v. 3, n. 17, 2023

International Journal of Human Sciences Research

# FARIA DE VASCONCELOS AND THE NEW EDUCATION IN NATURAL SCIENCES

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**Abstract**: Adolphe Ferrière says the School at Bierges-les-Wavre, founded by the Portuguese educator Faria de Vasconcelos, in 1912, fulfilled 28 of the 30 programmatic points of the New Education movement. Thus, the figure of Faria de Vasconcelos is established as a pillar of this movement of pedagogical renewal that swept the educational panorama like a hurricane in the Western world in the first quarter of the 20th century. In this article, we review a handbook that Faria de Vasconcelos produced in 1919 when he was director of the Normal School at Sucre in Bolivia. It is a guide to train teachers to teach natural sciences. To prepare this handbook, Faria de Vasconcelos reviews the best material that had been written in the field of science education in Europe and in the USA and selectively retains what best suits his pedagogical convictions, characterised by his firm commitment to the ideas of his friends and co-religionists at the Jean-Jacques Rousseau Institute.
**Keywords:** progressive education movement, science education, active pedagogy, First Portuguese Republic

## INTRODUCTION

António de Sena Faria de Vasconcelos was born in Castelo Branco, Portugal, on 2nd March 1880. He completed his secondary studies at the *Colégio do Espírito Santo* [Holy Spirit College] in Braga, Portugal, and followed the family tradition and graduated in Law at the University of Coimbra. He went to Brussels in 1902, where he completed a doctorate in Social Sciences. There he developed an intense teaching activity in the area of psychopedagogy and became deeply involved with the New Education movement, having founded and directed between 1911 and 1914 a New School which, according to Adolphe Ferrière, fulfilled 28 of the 30 New Education programmatic points. With the outbreak of World War I between 1914 and 1918, the *École Nouvelle à la Campagne [New School in the Countryside]* at Bierges-les-Wavre, as it was called, closed, and Faria de Vasconcelos took refuge in Geneva, where he collaborated with the Jean-Jaques Rousseau Institute. Between 1915 and 1921, he was invited first by the government of Cuba and then by the government of Bolivia to collaborate in the processes of education reform in these countries.

In 1921, he returned to Portugal where he carried out an intense pedagogical and political activity until 1939, the year of his death at only 59 years of age. For example, he was the main person responsible for draughting the ambitious education reform programme of the First Portuguese Republic that became known as the Camoesas Reform.

This article presents Faria de Vasconcelos' contribution to modernising Natural Sciences education in Portugal with the publication of a type of handbook for teachers in 1923. It is part of his more ample contribution to the *aggiornamento* [updating] of Pedagogy and educational practises in Portugal in which he was involved.

## FOUNDATIONS OF THE NEW EDUCATION IN NATURAL SCIENCES

At the beginning of the 20th century, within the framework of the great Copernican revolution in education, which, in fact, gave rise to the New Education movement, the discourse of thinkers of "scientific pedagogy" began to gain great significance and acceptance, including in Portugal, where the First Republic was trying at all costs to make up for Portugal's educational lag behind other European countries (Carvalho, 1996). The book by Faria de Vasconcelos presented herein, *Didáctica das Sciências Naturais I [Didactics of Natural Sciences I]*, begins by offering the main advantages for children to study natural sciences, as listed in his work *Une École Nouvelle en Belgique [A New School in Belgium]*: *a)* to awaken all children's activities (physical, manual, intellectual, and moral); *b)* to satisfy their needs and their interests; *c)* to exercise their sensory capacities, especially visual; *d)* to facilitate the acquisition of exact, clear images and accustom them to making clear, concrete judgements; and *e)* to contribute as an educational value to the formation of spirit and character and to the acquisition of emotional habits and true moral virtues (Vasconcelos, 1923).

The author chooses three principles on which to base an education in natural sciences: *a)* principle of utilitarianism, *b)* morphological or static principle, and *c)* biological and physical/chemical principle. Let us examine each of these principles.

According to the utilitarian criterion, the school should provide indispensable knowledge so that one can use the resources Nature provides. Utilitarianism is conceived as the general criterion of morality, where every action should be oriented towards producing the greatest amount of well-being. However, Faria de Vasconcelos perceives the limited educational and instructive value of applying this principle to education, *tout court*. He, therefore, considers it to be an incomplete criterion since it is only concerned with the useful or harmful manifestations of beings and disregards what is more important: knowledge of their conditions of existence, their relationship with the environment, and the relationship between the organs and their functions.

Faria de Vasconcelos draws on the Swiss educationist Eugène Dévaud (1876-1942) and the efforts of the German zoologist and botanist Otto Schmeil (1860-1943) to address biological education. He stresses that utilitarianism does not answer questions regarding the functional organisation of a duck, which lives in water, or a squirrel, which lives in trees, but merely affirms that both can be eaten by humans. It does not answer, for example, the question, "why is it that an apple tree cannot grow in the sand?" (Vasconcelos, 1923, p. 14).

The utilitarian criterion is empirical and routine. Faria de Vasconcelos understands that "putting the beings that render us services to the best use and containing the harm they cause us depends on our knowledge of their conditions and the laws of their life" (Vasconcelos, 1923, p. 15). Following Dévaud, he underscores that utilitarianism makes students believe that the world exists only to be used by human beings. Therefore, if living beings considered harmful exist, they must be destroyed. It is precisely this anthropocentrism, which twists the students' mentality and forms a short-sighted and narrow conscience, that Faria de Vasconcelos rejects. He concludes that an education inspired solely and exclusively by the principle of utilitarianism has no educational value.

