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An analysis of genetics content in elementary school according to BNCC

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ABSTRACT

Science education has been undergoing constant transformations, with each new government there is a reformist outbreak, mainly affecting basic education. The current curriculum proposals brought after the approval of the Common National Base Curriculum (BNCC) serve as a guide for public and private schools to develop their curricula. The BNCC is a normative document, with mandatory adherence throughout Brazilian territory. Thus, this article aimed to analyze, through a bibliographic survey through articles in the databases of SCIELO, SCIENCE DIRECT, ELSEVIER AND CAPES, BDTD, TCCs, magazines, books and official government documents, what BNCC proposes in the objects of knowledge that include genetics in the final years of elementary school. When we observe the summary and approach of some science textbooks approved by the PNLD-2020, the main teaching resource available to the teacher, we realize that the language and concepts of genetic terms used in teaching fundamental follow the same characteristics of those observed for secondary education, that is, the presence of an inadequate language, with isolated concepts, poorly synthesized and without historical context. The introduction of genetics in Elementary School can be considered positive when accompanied by a more interdisciplinary discussion using mathematics, chemistry and concatenated with the knowledge acquired in the previous year. These skills related to mathematics and chemistry need to be studied in a previous year or in the same year, as this prior knowledge needs to be consolidated so that the skills proposed for teaching genetics can be developed. Much of the difficulties associated with teaching genetics are not restricted to recent changes in curriculum formation guidelines, as these difficulties are old and recurrent, but the vast majority of the problems are focused on the way in which genetics has been taught and that the initial teacher education is closely related to the way in which he understands and later teaches genetics. Faced with many discussions on the subject, it is expected that in the future there will be a reduction in such problems, perhaps the hope is in those who will be fully involved in the teaching process, that is, the teacher.

KEYWORDS: Common National Base Curriculum. Science teaching. Genetics teaching in elementary school.

INTRODUCTION

The teaching of Science has been going through constant transformations over the years. Krasilchik (2000) discusses the importance of science teaching in educational institutions, this subject has always been mandatory in the school curriculum, however, as Science and Technology gained ground and were recognized as essential for economic, cultural and social development, the teaching of this discipline was gaining ground and was recognized as necessary in basic education.

To improve learning the changes need to be significant in order to have a practical and continuous purpose (MELGAR, 2014). The teaching process is characterized by the combination of activities between teacher and student (LIBÂNEO, 1994). Therefore, it can be said that teaching is the mediation of sets of elements that are organized among themselves to build knowledge (MASCARENHAS *et al.*, 2016).

The approval of the Common National Base Curriculum (BNCC) in Brazil for Elementary Education in 2017 brought changes in education, especially in science. Since this reference document was approved, the content related to the teaching of genetics starts in elementary school in the 80s and 90s, specifically both in the axis of thematic unit II: life and evolution. The objects of knowledge proposed by the BNCC for teaching genetics are: "Reproductive mechanisms and heredity and evolutionary ideas", both distributed in two and four skills in the 8th and 9th grades, respectively (BRASIL, 2017b).

From this introduction of specific skills for genetics in elementary school at BNCC, the National Textbook Program (PNLD) has been undergoing changes since its publication (2018), in order to supply the need for interaction between the base and the book which must supply its guidelines and support its implementation. In addition, the textbook is one of the supporting teaching resources in the implementation of teaching, being commonly found in schools and in most cases it is the only resource available to the teacher.

In a contemporary view of formal education, it is understood that the contents discussed at school should promote learning and have meaning for students in order to prepare them to act critically in their contexts. From this perspective, genetics is fundamental in science education because it helps in the perception of the relationship between scientific and technological knowledge throughout society in order to instrument it for the formation of opinion and for grounded action (AGAMME, 2010).

Even within a scenario that involves countless biotechnological and scientific advances in constant transformation, the teaching of genetics has been identified as the most difficult area to teach and learn associated with numerous difficulties, both in high school and university (RODRIGUES, 1995; AYUSO; BANET, 2002; SILVEIRA; AMABIS, 2003).

Thus, some questions about the teaching of genetics, such as: Was the inclusion of specific skills in this area in the teaching of science in elementary school by BNCC an important step? Wouldn't it be interesting to try to alleviate a recurring problem in teaching before changing the curriculum formation guidelines? Will the introduction of this concept without a theoretical basis not compromise the learning of students in these years of education?

