Microsoft Encarta [13] dictionary [14] a property is an “essential attribute or quality of someone or something”, that is, something that is distinctive. According to the different bibliographies consulted, property is a concept with various uses. It can be used to name a quality, a characteristic, a state, a condition or a faculty. It has a wide variety of meanings depending on the context.

In the provisional textbook of Biology 5 for the new improvement, property is defined as: “its own, essential and characteristic quality of something, which allows it to be characterized and to establish similarities and differences...” [7]. In other words, if we analyze this definition from the point of view of Human Anatomy, we can say that an element that distinguishes the stomach from the liver is its ability to relax before the arrival of large volumes of food; therefore, we conclude that one of its properties is that of stretching. Properties of matter are called its specific characteristics. Some of these characteristics are common to all forms of matter and for this reason they are recognized as general properties. Others differ by group and are known as particular properties. Some, too, are different even within the same group for each of the substances that are part of it, considering specific properties. However, there is another fundamental classification regarding the properties of matter, linked to the type of characteristic that each of them comes to differentiate. It is the one that divides the properties between physical and chemical.

A physical property is one that is based primarily on the structure of the object, substance, or matter. We can determine them by observation and measurement. (“Physical properties”, 2018). For example, the physical properties of the stomach would be the aforementioned distension, hollow viscera, “j” shape, etc.

The difference between physical and chemical properties is that physical properties are visible, measurable and do not alter the original substance, on the other hand, chemical properties involve the reaction of a substance with respect to other substances, both in its chemical behavior and in the alteration of its composition creating, consequently, a new substance. Such is the case of hydrochloric acid secreted by stomach cells and the action it exerts on food to form chyme.

Therefore, the chemical properties guide the analysis of composition, structure and transformation. To determine the essential quality of an organ or organ system we must correlate the predominant tissue property with the function of the organ or system. According to the Significados.com dictionary (2013-2020), a function is the purpose or task that is attributed to

something. It comes from the Latin *functio*, *funciōnis*, and means “executing or exercising a faculty”. In its conception associated with life, it is defined in the ninth-grade book Biology 3 as: “Specific activity that characterizes all structures in an organism. Process that is carried out in organisms through their structures” [6]. In this definition, the link of the function with the dynamics of living matter is evident, but a narrow character is manifested.

The same occurs with the definition of this category in the Dictionary of Biological Terms, where function is defined as “... activity or action of any part of the organism aimed at maintaining life, the organism’s reproductive capacity or its development.” [9]. [15], in his work, “The superior cortical functions of man”, states that “... one of the essential achievements of modern physiological science is the radical revision of the concept of “function”,...” (p.24). As a result of this review, the function is no longer considered as that property that is related to the work of certain specialized cells of a given organ.

In the aforementioned work, the author refers to how the prominent physiologist PK Anokhin (1935-1940) stated that in his time the concept of function was used in two different senses: as the exercise or activity of a given organ or tissue (example: the function of the pancreas is the secretion of insulin, the function of the liver cells is the secretion of bile) and as the adaptive activity of the organism directed to the fulfillment of both a physiological and psychological task (example: the function of locomotion, perception, breathing).

In this regard, Luria states, “This understanding of functions... has been widely extended in modern science and is currently accepted by all contemporary physiology.” And he defines: “... the “function” ... is actually a functional system (concept introduced by PK Anojin), intended to fulfill a given biological task and ensured by a complex of interlinked acts that, in the end, lead to the achievement of the corresponding biological effect.” (p.25).

In the books edited for the new improvement of secondary and pre-university education, function definitions appear that we consider a little more explicit and in which the interrelationship between the categories studied can be appreciated. In the provisional textbook glossary for Biology 3, Grade 9 is defined as: “specific activity of an organ, tissue, cell, or cellular organelle. A process carried out in organisms by structures” [6]. And in Biology 5, eleventh grade, it is stated that the function is the “external manifestation of the properties of any object in a given system of relations” [7]. In this last definition, the relationship between property and function is exposed, for example, the stomach has the property of distension thanks to the presence of muscle tissue, and this is related to one of its functions, which is to temporarily store food.