Most of the books that the schools followed at the time adopted the static or morphological principle, an exact and meticulous description of the forms of beings and their classification: the traditional education in Natural History. For Faria de Vasconcelos, while studies oriented by this principle are necessary and important, they are insufficient as they do not address what is essential: the conditions of existence of beings and the imperious relationship between their organisation and the environment and between the organs and their functions. According to the author, an education based on description and observation does not allow for thinking and reflection. A culture of intelligence can only grow from thoughtful, reflective observations of the conditions for life of beings, *i.e.*, the relationship between the organism and the environment and between the organ and its function, or, in more recent language, the biotic and abiotic relationships that are established in an ecosystem.

Faria de Vasconcelos brings the dynamic or biological and physical/chemical principles to the fore in the organisation of an education in natural sciences, subordinating the two previous principles to these principles. Only the biological criterion has the conditions to place the being in its environment and determine the essential conditions that allow it to live according to a certain form. For comparison, the author refers to a lesson on the chicken that is studied in its environment so as to determine the characteristic, essential element that distinguishes it from other beings. To this end, he poses a starting question as a guiding principle of the lesson. This is followed by a description of its characteristics and an investigation into the utility of the chicken to the human being.

This thinking is transferred to the teaching of botany. "The solution to biological problems must precede the solution to descriptive utilitarian problems." Therefore, the guiding principle of a biological education resides in the structure, in the intimate constitution of the being and tends to reveal what is essential in that same being – animal or plant: its life" (Vasconcelos, 1923, p. 22).

The physical/chemical principle is the dominant principle in teaching mineralogy. To demonstrate the contrast in positions, Faria de Vasconcelos presents as examples a lesson on clay taken from the *Manuel Général de l'Instruction Primaire [General Manual of Primary Instruction]* of France, which has a descriptive orientation, and another lesson on the same subject prepared by Eugène Dévaud, which has another orientation.

Faria de Vasconcelos notes that the application of biological and physical/chemical principles, which were adopted in Dévaud's lesson, aims to highlight what is characteristic and essential in the object of study: constitution and properties in inorganic beings, life in living beings. Therefore, he argues that these principles should prevail in an education in natural sciences and that the morphology and utility of beings should serve to complement this education and be clarified by biological and physical / chemical principles.

Having explained the principles that should orient an education in natural sciences, Faria de Vasconcelos establishes the conditions that the organisation of an educational programme should obey: *a)* the local environment, *b)* the scientific classification system, *c)* the principle of natural collectivities.

Let us consider the first condition. Since the natural sciences are, par excellence, sciences of observation and experimentation, subjects should be chosen, first of all, based on the local environment in which the children live, so as to bring them into direct contact with nature. The author argues that studying the local environment facilitates direct observation and intuition as they induce "an understanding of natural phenomena that is created in better conditions of intelligence, clarity, and logic" (Vasconcelos, 1923, p. 28).

Two corollaries are derived from this condition for the organisation of an educational programme:

*a)* The need for the programme to include a component related to the region where the school is located and thus refuse a uniform national programme

A rural school environment is not the same as an urban school environment, just as a school in an industrial region does not coincide with a school in a maritime or agricultural region.

*b)* Adapting education to the succession of seasons throughout the year

Phenomena should be observed *in tempore*, particularly with respect to living or recent specimens, so that students acquire "the habit of considering things in their multiple relations, not isolated in special systems" (Vasconcelos, 1923, p. 29), which facilitates learning in environments outside the classroom.

Educationists who were contemporaries of Faria de Vasconcelos agreed on the existence of the first corollary, but problems arose as to its extent. While some dismissed arguments because they intended to restrict education in natural sciences only to the study of the local environment and thereby forego nature that exists outside this environment, others argued in favour of studying Nature beyond the local environment.

Faria de Vasconcelos again relies on Dévaud as a guide. First, children should study examples of the beings that exist in their daily observation, which are related to their life in the local environment and familiar to them. The examples must be useful or harmful and arouse the child's interest and clearly represent the manifestation of life intended for observation. The environment which is foreign to the local environment is examined through these examples so that the child sees that the world is not limited to the horizon of their neighbourhood, and it promotes learning about economic, industrial, and human solidarity at a global level. Thus, foreign Nature is studied by comparisons with the beings of the local environment. Intuition is mediated; therefore, biological, and physical/chemical principles yield to morphological and utilitarian principles on this occasion.

Educationists were concerned with presenting organised syntheses of knowledge as a method to facilitate learning at a global level. With respect to the second condition, Faria de Vasconcelos tries to organise a teaching programme – scientific classification system – just to argue against it. So that no one would assume that the author had forgotten the scientific classification system or that he was tacitly defending it, he offers it as a comparison to Paul Bert's thinking.

Paul Bert (1833-1886) was a French physiologist and politician and was one of Claude Bernard's most brilliant disciples. Between 1881 and 1882, he was minister of education, occupying the cabinet of Léon Gambetta (1838-1882) (Beers, 2022). In 1882, Paul Bert wrote *La Première Année d'Enseignement Scientifique [The First Year of Science Education]*, which was intended for children between 9 and 11 years old and presented subjects about human beings, animals, plants, rocks, physics, and chemistry. A few months later, the French Superior Council of Education published the new scientific education programme for primary schools, which corresponded, even down to the details, to the plan set forth in Paul Bert's book. This author anticipates by a few decades what will come to be called constructivism, as he advocates a method in which the same subjects are revisited in a successive series in a spiral that always presents a greater abundance of complexity and information (Bert, 1903).