With this questioning, this article analyzes the BNCC proposal relating the skills for genetics content guided by this document and the summary of some textbooks on natural sciences from the 8th and 9th grades, edited after the year 2019, and discusses learning in teaching genetics in teaching science.

This research, from an epistemological perspective is exploratory, qualitative, bibliographical and documentary, since the content of genetics composed/guided by the BNCC for the 8th and 9th grade of elementary school. The Law of Guidelines and Bases was analyzed (LDB), as well as a bibliographic survey through articles in the databases of SCIELO, SCIENCE DIRECT, ELSEVIER AND CAPES, BDTD, TCCs, magazines, books and official government documents. As for the search criteria, the keywords were used: Common National Base Curriculum and Science Teaching, Teaching of Genetics in Elementary School and Difficulties in Learning in Genetics.

To analyze the information, we resorted to renowned authors who discuss the topic, who gave us theoretical and methodological support for the work. For interpretation, the technique of content analysis was used, which requires a floating reading of the data, according to Bardin (2011, p. 56) "consists of an initial view, which will become familiar with the documents, with the texts that will be analyzed", whose reading provides the research with an overview of the problem to be investigated.

This importance is also accentuated when we analyze the changes recently introduced with the implementation of the BNCC. In the search for papers on the teaching of genetics, it is noted that this is a widely discussed topic in high school, but, however, for elementary school, these are still relatively scarce, which justifies the need for this research.

BNCC AND CHANGES IN THE TEACHING OF NATURE SCIENCES

Since 1961, the Law of Directives and Bases of Education (LDB) No. 4061/61, made the teaching of science mandatory in Elementary School, at first only for the final years. Ten years later, with the political transformations imposed by the military dictatorship, through the new edition of the LDB, Law n° 5.692 of 1971, the subject of Science was standardized as mandatory in the eight grades of elementary school (KRASILCHIK, 1987). This version of the 1971 LDB was in force until the promulgation of LDB No. 9394 of 1996, which is still in force to this day.

In Brazil, there were several changes in education and also initiatives for the formation of the curriculum, some were even consolidated, while others were forgotten at the end of the government. Krasilchik (2000), reflected on the changes that occur in society with each new government, considering that with each change, new changes are instituted, which sometimes directly affect basic education. One of these changes arose to the need to create a base that would serve as a reference for the formation of the curriculum throughout the country. This discussion was already relatively old, since the need to create a Common National Base where the minimum contents for elementary education could be fixed was already provided for even in the Federal Constitution of 1988, in its art. 210 (BRASIL, 1988).

It is interesting to note that in one of the pioneering initiatives for curriculum formation in Brazil, the National Curriculum Parameters (PCNs) were created,

which were created to assist school teams and help in the development of the curriculum, this document was divided into three volumes: one for the 1st to 5th grades, which was consolidated in 1997; another to the 6th and 9th grades, consolidated in 1998, and finally, the one referring to secondary education, which was consolidated in 2000 (DINIZ, 2018). The PCNs were national references for the formation of the curriculum, but unlike the BNCC their adherence was not mandatory.

In 2015, discussions began on the creation of a Common National Curriculum Base (BNCC), which was instituted by the Federal Government as a normative document and curriculum guide. It is important to mention that the BNCC was prepared in light of what the National Curriculum Guidelines for Basic Education (DCNs) say. The DCNs were instituted by the LDB in 1996, and are mandatory norms for Basic Education that establish goals, objectives and guide the curriculum planning of schools and education systems. They remain valid, so one document does not exclude the other. Because, both documents are mandatory and must be respected by all schools in the country (O QUE..., 2018).

Since then, the preparation of the base has counted with the collaboration of several experts and also with the holding of seminars, public consultations, public hearings, conferences, etc., all led by the National Council of Education Secretaries (Consed), by the National Union of Municipal Education Directors (Undime) and the Ministry of Education (MEC), which together created a kind of national mobilization in order to discuss the creation of a Common National Base Curriculum.

The BNCC was debated in public consultations, through state seminars, and, despite being the target of numerous criticisms, it was approved by the Ministry of Education (MEC) in December 2017, (BRASIL, 2017b). The National Association of Graduate Studies and Research in Education (ANPED) took a critical stance on the approval of the document and reiterated that it was inspired by experiences of curriculum centralization, which resembles the National Curriculum developed in Australia and the curriculum reform Chile, both criticized in several studies (DINIZ, 2018).

