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BIOLOGY SUBJECT CONTENT – DYNAMIC CURRICULAR VECTOR

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The article highlights the role of Biology subject contents as a dynamic curricular vector aimed at developing both specific and transversal competences in students. It examines the informative, formative, and axiological dimensions of the content, the concentric structure at the middle school level, and the linear grade-based system at the high school level, as well as their functions in fostering students' competences. The article emphasizes the importance of selecting and organizing content according to epistemological, curricular, and didactic criteria, and its role in consolidating knowledge, developing critical thinking, and promoting responsibility toward the environment and health. Furthermore, it underscores the spiral progression of concepts, the integration of practical applications with theoretical learning, and the facilitation of knowledge transfer to real-life contexts, highlighting the contribution of Biology contents to the development of systemic thinking and the cultivation of students' autonomous, responsible, and reflective perspectives on the living world.

Keywords: *Biology, curriculum, competences, contents, formative dimension, critical thinking, ecological responsibility, spiral progression.*

CONȚINUTUL DISCIPLINEI BIOLOGIA – VECTOR CURRICULAR DINAMIC

Articolul evidențiază rolul conținuturilor disciplinei Biologie ca vector curricular dinamic, orientat spre formarea competențelor specifice și transversale ale elevilor. Sunt analizate dimensiunile informativă, formativă și axiologică ale conținuturilor, structura concentrică la gimnaziu și sistemul liniar pe clase la liceu, precum și funcția acestora în dezvoltarea competențelor la elevi. Se subliniază importanța selecției și organizării conținuturilor pe criterii epistemologice, curriculare și didactice, precum și rolul lor în consolidarea cunoștințelor, dezvoltarea gândirii critice și promovarea responsabilității față de mediu și sănătate. Totodată, articolul pune accent pe progresia spiralată a conceptelor, integrarea aplicațiilor practice cu învățarea teoretică și facilitarea transferului cunoștințelor în contexte reale, evidențiind contribuția conținuturilor biologice la formarea unei gândiri sistemice și la dezvoltarea unei perspective autonome, responsabile și reflexive a elevilor asupra lumii vii.

Cuvinte-cheie*: Biologie, curriculum, competențe, conținuturi, dimensiune formativă, gândire critică, responsabilitate ecologică, progresie spiralată.*

Introduction

Curriculum development for Biology subject requires a functional correlation between the targeted competences and the learning contents that support their formation. While the objectives and competences define the direction and expected outcomes of biological education, the contents constitute the essential structure through which these objectives are embodied in meaningful and relevant learning experiences for the student [5, 11, 15, 16, 17, 18].

In the contemporary perspective, the contents of Biology subject are no longer viewed simply as an inventory of scientific knowledge, but as a dynamic curricular vector, closely linked to the specific and transversal competences, the values promoted and the training needs of the students. This approach reflects the transition from an informative paradigm to one centered on competences [14, 15, 16, 17, 18], oriented towards the development of scientific thinking, the capacity for investigation, responsibility towards health and the environment, as well as active involvement in social life.

Thus, biological contents become essential tools for integrating knowledge, developing competences and consolidating a systemic vision of the living world, constituting the foundation of a relevant, coherent and adapted curriculum to the requirements of modern education [5, 11, 15, 16, 17, 18].

Methods and Materials

The analysis was carried out through bibliographic and comparative research of specialized sources, national and international curricula, correlating curricular documents (National Curriculum, 2019) with the

recommendations of the OECD, UNESCO and the European Commission [14, 15, 16, 17, 18], as well as by examining biology curricula at middle school and high school [5, 6], identifying the structure, selection and progression of the contents.

Conceptual Benchmarks Regarding Peculiarities of Content in Biology Subject

The concept of Biology subject content, viewed from a curricular perspective, is characterized by functionality, relevance and direct links to the targeted competences. Next, the article will explore how these characteristics contribute to the development of students' competences, analyzing the informative, formative and axiological dimensions of the contents. It will also highlight the selection criteria, the structure and organization of the contents, as well as their role in facilitating meaningful learning and the application of knowledge in interdisciplinary and transdisciplinary contexts.

Content of Biology Subject from Curricular Perspective

Within the general education curriculum, the concept of "content" designates the structured set of knowledge, concepts, processes, relationships and learning contexts selected to achieve educational objectives. From a curricular perspective, the contents of the Biology subject represent a fundamental element of the curriculum architecture, being in an interdependent relationship with the educational objectives, the targeted competences and the assessment methods [12, 13].