Paul Bert argues, as do others, that it is necessary to "do science" in primary school; in other words, natural sciences should be taught according to a scientific method. Thus, as recommended in the programmes of *lycées* and schools of various countries at that time, zoology and botany should be taught based on observations and descriptions of individuals, plants, or animals. The pupil is gradually led to make comparisons between similar forms until they acquire essential notions of morphology and knowledge of the system and are introduced to the most important manifestations and laws of animal and plant life. Accordingly, all the textbooks begin with a description of the characteristics of the species and progressively move up the levels of classification through comparisons.

Whether they begin with the general to the concrete or with the specific to the abstract, classifications formed the skeletal structure of lessons in natural history in most schools.

Faria de Vasconcelos is opposed to this criterion. He thinks that classifications should not be included in primary education or in the first years of secondary education and presents a set of arguments. Resorting to Dévaud once again, Faria de Vasconcelos believes that classifications initiate the student into the system, not into Nature, since they are based on particularities and forms that do not give an adequate idea of the being. Furthermore, the classification system is abstract, difficult to understand, and too external and superficial, and it foregoes a biological viewpoint, the conditions for life, and the relationship between beings and their environment. Therefore, an introduction to the study of zoology or botany should avoid the classification system, which is incomplete and artificial by nature, and opt for the coordination of knowledge resulting from a concentration, a natural grouping of beings.

In short, Faria de Vasconcelos is mindful of the need for students to form an idea of a whole, where various details coalesce into the harmony of the whole.

The concerns of 19$^{th}$ century naturalists, which centred on morphological descriptions of the characteristics of living beings, shifts to the theoretical elaboration of laws and the conditions for their existence at the end of the century and in the beginning of the next. Here we see how essential it is to study the influence of the environment, food, and heredity in comparison to the study of classifications.

Botanists and zoologists become aware of a necessary step to take in studying species: to observe individuals in the environment in which they live, in their relationship with the beings around them, and in the successive transformations resulting from their adaptation. Life evolves in a space of interaction with other living beings; it is a collective phenomenon. Groups of individuals – communities – form to better satisfy their needs of existence. There is also a focus on the study of communities as the study of morphological characteristics of species has already been conducted. We are clearly addressing the emergence of the study of biological collectivities, what would later be called biotic and abiotic relationships, interactions that living beings occupying the same ecosystem can establish. As we shall see, Faria de Vasconcelos was already aware that living beings should be studied as natural communities, given his contacts, and reading sources.

One is the work of August Heinrich Philipp Lüben (1804-1874), an outstanding teacher who took up the post of primary school teacher in Dorf-Alsleben an der Saale in the German state of Sachsen-Anhalt in 1825 and was mainly responsible for presenting the principle of biological collectivity in 1832. This principle became established with the work of Iunge in 1885. A few years later, Otto Schmeil published *On Reform Efforts in the Field of Natural History Teaching* (1896) and set out the services that can be provided in teaching natural collectivities.

Faria de Vasconcelos had access to a textbook by Jaccard and Henchoz that was intended for use in primary schools and inspired by biological and physical/chemical principles, whose presentation was divided into natural collectivities (Jaccard, 1895). Influenced by these authors, the principle of collectivities penetrates official education and are adopted in German primary schools and in the Vaud schools of Switzerland. Lessons that take place outside the classroom become absolutely essential as living beings should be studied in their own habitat, and these topics constitute the object of study in the classroom.

Special, typical topics are chosen from the general topics and are examined with in greater depth, supplemented by observations made by the children. Although the programmes indicate topics, the teacher is free to choose other topics that are easier to observe in the local environment. As previously stated, the criterion of the local environment prevails in the selection of special topics or in their order of study. The core structure is no longer the topic; it is the teaching methodology. At the higher levels of education, the teaching methodology should have a more utilitarian character and adapt to the social context of the school, and it should be oriented towards an active life, whether it is essentially agricultural or predominantly made up of trades and professions.

It is not surprising, therefore, that Faria de Vasconcelos, who is attentive to everyday life, presents the principle of collectivities as the last criterion for organising an educational programme. The author even distinguishes biological collectivities from natural collectivities. The former corresponds to exclusive sites and the living beings that live in them and the physical/chemical conditions indispensable to their survival in these sites (*e.g.*, river, swamp, mountain, lake, sea). Biological collectivities correspond to the concept of biocoenosis introduced in 1877 by the German biologist Karl August Möbius (1825-1908), *i.e.*, a set of communities inhabiting a biotope. Natural collectivities result from the involvement of human beings in bringing together living beings at a site (*e.g.*, house, garden, meadow, field, path, forest). Natural communities, even if maintained by humans, are still biocoenoses.

In short, the principle of collectivities allows for the following:

*a)* To observe living beings in their habitat

*b)* To understand intra- and interspecific relationships

*c)* To study the conditions and laws of existence of organisms in an orderly, helpful manner

Faria de Vasconcelos maintains that an education based on this principle follows Nature itself as it groups organisms into collectivities. Consequently, following the outline of the German and Swiss programmes, the author presents his position:

*a)* Each teacher chooses the collectivities based on the local environment and organises their lessons accordingly.

*b)* Local circumstances determine the order and succession of study.

*c)* As for the study of collectivities, besides the animal and plant kingdoms, the mineral kingdoms which are more appropriate, and representative of the natural environment chosen should be studied.