As mentioned before, the base is taken as a reference in the formation of the curriculum. Therefore, it is not the curriculum itself, but it contains guidelines that must be considered when educational institutions prepare their curriculum. After the date of approval of the base, according to the Resolution of the National Education Council (CNE), all schools in the country had until the year 2019 to adapt their curricula, with the beginning of the 2020 school year as the maximum deadline (BRASIL, 2017a).

The BNCC is structured in three stages of schooling (Kindergarten, Elementary School and High School), defining the set of essential learning that students must develop throughout these stages of Basic Education, and also the ten general skills that will ensure training integral human. (BRASIL, 2017b). It was organized into five areas of knowledge (Languages, Mathematics, Natural Sciences, Human Sciences and Religious Education), each area of knowledge has specific competences explaining how the ten general competences are expressed in each area (BRASIL, 2017b).

In areas that contain more than one curricular component (Languages and Human Sciences), specific competences of the component were also defined,

which allows for a horizontal articulation between the areas. Each curricular component presents a set of skills related to different objects of knowledge, which were organized into thematic units, which guarantees the development of these specific skills (BRASIL, 2017b, p. 28).

For the teaching of the Science curriculum component, learning was organized into three thematic units, which will be repeated throughout Elementary School. They are: Matter and Energy: which includes the study of matter, sources and types of energy and the use of natural and energy resources; Life and Evolution: involves studies on living beings, their social and natural phenomena, ecosystem characteristics and their interactions with biotic and abiotic beings and Earth and Universe: with information about the Earth, Sun, Moon and other celestial bodies, studying important characteristics for the maintenance of life on Earth, knowledge about the possibilities of creating the Universe and notions of climate and weather (BRASIL, 2017b, p. 326-327).

In Natural Sciences area, the changes proposed by BNCC were very expressive. Knowledge about different areas of science has been transposed throughout elementary education, offering the necessary means for students to develop the investigative process. The three thematic units will develop, for example, themes such as socio-environmental sustainability, environment, human body, health and technology, throughout elementary school, no longer being concentrated in a specific grade, as the old traditional curricula used to guide (MODERNA, 2019). These thematic units organize the contents of the curricular component, always maintaining the proposal of learning progression, with skills being worked on year after year with an increasing degree of complexity (BRASIL, 2017b).

Regarding the implementation of the BNCC, in the State of Maranhão, the State Government launched the Curriculum Document of the Maranhense Territory for Early Childhood Education and Elementary Education (DCTMA), this document was approved by the State Council of Education (CEE-MA) on December 28th, 2019 and serves as a basis for public and private schools to prepare or re-elaborate their curricula, their Political Pedagogical Projects (PPP) and the lesson plans of their teachers (BRASIL, 2019a). The DCTMA presents suggestions for activities for all areas of knowledge. These activities will help teachers in planning classroom activities. Thus, it is important to open a parenthesis and emphasize that in the curriculum organization, there are no suggestions for activities for the objects of knowledge aimed at teaching genetics.

GENETICS IN SCIENCE TEACHING-BNCC

Science is still perceived by some subjects as something distant, apparently without any influence on their reality, its teaching is still restricted to offering knowledge of ready-made and finished products to students (NASCIMENTO; MENDONÇA, 2010). Therefore, when teaching the sciences we must not present it in this way, but when teaching we must present it as historical and provisional knowledge. Understanding that learning it is not acquiring absolute knowledge, but an exercise in knowing how to compare and differentiate models (POZZO; CRESPO, 2009).

This corroborates one of the main premises of the specific competences of BNCC for teaching natural sciences in elementary school, where it is read that the

student needs to "Understand the Natural Sciences as a human enterprise, and scientific knowledge as provisional, cultural and historical" (BRASIL, 2017b). Therefore, the student must develop skills, critical thoughts and understand that there is not only one absolute truth, but several, and it is up to him to question and be able to decide whether these truths are sustainable or not.

Pozzo and Crespo (2009) demonstrated in their work that inappropriate attitudes and beliefs, such as thinking that "to learn science it is better not to try to find your own answers, but to accept what the teacher and the textbook say", or that "scientific knowledge is always neutral and objective" are among some inappropriate attitudes that students maintain about the nature of science and its learning. According to Scheid and Ferrari (2006), one of the biggest problems in teaching genetics is precisely this type of dissemination of the view of Science as an unquestionable truth, because this makes the nature of scientific conception difficult and ends up discouraging students.