The disciplinary content includes fundamental concepts of the life sciences, such as biological processes at the level of cell, organism and ecosystems, scientific methods of investigation, as well as real-life application contexts [4, 11, 15, 16, 17, 18]. They facilitate the transfer of knowledge and the development of investigation, analysis and problem-solving competences.

This organization ensures a balance between the theoretical foundations necessary for understanding natural phenomena and practical applications, giving relevance and significance to the learning experience for the student.

Therefore, the subject contents are not simple lists of information, but constitute an integrative framework that supports the formation of specific and transversal competences, the development of critical thinking, civic and ecological responsibility, as well as the ability of students to apply biological knowledge in real and multidisciplinary contexts.

Informative, Formative and Axiological Dimension of Contents in Biology

The contents of Biology subject reflect not only the scientific information specific to the field, but also their formative and axiological role in the development of students [14, 15, 16, 17, 18]. In a modern curriculum, these are not simple lists of notions, but deliberate tools for developing competences and promoting behavioral, social and civic values.

The structuring of contents thus simultaneously responds to three interdependent dimensions: **informative, formative and axiological.**

The informative dimension aims at the accumulation and organization of fundamental knowledge of biology – biological concepts, processes, laws and phenomena – which are the basis for understanding the living world. In the curriculum of subject, these contents are presented in a progressive logic, from general concepts, such as "The cell – the basic unit of life", to more complex topics, such as "Ecology and Environmental Protection" [5, 15]. This dimension provides the cognitive support necessary for the development of scientific competences and for the investigation of biological phenomena.

The formative dimension refers to the role of content in developing students' abilities, skills and practical competences. The current curriculum emphasizes the formation of scientific and methodological competences, such as investigating the living world through scientific methods, planning and carrying out experimental activities or interpreting biological data, going beyond the simple memorization of information. This orientation is supported by the curricular methodological recommendations, which promote interactive and experimental teaching strategies, such as case studies, research projects and practical activities [12, 13].

The axiological dimension of Biology subject contents aims to promote values and attitudes specific to biological education, such as responsibility for one's own health, environmental protection and biodiversity conservation. In the secondary school curriculum, the emphasis is explicitly placed on the involvement of

students in activities that stimulate ecological responsibility and healthy behaviors, thus integrating values into the structure of educational content [5, 6, 14, 18].

The articulation of informative, formative and axiological dimensions ensures a holistic curricular balance, which responds not only to the cognitive requirements of learning, but also to the socio-affective and behavioral ones. In this way, the Biology subject contents become instruments for the integral development of the student, contributing to the formation of an autonomous, responsible personality adapted to the requirements of a society based on knowledge, innovation and sustainability [15, 16, 17, 18].

Selecting, Structuring and Organizing Contents in Biology

In the architecture of biology curriculum, the selection, structuring and organization of contents constitute a complex pedagogical approach, located at the intersection of biological science requirements, educational purposes and developmental peculiarities of students. In the paradigm of competency-based curriculum, contents no longer represent an end in themselves, but become formative means for the development of specific and transversal competences and for the configuration of the graduate's profile.

The selection of Biology subject contents is based on clear criteria, which ensure the relevance and efficiency of the educational process [12, 13]:

- *Epistemological criteria* – the contents must reflect the foundations of biological science and be scientifically correct;
- *Curricular criteria* – the selection must correspond to the educational objectives and the competences targeted at national and European level [14, 15, 16];
- *Didactic criteria* – the contents must be appropriate to the level of cognitive development of the students, allow for progressive learning and facilitate the development of skills, attitudes and values associated with scientific thinking.

The structuring of contents respects the logic of vertical and horizontal progression, so that each learning unit is correlated with the specific competences provided for in the curriculum. The contents are organized into modules or content units, adapted to each level of schooling. At the middle school level, the Biology curriculum adopts a concentric structure, with five main modules [5]:

1. Cell, the basic unit of life;
2. Diversity and classification of living organisms;
3. Plants;
4. Human body and health;
5. Organisms in their living environments.

Each module reflects a predominant object of study, ensuring consistency, continuity and coherence in the formation of students' competences. The concentric structure allows the progressive resumption and deepening of the contents from one year of study to another, consolidating previous acquisitions and facilitating the integration of new knowledge.