All these aspects constitute elements that provide the bases for the work in relation to the integration that is manifested in the organisms, both horizontal integration, that is, that which

exists between the organs of the same system, and vertical integration, that exists between the different systems of the organism. At the same time, all this allows to acquire the notion of the organism as a whole related to the environment, which is the maximum generalization that must be achieved in the discipline. The structure-property-function are dialectically interrelated, constituting a unit. The cells, tissues, and organs that make up an organism are various forms of matter in motion; its specific characteristics or qualities are the properties, and the function is then the external manifestation of said property.

To explain the function of a certain structure, it is necessary to know the causes of its development; Therefore, a histological study is necessary. The histologist, Eliséiev [16] stated: "The structure is the material substrate of any function of the organism." (p.12). This confirms that there is no structure in the organism that does not perform a certain function, in the same way that there is no function that is not developed in a certain structure. That is why structure and function constitute a dialectical unit that concretizes matter and movement. (Reinous, 2001).

The approach of Prives [2] is considered very correct when expressing that "The structure of the living is, in this way, the unity of its morphological substratum, that is, the material, with the dynamics of its changes, that is, the motion. The structure of the living thing includes not only the morphological particularities of the organism, but also the functional ones. (p.18). This idea contributed by Prives further confirms the relationship that must be established between the four categories: structure-property-function-operation for a better understanding of Human Anatomy and Physiology. In order to understand the meaning of the term functioning, it is essential that we proceed, first of all, to determine its etymological origin. In this sense, we come across the fact that it emanates from the Latin "functio", which can be defined as "execution", and that it is the result of the sum of two words: the verb "functus", which can be translated as "to comply", and the suffix "-ito", which is equivalent to "action". (Meanings.com, 2013-2020).

The concept is very broad since, in a certain sense, everything has a function (it exists for something). Organ systems and apparatus as a whole tend to have a complex function, while other structures of the body fulfill simpler functions. The operation can be defined as the implementation of a function or activity for the realization of certain purposes. When something starts working, it goes from static to dynamic, it moves, it puts a power into action [17]. The machines fulfill functions in view of what they have been created, in general when they are turned on, or when they are manually activated, where appropriate, and may have periods of inactivity. Their operation may be at the service of one or more individuals or the community in general, as in the case of a transport line, which may operate on certain days, routes and frequencies. Living beings generally need to be in constant

operation, especially the systems that control vital functions, such as blood circulation or respiration. The complexity of the operation is variable.

Functioning is the action and effect of functioning. This verb refers to executing the functions that are proper to something or someone or to that which works or turns out well. For example: "The organs of the digestive system are not working well: the patient continues with liquid stools." "The gallbladder is having a somewhat strange function: bile is not being released into the duodenum to promote digestion", "The Intestinal villi are vital for the proper functioning of the small intestine. The functioning of a structure is linked to its ability to fulfill its usual functions. When you cannot do this, we speak of a malfunction for different reasons.

In addition to all of the above, we would have to highlight the existence of what is known as the operating principle. It is a term that is used to refer to the fact that any system or device must carry out an action in a certain way in order to allow it to work and this depends on the changes that may occur in the environment.

This is addressed in the definition of functioning that appears in the provisional textbook of Biology 5, eleventh grade, and which is assumed in this work; states that it is the "dynamic integration of the different components, structures, properties and functions in a biological system, in a single whole, which responds in an integral way to a certain stimulus or change that occurs in the environment" [7].

As can be seen in this definition, in order to make something work, it is necessary that each of the elements of the corresponding object be put together and shown as a perfect gear and that there is an interrelationship between all of them. The structure must have the capacity to carry out a certain work based on internal changes, in correspondence with the needs of the organism, this is the basis that the maintenance and continuity of the structure are ensured through the continuity of its operation.