Currently, the fragmented understanding of the sciences has made it reiterate its neutral role. The vast majority of students even know the results of their applications, but, however, they are totally unfamiliar with regard to their achievement history (BOZANINI, 2011). Issues like these have further distanced the teaching of genetics from the reality of the student, since some even limit themselves to thinking about how such a feat could be achieved, as they feel they are too minority to possess such knowledge. This further emphasizes the existence of inappropriate concepts, such as thinking that this knowledge is exclusive to scientists and researchers. Since assimilation demands a high level of abstraction on the part of the student, which often makes them feel unmotivated to learn this subject (CATARINACHO, 2011).

In addition, there is still a perceived lack of connection between laboratory activities and classes, and also between classroom science teaching and real-world applications. Part of the interest in learning about genetics is being able to relate the information learned in the classroom to everyday life and advancing our understanding of our health, family, environment and workplace - something that scientific laws, theories and history not necessarily provide (HAGA, 2006).

It is desirable that the teaching of genetics is not limited only to familiarizing students with the content of this science, but rather, provide opportunities for critical education that is instrumental in judging issues involving respect for gender diversity, racial discrimination, the use of transgenics, vaccines, cloning, genomic sequencing of species, paternity tests, among others, which are commonly addressed by the media. There are also certain controversial issues that often generate controversial feelings ranging from apprehension and fear, to euphoria, sometimes exaggerated, as we have seen in the results of research related to the 2020 pandemic due to COVID-19, for example.

People are faced with these questions constantly, but when it comes to applicability, discussion and explanation of why these events happen, most people do not know how to formulate an opinion about it. This further reinforces what was said earlier, that this information is reaching people in a piecemeal way. Giordan and De Vecchi (1996) in their studies, observed that high school students remain confused about the concepts involved, even though practically everyone has something to say about the topic, most of them use scientific terminology confusing the meaning of different terms, configuring a pseudo-knowing.

In elementary school, from the few records we found, we can highlight the research by Horzum and Alper (2006) apud Güccük and Köksal (2017), in which they performed a comparison of teaching methods with the case study and the common (lectures, questions and answers) in science classes, involving the theme "environmental pollution". After three weeks of observation, a performance test was applied and revealed that teaching through the case study was the most successful compared to those who had the science class with the common teaching method, thus strengthening this method of teaching to improve student learning and academic performance.

When faced with issues similar to those mentioned above, we can have a brief notion of the importance of genetics teaching strategies in science. Well, we are no longer talking about teaching science just passing on content, and students receiving them, being mere recipients, as they were characterized in the past in traditional teaching. Currently, we are talking about teaching practice that is capable of teaching the individual not only to behave critically, but also to change the social environment in which they live. The student becomes the protagonist, and the science teacher has the role of mediating this process. Therefore, we understand that the potential of teaching genetics in science education is gigantic. In possession of this knowledge, students will be able to know each other, in a completely different way. They will understand that genetics is not restricted to a closed laboratory or a group of scientists, but very accessible, circulating throughout your surroundings, including your own body.

Currently, we know that professionals who work with science in the final grades of elementary school are teachers usually graduated in chemistry, physics or biology (MACEDO, 2001). So how can a professor with a chemistry and physics degree be able to teach genetics classes in elementary school if in the course in which such a professional was trained, was this knowledge limited since such concepts were not part of the curriculum of your course?

The BNCC have ten general competences for basic education that must be developed by students, and ensure, as a result of their learning and development process, an integral human formation aimed at building a fair, democratic and inclusive society (BRASIL, 2017b). Therefore, due to the rapid change in the knowledge base, educational resources in genetics need to be updated, including to reach the ten general competences for integral training.

Although there are already many programs and initiatives, as well as others in progress, new proposals and experiences are needed, as they can help to improve the teaching of genetics and its improvement in education. When starting in elementary school, this knowledge base will adequately allow individuals to understand in general genetic concepts, social applications and ethical issues throughout their learning in basic education. We believe that the training of science teachers needs to be further explored, as the implications for the training of these professionals who will work in the science area are gigantic, their training may be decisive and directly influence the teaching process, after all, they need to be in possession of several knowledge to develop the entire content of genetics in elementary school.

It so happens that, for the most part, the training given by universities is not enough to develop in the professional a teaching practice that makes this teaching-learning process feasible for students. Thus, the teacher has a great need to be in

constant training, seeking to improve their work in the day-to-day classroom, thus seeking the development of methodologies that address the learning difficulties of the student.