In high school education, the contents are organized linearly, by grades, corresponding to the students' study progression [6]:

- Grade 10: exploration of fundamental concepts and initial organization of disciplinary contents;
- Grade 11: approach to biological systems (nervous, sensory, humoral, locomotor, etc.);
- Grade 12: deepening of genetics, biotechnology and ecology, with an emphasis on the human role in ecosystems and environmental protection.

The modular and linear approach facilitates the transfer of knowledge between contexts, the development of critical thinking and investigation and problem-solving competences, integrating theory with practical and experimental activities. The spiral progression of fundamental concepts, gradually revisited and deepened, contributes to the formation of a systemic vision of the living world and the development of responsibility towards nature and life [2, 3].

Thus, the selection, structuring and organization of biology contents represents a strategic, epistemologically grounded curricular process oriented towards the development of students' competences, critical thinking and civic and ecological responsibility.

Biology Contents – Support for Interdisciplinarity and Transdisciplinarity

The Biology subject contents provide an effective framework for the development of interdisciplinary and transdisciplinary relationships, facilitating functional connections between the knowledge and competences acquired in the natural sciences and those specific to the humanities and social sciences. Through its explanatory and integrative nature, biology allows the correlation of life phenomena with physicochemical processes, with the geographical and ecological dimensions of the environment, as well as with the social, ethical and cultural implications of scientific progress. The curriculum extends this approach, allowing the correlation of biology with mathematics, physics, chemistry, geography, environmental education and other humanities and social sciences [9, 14, 15, 16, 17, 18], thus promoting critical thinking, problem-solving competences and civic and ecological responsibility.

Interdisciplinarity involves the explicit correlation of biological content with concepts and methods from mathematics, chemistry, physics, geography and environmental education, highlighting the relationships between biological phenomena and the general laws of nature. For example, the study of human respiratory system can be integrated with physics concepts regarding gas exchange, with chemical aspects related to oxidation reactions and with the issue of the impact of pollution on population health. Such connections support the transfer of knowledge and the development of transversal competences, such as critical analysis, data interpretation and the application of information in real situations [1, 7, 8].

Transdisciplinarity extends the interdisciplinary logic by integrating biological contents into educational contexts that transcend disciplinary boundaries, involving social, ethical, economic and cultural dimensions. In this sense, biology becomes an educational tool for the formation of civic and ecological responsibility, awareness of environmental sustainability and the capacity to make informed decisions. Themes such as biodiversity, public health, bioethics or climate change can be addressed through transdisciplinary projects and activities, correlated with civic education, community development and education for democratic citizenship, generating an integrated and applicable understanding of contemporary reality [14].

In the context of modern curriculum, the emphasis on interdisciplinarity and transdisciplinarity supports the development of investigation, analysis and critical reflection competences, promoting active learning methods such as case studies, research projects, problem-based learning and simulations. This orientation is in line with both the European recommendations on the training of key competences for lifelong learning and with national curriculum documents, which emphasize the need for an education focused on competences, social relevance and adaptability [10, 14].

Therefore, the Biology subject contents do not constitute simple isolated units of study, but function as platforms for interdisciplinary and transdisciplinary relationships, contributing to the internal coherence of curriculum, to the increasing of educational approach relevance and to the training of competences necessary for an active, responsible and informed citizen in a society based on knowledge and sustainability.

Conclusions

The analysis of Biology subject contents highlights their role as a dynamic curricular vector, essential in the training of students' specific and transversal competences. The contents are not limited to the transmission of knowledge, but integrate informative, formative and axiological dimensions, supporting the development of critical thinking, ecological responsibility and the skills of investigation and application of knowledge in real contexts.

The selection, structuring and organization of content based on epistemological, curricular and didactic criteria ensure the coherence of learning, progression and relevance for the different levels of schooling. The spiral progression, the modular approach and the concentric or linear structures by grade facilitate the consolidation of knowledge, interdisciplinary integration and the development of complex competences, contributing to the formation of an autonomous, responsible and reflective student profile.

Also, the Biology subject contents function as platforms for interdisciplinary and transdisciplinary relationships, correlating the natural sciences with the humanities, social and applied disciplines. This approach promotes a holistic education, oriented towards real problems, sustainability and active citizenship, respecting international and national recommendations on the curriculum focused on competences and lifelong learning.

Therefore, the Biology discipline contents are not just informative support, but strategic tools for training competences, systemic thinking, and civic and ecological attitudes, contributing to the development of an integrated, autonomous, and responsible perspective on the living world.

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