*d)* Only three to four biological and natural collectivities, which are sufficiently large, rich, and diverse, should be examined each year.

*e)* Collectivities that exist outside the site should be studied as an extension of the site.

*f)* The local environment is studied as a single collectivity at the end of the child's schooling, constituting a kind of synthetic recapitulation of the collectivities examined in past years.

## WORK METHODS

In continuation of his vision for education, following the conditions to establish an educational programme in natural sciences, Faria de Vasconcelos knows that it is necessary to pay attention to work methods. The way one teaches, the culture of mental functions, and, consequently, the type and quality of learning that can be generated depend on these methods.

Faria de Vasconcelos is well aware that "what matters in life is to possess not only knowledge but, above all, the ability to know how to use it, to apply it at the opportune moment, and to execute it as and when the needs of existence demand it" (Vasconcelos, 1923, p. 44). He understands that this transfer of knowledge depends largely on the technique of its acquisition.

The pedagogy of the late 19th century and the first quarter of the 20th century completely renewed the educational methods and processes that had been propagated up until then. It did so on the basis of the recent results of experimental psychopedagogy. Faria de Vasconcelos lists the bases for "new" education (Vasconcelos, 1923, p. 45-47):

*a) Intuition*

In the words of Couturat, intuition *"(en tant qu'elle est inventive, c'est-à-dire vraie), consiste dans l'aperception synthétique d'une relation ou d'un ensemble de relations logiques de la déduction doit pouvoir toujours expliciter et vérifier"* (Couturat, 1913). There is a need to have students see, hear, touch, *i.e.*, to experience the objects to be apprehended by passing things on before words.

*b) Activity*

In the words of Freinet, *"nous voulons des activités scolaires vivantes, liées à l'intérêt et au devenir profond des enfants, beacoup mieux qu'un jeu et un passe-temps, mais du travail véritable, auquel on se donne totalement"* (Freinet, 1967, p. 302). The need to have students enact, manipulate, and construct activities oriented towards their understanding and assimilation of information is recognised.

*c) Observation and experimentation*

The student should be trained to observe natural phenomena directly and individually and to conduct experimental activities. Observation should be the chosen teaching method. *"Observer annonce ou suppose un plus grand travail de l'esprit. On observe ce qu'on étudie: on remarque ce qui frappe. (...) On observe, en cherchant. (...) On remarque quelquefois comme on rencontre, par hasard"* (Lafaye, 1869, p. 911). Therefore, it is necessary to place the pupil in direct contact with the conditions and forms of nature and life. For Émile Brucker, teaching botany without plants and zoology without animals was a crime against the intelligence of children (Brucker, 1912).

*d) Induction*

Facts are determined by phenomena and concepts are developed through logical reasoning.

*e) Scientific attitude*

This involves stimulating a spirit of initiative, research, and personal discovery. *"L'esprit scientifique est fait surtout d'amour de la vérité, de conscience intellectuelle, et d'un empire de la volonté sur le jugement qui préserve de toute influence étrangère à la raison"* (Goblot, 1958, p. 11).

*f) Interests and natural abilities*

This relates to making use of the pupils' innate aptitudes, interests, and natural abilities. The pupil's personal activity constitutes the essential drive behind the acquisition of knowledge and the culture of thinking.

*g) Reasoning skills*

Education promotes the cultivation of judgement, reasoning, and critical sense over and the accumulation of knowledge through sterilising verbiage and memorisation.

*h) Disciplinary spirit and technique*

Students must be introduced to the way the science they are studying is constructed by becoming familiar with methodological procedures and research techniques.

As a result, it is necessary to opt for a panoply of work methods based on these guidelines. We consider some of these methodologies in the following passages.

Let us recall that a science education should adhere to the first principle: observe and experiment. Goué and Goué, very relevant authors for our Portuguese educationist, underscore the importance of training children to observe as a basis for constructing knowledge (Goué, & Goué, 1917).

Faria de Vasconcelos (1923) highlights the purposes and the pedagogical conditions that the exercises and work in personal observation should satisfy in a natural sciences education, based on several contemporaries, such as Eugène Dévaud, the Goué couple, and Victor Mercante (1870-1934). Following the bases of "new" education, these exercises allow the student to come into direct contact with Nature and thus stimulate their spirit of initiative and personal investigation. They awaken the student's curiosity and activity and serve as a way to practise reflective and methodical observation.

First of all, the author warns that students do not know how to observe. It is necessary to teach them how to observe by means of a plan: to determine the purpose of the observation (observe "what for?"), the object of observation (observe "what?"), and how to observe (observe "how?"). Information should always be collected as a function of the "what for?" observation and help students identify individual and common elements, establish relationships between the parts observed and the parts as a whole, and construct concepts: "When the examples observed are sufficiently numerous, it is necessary to compare, order, and classify them in order to induce general propositions, appropriate generalisations" (Vasconcelos, 1923, p. 50).

Observation and analysis is followed by a comparison between two distinct objects or between two states of the same being. Finally, with the general ideas, the student should be able to group the facts, arrive at generalisations, and formulate synthetic groups and classifications. The author proposes the following educational alignment: *a)* presentation of the specimen, *b)* systematic observation, *c)* analysis of the collected information, *d)* classification, *e)* induction of general laws, *f)* formulation of hypothesis or explanatory theory, g) systematic, h) transferability of knowledge. In sum, the author suggests that the teaching method should be the method of natural sciences.