In the state of Maranhão, the Federal University of Maranhão (UFMA) since 2010 has offered interdisciplinary degree courses in Natural Sciences, whose basic training includes the content of chemistry, physics and biology covered in Elementary School and also differ in: biology, chemistry and physics for acting in high school. Teacher training courses of this nature allow not only an interaction between the areas of chemistry, physics and biology, but also articulate the learning of these three components, which throughout elementary school, are crucial for the practice of teaching science and, consequently, from genetics, as this curricular component is part of teacher education, whether in biology, chemistry or physics. Also, in elementary school there is still no fragmentation of the science discipline, as we already found in high school, where students study chemistry, physics and biology separately, each discipline with a specific teacher trained to work in the area.

Science education must incorporate strategies that help with contemporary demands. In this regard, it is important to emphasize that Science, technology and innovation - CTI have been essential factors in the development process of nations and fundamental to achieving the Millennium Development Goals (ORGANIZATION OF THE UNITED NATIONS, 2015). That, in addition to boosting progress in sectors ranging from public health to security, concepts such as integration, globalization and internationalization that permeate a series of social changes, in which the science/politics/education interface is implied, therefore, have basic knowledge in genetics It is also critical to understand that certain biological processes do not just affect a cell or descendant.

BNCC's skills focused on genetics in elementary school are comprehensive, which ends up requiring a lot of prior knowledge so that meaningful learning can be developed, thus reinforcing the need for activities aimed at scientific literacy. In another words, these skills, in a way, demarcate the finish line, however, the starting line, as well as the entire route to be covered until the finish line, seems not to be well demarcated. It's as if an end were established without worrying about the means, which is worrying.

The summary and content of some natural science textbooks approved by PNLD-2020 which were six books in all from three different publishers, FTD, Araribá Mais Ciências and Teláris, were analyzed. From these publishers, books referring to the eighth and ninth grades of elementary school were analyzed, where they are developing the skills proposed by the BNCC for teaching genetics in elementary school. In the analysis, we noticed that the language and concepts of genetic terms used in elementary school follow the same characteristics as those observed for high school, that is, the presence of an inadequate language, with isolated concepts, poorly synthesized and without historical context. Thus, what could help in teaching, ends up anticipating a difficulty and maintaining a recurrent problem in learning concepts related to genetics.

Chart 1 displays the genetics content presented in the 8th grade science textbooks related to your ability at BNCC. In general, it was possible to clearly observe that the concepts of karyotype, chromosome, gene and allele are practically not discussed, much less with emphasis on their importance in genetic

inheritance. Considering that these concepts are new, it is important that they are fully understood, which contributes to apathy and rejection on the part of students. And, for non-rejection and/or no appreciation for new discoveries in genetics, students, citizens, need a sense of the applications and implications of both basic and applied genetics. Otherwise, the teaching will move towards a limited compression of basic structures and concepts that could and would help to develop an understanding of the content (JUSTINA, 2003; AYUSO; BANET, 2002).

In order to make it possible to understand the basic concepts used in genetics, there is a constant need for scientific literacy to retake content. This further emphasizes the need for prior knowledge to exist. In this case, skill EF08CI07, which deals with the reproduction of living beings, involves concepts about anatomy and physiology of reproductive organs, life cycles of species that need to be resumed so that students understand how self- and cross-fertilization occurs. And then, in the following year, they would understand how the biologist, botanist and monk Gregor Mendel, known as the father of genetics, was able to carry out the crosses with peas and consolidate his conclusions.

After analyzing the textbooks, we observed that for the skills proposed for teaching genetics to be developed, it is necessary to have well-established prior knowledge. Therefore, Chart 1 below demonstrates the contents of genetics that were presented in the eighth grade science textbooks and the corresponding background.

Chart 1 – Contents of genetics presented in science textbooks of the 8th grade with ability (BNCC), and corresponding prior knowledge

Knowledge Objects	Skills	Textbook (Content)	Previous knowledge
Reproductive Mechanisms and Sexuality	(EF08CI07) Compare different reproductive processes in plants and animals in relation to adaptive and evolutionary mechanisms.	- Genetic material - Mitosis and meiosis - Types of fertilization in living beings; - Advantages of reproductive mechanisms for the species; - parental care - Reproduction in living beings - Gametogenesis - Sexualities in biological, socio-cultural, affective and ethical dimensions	- Molecules and chemical bonding - Chromosomes, karyotype and gene - Cells and their components, - Anatomy and morphology of the organs of the reproductive systems of living beings

Source: Authors (2021).