The analysis of the integrity of the living organism leads to the discovery of the elements that can contribute the relations of integration that are established by the structural association of all its parts; by their relationship with body fluids; by the control exerted by the nervous, endocrine, and immune systems; for the unity between the vegetative processes. The previous arguments about the EPFF relationship, in the discipline of Human Anatomy and Physiology must be treated from the analysis in a determined organ system, even more, in specific organs. This relationship is evident in all organs and has a didactic basis; To get to the essence of these phenomena, a histological analysis of the given organ is necessary, based on the background elements provided by the subject Molecular and Cellular Biology (BMC).

Then the links between the four categories can be established. To determine the structure, property, function, functioning of an

organ and establish the relationship between these categories, the following didactic procedures are proposed:

- a) Determine the organ system under study.
- b) Select organ to study.
- c) Study in depth the structural and functional characteristics of the selected organ from the consultation of various texts of the specialty.
- d) To determine microscopic and macroscopic structure of the organ:
 - i) Identify cells and tissues that form it and summarize their specific characteristics. They can rely on the background content provided by the BMC and Introduction to the study of Biology.
 - ii) Regarding the organ as such, refer to its shape, size, color, parts that form it, relationship between its parts. It is suggested to schematize the organ in the notebook for a better fixation of the content.
 - e) To determine the property or properties, refer to the tissues that make up the organ, for example, if it is made up of nervous tissue, one of its properties is conductivity; if muscle tissue predominates, one of the properties is contractility. At this time, links are established between the structure and ownership of the organ.
 - f) To determine the function of the organ as a whole, that is, its specific task or activity, the external manifestation of the property is taken into account, for example, taking into account the examples given above, one of the functions of the medulla oblongata is transmission of impulses from the spinal cord to the brain and from the muscles to movement.
 - g) In order to treat the last category, which is operation, the following question must be answered: How is this function executed? We continue with the example of the medulla oblongata as an organ of the nervous system. To refer to its functioning, it is necessary to explain how the transmission of nerve impulses from the spinal cord to the brain occurs. If it is appropriate to expose the functioning of the muscles, the contractile cycle of the sarcomere must be explained.
 - h) It is recommended to show students a video where they can visualize the relationship between the four categories, this will promote a greater fixation and understanding of what has been studied.
 - i) The preparation of conceptual maps, tables, schemes, which help to specify the information, can be oriented.

The previous idea allows us to consider that the relationship between the four EPFF categories offers training potential; one

presupposes the existence of the other. With the study of Human Anatomy and Physiology, students learn about vital processes, their material basis, and how they are related to the activity of cells, tissues, and organs.

Hence the importance of the formation of the concept of these categories as basic pillars in the scientific conception of the world, since they are part of the system of concepts that must have about the material existence of human beings, and constitute an important element of knowledge that serves of base to the formation of convictions about that the way of existence of the matter is the movement, the physiological processes that assure the life of the organisms and the continuity of the species.

Conclusions

The preliminary analyzes carried out demonstrate the difficulties that are presented to establish the EPFF relationship in the discipline of Human Anatomy and Physiology by students of the Bachelor's degree in Education, specializing in Biology; They lie not only in the lack of skills and the lack of a specialized book, but also in the scarce information that exists about the subject under study of the investigation and the deficiencies that teachers have to deal with this situation.

This confirms the need to propose to teachers didactic procedures to introduce the teaching-learning process not only of Anatomy but also of other disciplines that are part of the curricular design of the career. The procedures were designed from the analysis of different definitions of structure, property, function and operation in different bibliographic sources, which allowed establishing the relationship between the four categories. These biological categories used as a central axis in the teaching-learning process of the Human Anatomy and Physiology discipline, make it possible to direct the mental activity of students on the basis of logical thinking. They allow establishing essential features through analysis, synthesis and comparison, which will simply an active participation of the student during learning. It favors a correct understanding of the contents, the assimilation of the conception of the organism as a whole and the discovery of its relations with the environment that allow the maintenance of its internal balance.

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