Students may begin to work autonomously only after they acquire the observational skills. Faria de Vasconcelos underscores written quizzes and individual practical work as appropriate methods. With regard to the former, he draws on the experience of American notebooks with 100-300 sheets of printed quizzes and just as many blank sheets. These quizzes are arranged in a methodical, logical sequence and according to the lesson plans for each subject. Each student carries out the observations, experiments, and exercises prescribed in their notebook and then fills out the corresponding blank sheet in the laboratory. They constitute an entire lesson or serve as an intuitive and active preparation for a lesson.

This type of quiz allows the teacher to intervene frequently in the students' work while promoting their autonomy and proactivity. The students do not get distracted, and the proposed exercise can become an appealing activity that everyone performs. There are, however, a number of conditions for notebooks to be effective.

They must be simple, comfortable, and precise from a formal point of view. Half of the sheet should present the questions, exercises, observations, and experiences and the other half should be blank. They must include indications and schematic figures that help students learn how to observe and act since these are individual assignments. The plan should include a methodical distribution of the material, set forth the method, and orient the work.

The questions intend to lead the learner, beginning with inductive questions that refer to particular facts so as to “shed light” on their own knowledge as they arrive at solutions to general matters. In this dialectical exchange, the teacher does not instil knowledge in the student. Instead, the teacher guides them along as they construct knowledge through questioning.

Therefore, Faria de Vasconcelos is totally against catechistic and dogmatic quizzes, which, in his words, are associated with habitual, unprepared teachers and can be found at the end of the texts of many lessons.

Aside from observation, quizzes should help students cultivate construction, generalisation, and reasoning skills that lead them to work with systematic exposition, extending even to composition. In addition to self-observation, the student should resort to and receive orientation from a textbook based on the same principles as the quiz.

The outlines for practical activities – or quizzes, as Faria de Vasconcelos refers to them – conducted in the classroom, the laboratory, or external space, as proposed by Mercante, follow a general spiral alignment: observation/experimentation is followed by questions about what was observed, and then new observations/experimentations are oriented by the questions. The cycle repeats itself. The questions guide the observation/experimentation. Without this orientation, observation/experimentation remains aimless and can never provide answers to the questions. Thus, this is how a heuristic, rational, and critical method is conducted.

However, Faria de Vasconcelos does not entirely follow the American notebooks or, particularly, the abovementioned examples. Some notebooks have considerably mechanised the quizzing practise, which, in his thinking, is heavily circumscribed by observation and simplifies the material into details, which has already been designated and wrongly interpreted by excessive objectivity. Other notebooks intended for primary education seem to be too difficult for this age group, and their distribution and the sequence of questions and exercises are incompatible with the aforementioned biological and physical/chemical principles. Nevertheless, the quizzes taken from Mercante seem important to him as they offer indications and suggestions to elaborate better ones.

Another type of quiz is applied in activities that take place outside the classroom, or school trips, as designated by Faria de Vasconcelos. To illustrate one of the corollaries to the organisation of an educational programme – adapting education to the succession of seasons throughout the year – the author refers to the work written in 1912 by Madame Goué and Émile Goué. The work is divided into three parts. The application of the observational method is explained in some detail in the first part. The second part is entirely composed of a panoply of 2289 questions distributed across several months of the school year and corresponds to the application of the first part, and students generally answer in writing and often with drawings. Each section is divided into three parts: botany, zoology, and miscellaneous questions. The third part consists of recapitulation exercises.

Faria de Vasconcelos also recommends a method for correcting the quizzes in the classroom. The teacher designates a student to provide a brief report of what they observed and experienced. The other classmates intervene, complete, correct, and comment on the quiz in a classroom discussion.

## RECAPITULATIONS, TECHNIQUES, AND SCHEDULES

Goué and Goué had already insisted on the importance of recapitulations, assigning them to the third part of their work. Faria de Vasconcelos invokes William James (1842-1910), American philosopher and psychologist, leader of the philosophical movement which became known as pragmatism and one of the founders of the psychological movement of functionalism, to argue that the subjects should be presented in a new aspect in recapitulations. If a learning process has been conducted at an analytical level at any given moment, it can be synthesised in recapitulation. Faria de Vasconcelos presents the objectives of recapitulations and the conditions in which they should be conducted. He believes that new relationships, which can only be understood after a subsequent set of notions, are beneficial and fruitful for learning. Thus, recapitulations should occur frequently and be incorporated into the chronology, and they should be thoroughly prepared and follow a logical order. Monographs are presented as an excellent recapitulation exercise that offer students an opportunity to analyse and synthesise their learning.

As for diagrams and synoptic tables, Faria de Vasconcelos refers to the work of Gabriel Charles Revault d'Allonnes (1872-1949), a French psychologist known for his studies on the psychology of attention. The idea that thinking without images is impossible, defended by Aristotle, is replaced by this author's suggestion that one cannot think without schematisation. The schema has an abbreviatory function, a vision, a figuration that approximates, extracts, and simplifies the characteristics of an object.

Faria de Vasconcelos is against textbooks, commonly known as compendia or handbooks of knowledge to retain by memory, arguing that the foundations of modern pedagogy are rooted in

> intuition; in the pupil's integral and personal activity; in the observation and experimentation of facts; in induction; in the pupil's spirit of initiative, investigation, and discovery; in considering education as a means of cultivating judgement, reasoning, and critical sense rather than the accumulation of knowledge. (Vasconcelos, 1923, p. 81).

In this "new" education, things take precedence over words. They tend to mould the spirit and open the student more effectively towards active discovery in a permanent effort to investigate and construct personal knowledge. Faria de Vasconcelos defends the existence of various, abundant copies of natural science books that are profusely illustrated so that students may consult them. These books serve to complement the notions acquired by the students and illustrates their thinking with multiple examples.