From the BNCC skills related to genetics for 9th grade science teaching, two are directly linked to evolution (EF09CI10 and EF09CI11) and also involve basic concepts of ecology, so they were not discussed in this paper.

In Chart 2, it can be noticed in textbooks from the summary that studies on Mendel's works are approached very succinctly, and in some books there are many open gaps and inconclusive contents. In addition to the introduction of new

information without connection with concepts that should have been consolidated in the previous year and were not, favoring the emergence of learning difficulties in teaching genetics, so mentioned by educators and students.

Students' difficulties in understanding and relating mitosis, meiosis, fertilization and transmission of genetic information are well reported in the literature (AYUSO; BARNET, 1995; LEWIS, 2004). In textbooks this content appears only with the help of simplified schemes, generally very reduced. It is intriguing that an extremely relevant subject, such as meiosis and the crossing over event, which explains part of the genetic variability inherited in living beings, is left aside and is approached in a timid and succinct way. Some books work on this content exclusively in the eighth grade, restricting its appearance in the ninth and not even relating to Mendel's laws. Lewis (2004) highlights that one of the potential barriers to the development of a scientific understanding of genetic phenomena seems to be related to the students' previous conceptions.

Justina and Rippel (2003) reports that when Mendel is isolated from the context that made his discoveries possible, a mystical image of genetic science is conveyed, assuming that he had an inspiration, created his laws and proved them through experiments with peas. Such an approach, starting and ending with Mendel, presupposes that genetic science is reduced to Mendelian genetics, as the esoteric production of a group of experts, in which "ordinary" people cannot interfere and which they have to accept as something inevitable. However, there is a knowledge of heredity “prior to Mendelism” and also “post-Mendelism”.

The importance of having skills in mathematics, but precisely in terms of probability, would also help a lot in understanding, because, in addition to having to understand Mendelian laws, solving the proposed problems becomes a real challenge. Since most students have some difficulty in performing these calculations. The use of Mathematics as an interdisciplinary tool to teach probability. In the books themselves, one can see a variation in the level of difficulty of the problem situations presented. The important thing is to be coherent with the level of information, contextualization with the areas of chemistry and mathematics, as well as the well-established student's prior knowledge. It was also observed in some works that genetic calculations were totally dispensed with, focusing only on the analysis of heredograms.

Regarding to the genetic variability of species, which is a key issue for understanding its perpetuation in the environment, to discuss, even if less intensely, its relationship with adaptive capacity, disease resistance, as well as mutation with the alteration of the DNA sequence, diseases, advantages and cancer are necessary to understand the mechanisms of genetic inheritance in individuals as shown in Chart 2.

Chart 2 – Contents of genetics presented in 9th grade science textbooks with ability (BNCC), and corresponding prior knowledge

Knowledge Objects	Skills	Textbook	Previous knowledge
Heredity	(EF09CI08) Associate gametes with the transmission of hereditary characteristics, establishing relationships between ancestors and descendants.	- DNA-gene-allele - Homologous Chromosomes - Number of Chromosomes and human reproduction: Aneuplodia in vitro fertilization	- Cell-core - Meiosis and crossing over - DNA molecule - Gametogenesis - Types of fertilization
	(EF09CI09) Discuss Mendel's ideas about heredity (hereditary factors, segregation, gametes, fertilization), considering them to solve problems involving the transmission of hereditary characteristics in different organisms.	- What is genetics? - Genotype and phenotype - Mendel's First Law - Allele and dominant genes - Blood groups - Sex chromosomes - Hereditary diseases - Inheritance	Mathematics: probability - Chemistry: DNA and protein, enzyme - Blood tissue - Anatomy and morphology of the organs of the reproductive systems of living beings

Source: Authors (2021).

It should be noted that for the study involving the DNA molecule (acronym for deoxyribonucleic acid) some authors present only the concepts in chemistry, for example for: nucleotides, dexoribose, phosphate group, nitrogenous bases, chemical bonds, molecules. Subject that involves the chemistry curriculum component and, therefore, concepts that need to be studied before or in the same grade. Otherwise, it further aggravates the difficulties in learning genetics and understanding techniques involving DNA molecule. Meaningful learning in genetics is linked to subsumer concepts such as genes, chromosomes and DNA, which are important for understanding biology as a whole.