Regarding learning schedules, Faria de Vasconcelos maintains that "the natural sciences should be the basis and essential core of intellectual education in schools" (Vasconcelos, 1923, p. 83). Truly active, intuitive, and experimental education occupies a significant amount of time and should be offered in large blocks of concentrated work so that students are occupied solely with the study of sciences during this period. Consequently, he suggests devoting a whole morning or afternoon to natural sciences, i.e., two to three contiguous hours without the intrusion of other sciences. In conclusion, he argues that lessons with a duration of 45 minutes can only result in a verbal, lifeless, uninteresting, and unprofitable education, which is effectively a waste of time.

## SCHOOL TRIPS

For Faria de Vasconcelos, the school's spiritual vitality and the teachers' morality and pedagogical skills is indicated by the number and quality of the school trips. The school trip translates into a journey or a study tour. The author presents five arguments to support its value in educational work:

*a) Physical* – an excellent exercise in culture and hygiene *b) Intellectual* – it provokes a spirit of observation, feeds curiosity, arouses attention, requires imagination, awakens intelligence

*c) Moral* – practical occasions for coexistence that generate social interests, friendly relations, solidarity and cultivate patience and the spirit of sacrifice

*d) Artistic* – This relates to a culture of love towards nature as "*jedes landschaftsbild ist ein seelenzustand*"[1] in the perspective of the Swiss mystic Henri-Frédéric Amiel (1927), which Faria de Vasconcelos understands. The school should transform feelings about nature into an indispensable spiritual need. The city is exhausting and depressing. Nature strengthens and elevates and enables recollection, meditation, the solitude of silence. Faria de Vasconcelos interprets the perspective of the English critic John Ruskin (1819-1900) as the continuous perception of holiness in nature as a whole, which is irreconcilable with every bad feeling. It means to return to a certain "inner lyricism (...) an open window to a noble ideal" (Vasconcelos, 1923, p. 90).

*e) Education* – It provides objects for study, observation, experience, and reflection. Natural sciences without school trips is an arid, dead-letter, inert, almost incomprehensible education.

This is why Faria de Vasconcelos recommends that ("well-organised") schools should include compulsory and frequent school trips in their calendar. However, school trips should also be supported by a methodology with a certain number of conditions for effective results.

A school trip must be prepared carefully. Here are the steps provided by the author:

> *a)* adopt a work plan and set a clear and precise objective that avoids useless and complicated details, which often obscure notions instead of organising them; *b)* whenever it is possible for the teacher, to plan the itinerary of the school trip so that they know what to say and what is relevant; *c)* organise the material for the school trip: notebooks, worksheets for collections, etc. (Vasconcelos, 1923, p. 91).

The object of study, its duration, the timing, and the number of students are factors that depend on the students' age, educational requirements, logistic conditions, among other aspects.

The school trip should follow the outlined plan, but Faria de Vasconcelos calls for teachers to seize opportunities for "occasional teaching" (transdisciplinarity) about subjects outside the objective of the school trip. Once the trip is over, learning must continue. One or more lessons should be dedicated to examining and organising the collected material, to taking notes, to explaining and completing the observations made, and to organising and presenting records: essays, conferences, exposition of collected materials.

Faria de Vasconcelos proposes applying a "school trip sheet" with the following fields: course, year, date, duration, number of students, object of the school trip, itinerary (sketch), occasional teaching, collections obtained, exercises relative to the trip, results obtained, expenses, observations. The author also encourages the real and effective participation of pupils in the preparation and organisation of the school trip due to the interest and initiative it arouses. To form and inform the associative spirit, he thinks it would be interesting to encourage the existence of a savings pool for school trip expenses and societies for school trips among students.

## SCHOOL GARDEN

Faria de Vasconcelos emphasises the importance of school gardens in natural sciences education as he is aware of several experiences that are highly successful in his view. He believes that gardens play a key role

1 "Each landscape is a state of mind" (loose translation by the authors).

in a school's life and are fruitful resources for general education as they provide the opportunity to exercise highly valuable qualities for life and awaken a sense and love for nature. "The school garden is introducing nature into the school and to the pupil in direct contact with it" (Vasconcelos, 1923, p. 96).

Gardening cultivates a set of qualities (patience, foresight, initiative, mutual help, responsibility) and facilitates physical exercise. As for the natural sciences, the school garden familiarises the student with biological processes, actual knowledge, and the utilisation of beings, and it may even provide a practical and experimental basis for a professional education in agriculture, horticulture, and arboriculture. Faria de Vasconcelos goes on to examine some effective factors involved in the installation and organisation of a school garden. All the work should be recorded in a notebook of observations, like the one shown by Faria de Vasconcelos, which he used at his school in Bierges.

## DRAWINGS AND SCHOOL PROJECTS

Drawing is a most precious aid in the natural sciences. Faria de Vasconcelos read the work of Friedrich Adolph Wilhelm Diesterweg (1790-1866), a progressive German educationist, and understands that an hour of drawing is more beneficial to intuition than contemplating an object for ten hours. He presents the purposes of drawing in teaching and learning science as he is aware that drawing often provides the best explanation of a notion and also serves as a recapitulation exercise. However, the author opposes the way in which drawing is used – as a copy of the objects, which arouses admiration but does not express what is essential about them – and defends the utilisation of scientific drawings, based on the Canadian biologist William Francis Ganong (1864-1941), such as "sketching [quick and short] diagrams that offer an idea of the characteristics of the object represented; even if a diagram is unrecognisable as a drawing of the object, it accurately represents its essential elements" (Vasconcelos, 1923, p. 103).

He indicates the conditions to properly apply drawing in a natural sciences education. In addition to drawing, Faria de Vasconcelos values the contribution that handmade school projects offer in science education, specifically: modelling, as a technique to replicate beings; poster board crafts of useful objects (e.g., cards for the garden, zoological charts, boxes), which teach precision, patience and accuracy; and various applications of woodwork (*e.g.*, boxes, cupboards, shelves), as excellent physical and sensorial exercises.

## EDUCATIONAL RESOURCES

Faria de Vasconcelos understands that "it is impossible to observe, to experiment, to work effectively, to acquire the disciplinary spirit and technique" (Vasconcelos, 1923, p. 107) without educational resources. Without materials, one falls into the compendium, into recitation from memory, passivism and verbosity. For this reason, he indicates that every school must have adequate and diverse teaching materials so that it can run well and begins by referring to the most characteristic equipment of the natural sciences: the laboratory. The "new" education cannot accept the possibility of learning mathematics, history, natural sciences, and grammar in the same space at the same table in the same layout. The following is necessary:

> workrooms and laboratories, as well as the furniture and work material (devices, instruments, pictures, collections, products, books, etc.), where one can breathe in the atmosphere of the discipline. The study should be conducted in the *environment* that the subject requires, which is why pedagogy recommends the term "class-environment",


International Journal of Human Sciences Research ISSN 2764-0558 DOI 10.22533/at.ed.5583172331059

> wherein “only the sensations of the discipline are experienced” in everything that makes it up – tables, walls, cabinets, pictures, collections, instruments, internal arrangement, etc. (Vasconcelos, 1923, p. 109).

Faria de Vasconcelos is aware of the high costs of maintaining a laboratory in each school, but he believes a time will come when no money will be spared for adequate school facilities. Until that time comes, he presents a set of resourceful alternatives that offer resources and include moderately priced equipment to minimise the absence of a laboratory.

Faria de Vasconcelos does not name the laboratory as a space to do science. He idealises “an environment that sparks interests and intellectual functions” and promotes educational exercise through observation and experimentation of the mental processes as a way to acquire knowledge. For this reason, the objective of practical work in primary and secondary school is to help students develop aptitudes and acquire habits and a minimum set of indispensable knowledge. He stresses, “experimental zoology, experimental botany, experimental geology, as *logical and systematic courses* of work and study, exceed the scope of the primary school’s function” (Vasconcelos, 1923, p. 110). Without the laboratory, Faria de Vasconcelos, like V. Mercante, relies on nature, the great hall of work in natural sciences, where the teacher’s mission takes place outside the school more often than inside it.

Faria de Vasconcelos also encourages the preparation of aquaria, terraria, beehives, ant colonies as unique opportunities to promote immediate intuition, fruitful observation and education. He provides a set of valuable instructions and entrusts the students with them. The author draws on the works of the American psychologist G. Stanley Hall (1846-1924) and the English psychologist and geneticist Sir Cyril Lodowic Burt (1883-1971) to support the creation of animal, plant, rock, and mineral collections. They promote a direct intuition about nature as they respond to an instinct in children which grows until the age of 12 and declines from the age of 14. The collections also contribute to collective and social education when they are prepared by the pupils to create a school museum. The author supports his argument by presenting a collection’s value and providing concrete indications as to how to build a collection.

Faria de Vasconcelos goes on to support the use of pictures in science teaching, provided they represent the environment in which the animal lives, its natural disposition, characteristics, or way of life and habits. He rejects pictures of fantasy and values those which correspond to a portion, a fragment of nature present in the image, as long as the elements are related to each other. The pictures must contain details of the animals or plants, be exact and precise, and make use of clear and vivid colours on matte paper.

Prepared models and specimens are one of the auxiliary means for teaching natural sciences. Faria de Vasconcelos only accepts models that are faithful to nature and rejects grotesque copies. Faria de Vasconcelos also comments on the role of photographs and projection devices in science education. He attributes great educational value to photographs, as long as they correspond to the necessary purpose, and they also allow for the organisation of botanical albums.

Finally, Faria de Vasconcelos refers to herbaria and calendars. He argues that herbaria should only be used for classification exercises

Zoological and botanical calendars can be created by noting the dates relative to natural events of the local environment: appearance of the first leaves, flowers, and fruits on plants; appearance of the first migrating birds and the duration of incubation and when it occurred;


International Journal of Human Sciences Research ISSN 2764-0558 DOI 10.22533/at.ed.5583172331059

appearance of familiar insects, etc. Faria de Vasconcelos draws on Dévaud, who affirms that this type of strategy keeps the spirit alive and curious in the activity of observation and discernment. It contributes to the students' understanding of the relationships between natural phenomena and the particular conditions of the local environment.

## POTENTIAL CONCLUSIONS

The New Education movement emerges as a counterpoint to traditional education, which was especially expository and passive and relied heavily on memorisation. It was mechanised in its procedures and characterised by the teacher's authoritarianism and violence, and it was disconnected from the social reality. The new education movement is a structured attempt at the international level and is particularly sensitive to the "pedagogical overtime" and to active pedagogy. It values observation, experimentation, and deduction.

Students are encouraged to take responsibility so that the role of self-government in learning forms a structure acquired by exercise and experience.