It is healthy to approach modern and controversial issues in biotechnology, however, if very superficially, limiting the information with texts taken from newspapers and magazines with recent studies, vaccines without discussing with the content, it becomes useless for learning.

Justina and Rippel (2003), point out that for an individual to develop opinions about new genetic technologies, he/she needs to be scientifically and technically literate. Be aware that scientific theories and models can only be well understood if the person knows why and for what purpose they were developed. After all, knowledge of a scientific concept implies the ability to transfer it to a different context (JUSTINA; RIPPEL, 2003)

Books, in a way, should be prepared to meet the current demand of students, being able to instruct them, and help them in the process of building a comprehensive human education. The document we have today for the NC area

emphasizes conceptual aspects of this field of knowledge and does not favor the articulation between the different elements that constitute the construction of science, which reflects a vision of teaching and learning that is not coherent with current discussions in the field of Science Education, (FRANCO; MUNFORD, 2018).

Such understanding must be favored by the information present in the curricula developed in schools. Thus, teachers must provide students with adequate information about certain concrete contexts in which certain technologies can be applied. In this way, students can gain experience to reflect on the social and ethical issues involved in achieving a rational point of view (JUSTINA; RIPPEL, 2003).

DIFFICULTIES IN TEACHING GENETICS

Knowledge of genetics is essential for society, from the revelation of Mendel's discoveries to the elucidation of the DNA molecule and the dogma of molecular biology: DNA-RNA-Protein. The volume of information and studies in this area have leveraged in such a way that they are important even for those who are unaware of its mechanisms. Currently, genetics has been highly emphasized by the media, but there is a huge discrepancy between what is constantly highlighted by the media and what is taught in practice in the classroom (MASCARENHAS *et al*., 2016). Despite genetics being an object of intense curiosity, little information comes to popular knowledge in a simple and understandable way (MOURA; FALÇAO, 2014).

It is remarkable the numerous scientific works aimed at teaching genetics that are being carried out lately. In continuing education courses for teachers, the contents related to genetics are the ones that cause the most concern (SCHEID; FERRARI, 2006). That also reflects on the students, as the difficulties in assimilating concepts by them are very evident, being considered as one of the most difficult contents to learn. Thus, the difficulty of learning concepts and the reality of schools is largely a teaching that has made the subject boring, uninteresting, based only on textbooks (ARAÚJO; GUSMÃO, 2018).

The large number of concepts related to genetics is also one of the barriers that ends up making it difficult for students to understand, as they have been more concerned with memorizing terms rather than understanding them. The difficulties of students with the language of genetics is usually attributed to the fact that it is an area characterized by a complex vocabulary, which in most cases makes it difficult to understand and differentiate concepts, thus, the insertion of new methodologies by the teacher can assist in this learning process (MASCARENHAS *et al.*, 2016).

Most of the difficulties associated with the teaching of genetics are not restricted to recent changes in curriculum formation guidelines, as these difficulties are old and recurrent, but for the most part, the problems are concentrated in the way in which genetics comes has being taught. We believe that the initial teacher education is closely related to the way in which he/she understands and later teaches genetics, it is expected that in the future there will be a reduction in such problems, and hope may lie in those who will be fully involved in the teaching process, that is the teacher.

With the changes brought about by the BNCC, it was already expected that the courses, programs or continuing education actions for teachers would adapt

to the curriculum. The BNCC is a reference for the initial and continued training of teachers, therefore, meeting the need, the National Curriculum Guidelines for Initial Teacher Training for Basic Education were defined and the Common National Base for the Training of Basic Education Teachers (BNC) - Training) (BRAZIL, 2019b).

For this reason, the MEC instituted this document "so that the teaching professional can be seen in the light of contemporary demands and the recently instituted BNCC". In addition to the general competences of the BNCC, which should be developed in courses for teacher training, the graduate must develop professional teaching skills. Such competences are composed of three dimensions: knowledge, practice and professional engagement (BRASIL, 2019b).

Difficulties in teaching genetics have always been present due to several factors, many of which have been pointed out in this work, this problem has become increasingly recurrent, therefore, efforts cannot be spared to identify them and try to solve them. In an attempt to reduce some gaps in science education, there are also some websites and societies in Brazil that promote activities related to teaching, such as the Brazilian Society of Physics (SBF), the Brazilian Society of Chemistry (SBQ) and the Brazilian Society of Genetics (SBG). (KRASILCHIK, 2000).

FINAL CONSIDERATIONS

After BNCC approval in 2017, some changes in basic education were proposed. The base brought changes and mostly targets of criticism that went from its creation to the remarkable rush for its approval.

The base also had the addition of new content in different grades, as in the case of genetics in elementary school. Diniz (2018) warns that it took the country about thirty-five years to prepare a Law of Guidelines and Bases (LDB), while the BNCC only two years were enough to prepare a document with such complexity as was the case for teaching fundamental.

In a way, the foundation isn't really a curriculum, but once it was like it was, as the skills often cited in the document say what students are expected to learn at the end of the activities. It's as if they don't impose a path, but nevertheless control the entire process, making us get exactly where they want. The introduction of genetics in elementary school can be considered positive when accompanied by a more interdisciplinary discussion (mathematics and chemistry) and concatenated with the knowledge acquired in the previous year. The use of Mathematics as an interdisciplinary tool to teach applied probability in Genetics is one of the challenges that primary school teachers face all the time (SHAUGHNESSY, 2007).

However, the content observed in science textbooks indicates that the learning difficulty in teaching genetics will only be anticipated, since the content of the text in the books is superficial, long-winded and disconnected. The understanding of complex processes and specific vocabulary requires scientific literacy, teacher training whose graduation has basic genetics in its curriculum and also mastery to use appropriate teaching methodologies that allow a correlation of knowledge with daily life. Also, good physical infrastructure and textbooks with content better presented and discussed in a cadenced way, respecting the

freedom of the teacher and the student in their social context and their historically constructed knowledge.

The guidelines for the formation of curricula can be the best, the best voted or accepted, but, however, if the teacher is not prepared to carry out such changes, adequate physical structure and prepared school, the main focus may be lost, which is to promote and favor learning in science and to facilitate the teaching-learning process, contributing to the construction of scientific knowledge in a significant way.

UMA ANÁLISE DO CONTEÚDO DE GENÉTICA NO ENSINO FUNDAMENTAL CONFORME A BNCC

RESUMO

O ensino de ciências vem passando por constantes transformações e, a cada novo governo, ocorre um surto reformista atingindo, principalmente, a educação básica. As atuais propostas curriculares trazidas após a homologação da Base Nacional Comum Curricular (BNCC) servem de orientação para que escolas públicas e privadas elaborarem seus currículos. A BNCC é um documento de caráter normativo, com adesão obrigatória em todo território brasileiro. Deste modo, o presente artigo objetivou analisar por meio de um levantamento bibliográfico através de artigos nas bases da SCIELO, SCIENCE DIRECT, ELSEVIER E CAPES, BDTD, TCCs, revistas, livros e documentos oficiais do governo o que propõe a BNCC nos objetos de conhecimento que contemplam a genética nos anos finais do Ensino Fundamental. Ao observamos o sumário e a abordagem de alguns livros didáticos de ciências aprovados pelo PNLD-2020, o principal recurso didático disponível para o professor, percebemos que a linguagem e os conceitos dos termos genéticos empregados no ensino fundamental seguem as mesmas características das observados para o ensino médio, ou seja, presença de uma linguagem inadequada, com conceitos isolados, mal sintetizados e sem contexto histórico. A introdução da genética no Ensino fundamental pode ser considerada positiva quando acompanhada de uma discussão mais interdisciplinar usando a matemática, a química e concatenada com o conhecimento adquirido em ano anterior. Essas habilidades relacionadas à matemática e à química precisam ser estudadas em ano anteriores ou no mesmo ano, pois esses conhecimentos prévios precisam estar consolidados para que seja possível desenvolver as habilidades propostas para o ensino da genética. Grande parte das dificuldades associadas ao ensino da genética, não se restringem apenas as mudanças recentes nas orientações de formação do currículo, visto que essas dificuldades são antigas e recorrentes, mas em grande parte, aos problemas que se concentram na maneira em como a genética vem sendo ensinada e que a formação inicial do professor esteja intimamente relacionada à forma em como ele compreende e, posteriormente, ensina a genética. Diante de muitas discussões sobre o tema, espera-se que futuramente haja uma amenização em tais problemas, talvez, a esperança esteja em quem estará inteiramente envolvido no processo de ensino, ou seja, o professor.

PALAVRAS-CHAVE: Base Nacional Comum Curricular. Ensino de ciências. Ensino de genética no ensino fundamental.

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