Inspired by Rousseau and making use of functional psychology, one of the images of this "new" pedagogy is the integration of naturalism with hygienic and educational advantages, which is why it values scouting. Therefore, it calls upon observation, experimentation, research, personal discovery and encourages students to act and think for themselves. The school is seen as a "laboratory of practical pedagogy".

Faria de Vasconcelos is one of the main educators linked to this movement of renovation. Pintassilgo believes that he was one of the most committed authors to showing and proclaiming the scientificity of pedagogical discourse, freeing himself from empiricism (Pintassilgo, 2018). Faria de Vasconcelos was a curious and interesting man. He was curious because he had the audacity to believe that he could contribute to the integral development of human beings, which had its maximum expression with his New School in Belgium. He was interesting because he was a Portuguese citizen.

Faria de Vasconcelos designs a New School as a "laboratory of practical pedagogy, in which manual work, life in the countryside, physical education would all help create a general culture of the spirit that goes far beyond the sum and accumulation of memorised knowledge" (Boto, 2019, p. 4). For the author, the school should teach as little as possible and allow the student discover as much as possible through their own personal efforts towards research and discovery. It is up to the students to organise, coordinate, and systematise what they learn through their own personal experience. The teacher plays the role of learning guide. The teacher, colleagues, and the student are involved in the process to assess learning.

A natural sciences education constitutes the basis and turning point of the intellectual education of children between the ages of 7 and 10 years, and it should be organised according to biological and physical/chemical principles. Teachers should steer away from books as a text for lessons as much as possible. Teaching methodologies should promote intuition, activity, observation and experimentation, induction, scientific attitude, interests and natural abilities, reasoning skills, and the disciplinary spirit and technique. Teachers should begin with concrete ideas and move towards more abstract ideas by using examples and orient the student's thinking from particular details to the general whole, wherein the various details harmonise into the whole.

The programme needs to include a component related to the region where the school is located and to adapt to the succession of the seasons of the year. The practical work is structural and aims to develop the students' aptitudes and help them acquire habits and a minimum set of indispensable knowledge. The laboratory is essential to natural science practises, and it promotes educational exercise through observation and experimentation of the mental processes. It serves as a means for students to acquire knowledge in "an exciting environment of interests and intellectual functions". Activities outside the classroom should occur frequently.

In his work *Didactics of Natural Sciences*, Faria de Vasconcelos provides a synthesis of his framework for a natural sciences education. He recreates his ideas from the New School at Bierges with respect to the school's organisation, intellectual education, actual experiences in nature, the inductive method, differentiated instruction, and the teacher's role. Duarte compares the principles inherent to Faria de Vasconcelos' pedagogy to the challenges of the 20th century for education in the 21st century and concludes that the education provided in Bierges is a valuable educational treasure that has yet to be discovered and represents a standard that Portugal has not yet reached (Duarte, 2010).

Faria de Vasconcelos closely followed the scientific knowledge of his time. He read a a vast amount of literature from Europe and the United States of America. This allowed him to synthesise the main pillars of science education at that time, which are so pertinent and coincident with the pillars that occupied educators in the following generations and relate to the current topics examined by science education researchers: *a)* the importance of science education in developing citizenship; *b)* understanding the nature of scientific knowledge; *c)* integrating knowledge and holistic perspectives; *d)* education in context; *e)* studying previous ideas; *f)* developing scientific attitudes; *g)* active learning: learning by doing; *h)* practical and experimental work; *i)* activities carried out in environments outside the classroom; *j)* reasoning and problem solving; *k)* language, text, information, and communication skills; *l)* critical and creative thinking; *m)* personal development and autonomy; *n)* constructivism; *o)* personal interest; *p)* criticism of textbooks; *q)* curricular materials; *r)* active schools.

In *Didactics of Natural Sciences*, Faria de Vasconcelos does not provide a definition for education. However, based on the content of his work, he disagreed with the view supported by Maurice Debesse that modern pedagogy considers education "*tout au plus comme un pis-aller parce qu'elle s'appuie surtout sur les mécanismes d'enregistrement mnémique, au lieu de favoriser l'assimilation du savoir par le travail de découvert et de creation*" (Debesse, 1955, 817). Faria de Vasconcelos understands it more as a science, "while researching and experimenting with new teaching techniques based mainly on biology, psychology, sociology, and philosophy" (Nérici, 1969, p. 51). It requires great effort that is "reflective-comprehensive and the elaboration of theoretical-applied models that allow the best interpretation of the teacher's task and the expectations and interests of the students" (Medina, 2002, p. 7).

At the core of education in Faria de Vasconcelos' "new" school is the natural sciences, in addition to mathematics, languages, geography, history, interdisciplinary activities, and other sciences, and it is based on scientific evidence collected in the most recent works about psychopedagogy. Faria de Vasconcelos reinforces the idea that the teacher is a primordial force in science education. Their initiative, dedication, and willingness is the source of triumph over countless difficulties, which entails the work of a true educator. Along with Duarte (2010), Felgueiras (2020), Fernandes (1979), and Martins (2019), we believe that the name of Faria de Vasconcelos should figure prominently among the great educators examined in initial teacher training. Furthermore, his legacy serves as a relevant point of reflection on the state of science education in Portugal. Diniz (2002) suggests that Faria de Vasconcelos could have been anything he wanted and that he deserved it for all his work.


## ACKNOWLEDGMENT

This work is financed by national funds from FCT - Foundation for Science and Technology, I.P., Portugal within the scope of the project UIDB/04312/2020.


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