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STUDY OF THE ANALOGIES PRESENT IN VOLUME 'COMPOSIÇÃO E ESTRUTURA DOS CORPOS' DA COLEÇÃO 'SER PROTAGONISTA: CIÊNCIAS DA NATUREZA E SUAS TECNOLOGIAS'

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ESTUDIO DE LAS ANALOGÍAS PRESENTES EN EL VOLUMEN "COMPOSICIÓN Y ESTRUCTURA DE LOS CUERPOS" DE LA COLECCIÓN "SER PROTAGONISTA: CIENCIAS NATURALES Y SUS TECNOLOGÍAS"

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ABSTRACT

Analogies are instruments used in teaching that contribute to the success of teaching and learning processes, because they can make an unknown concept (target concept) be understood, when compared to a known concept (analogous concept). The dissemination of its use in Natural Sciences and their technologies textbooks has boosted the demand for evaluations on the way they are being used. Thus, this work aims to present results of a study on the analogies found in volume 'Composição e estrutura dos corpos', from the collection 'Ser Protagonista: ciências da natureza e suas tecnologias'. After complete and detailed reading, we identified only three analogies in book. They were discussed and classified according to a system proposed by some researchers. Hardly any of them discuss important aspects related to their objectives. We highlight the importance and the need for more discussions on the use of analogies, especially in initial teacher training courses, so they can be used in a way that does not harm learning.

Keywords: Target Concept. Analogous Concept. Chemistry Teaching. Textbook.

RESUMO

Analogias são instrumentos empregados no ensino que contribuem para o sucesso dos processos de ensino e aprendizagem, pois podem fazer um conceito desconhecido (conceito alvo) ser compreendido, quando comparado a um conceito conhecido (conceito análogo). A disseminação de sua utilização em livros didáticos da área das Ciências da Natureza e suas tecnologias impulsionou a demanda de avaliações sobre a maneira como estão sendo empregadas. Assim, este trabalho objetiva apresentar resultados de um estudo sobre as analogias encontradas no volume 'Composição e estrutura dos corpos', da coleção 'Ser Protagonista: ciências da natureza e suas tecnologias'. Após a leitura integral e minuciosa da obra, identificamos apenas três analogias que foram discutidas e classificadas de acordo com um sistema proposto por alguns pesquisadores. Praticamente todas elas não discutem aspectos importantes relacionados aos seus objetivos. Evidenciamos a importância e a necessidade de mais discussões sobre o uso desses instrumentos, principalmente nos

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cursos de formação inicial de professores, para que possam ser utilizados de maneira a não prejudica o aprendizado.

Palavras-chave: Conceito Alvo. Conceito Análogo. Ensino de Química. Livro Didático.

RESUMEN
Las analogías son herramientas didácticas que contribuyen al éxito de los procesos de enseñanza y aprendizaje, ya que facilitan la comprensión de un concepto desconocido (concepto objetivo) al compararlo con un concepto conocido (concepto análogo). El uso generalizado de analogías en los libros de texto de Ciencias Naturales y sus tecnologías ha impulsado la demanda de evaluaciones sobre su aplicación. Por ello, este trabajo pretende presentar los resultados de un estudio sobre las analogías presentes en el volumen «Composición y Estructura de los Cuerpos», de la colección «Ser Protagonista: Ciencias Naturales y sus Tecnologías». Tras una lectura completa y minuciosa del trabajo, se identificaron solo tres analogías que se discutieron y clasificaron según un sistema propuesto por algunos investigadores. Prácticamente ninguna de ellas aborda aspectos importantes relacionados con sus objetivos. Resaltamos la importancia y la necesidad de profundizar en el uso de estas herramientas, especialmente en la formación inicial del profesorado, para que se utilicen de forma que no obstaculicen el aprendizaje.

Palabras clave: Concepto Objetivo. Concepto Análogo. Enseñanza de la Química. Libro de Texto.

1 INTRODUCTION

The textbook plays a fundamental role in the teaching and learning processes. For many teachers who, more specifically, work in Basic Education, this instrument becomes the most used resource during their classes, if not the only one. When it comes to teaching in the area of Natural Sciences and its technologies, this reality is very present in the work of teachers, as these are contents that often do not find more appropriate methodologies for their exploration other than those based on the use of textbooks (MUNAKATA, 2016).

However, when reflecting on the true role of this pedagogical instrument, Oliveira (2012, p. 26) argues that "[...] it is through the dialogue between scientific knowledge, the teacher's discourse and his own discourse that the student apprehends the meanings produced in the scientific construction", and that, therefore, the textbook should be an instrument capable of promoting the construction of the student's knowledge and, therefore, should constitute a material capable of contributing to facilitate the learning process.

In this sense, textbooks in the area of Natural Sciences and their technologies often resort to some artifices, analogies, which are also widely used by teachers during their classes. These devices have been used for a long time, both in formal and informal education and, in particular, have been guaranteed to be present in textbooks. In view of this, analogies have become targets of studies by many researchers from the most different areas (DUIT; 1991; GATES; JULIÃO, 2016; MÓL, 1999; MARTIN; JUSTI, 2000; OLIVEIRA, 2012; THIELE; TREAGUST, 1994).

Duit (1991) and Thiele and Treagust (1994) define analogy or analogical reasoning as a comparison between a 'known concept', also called an 'analogous domain' or an 'analogous concept', and an 'unknown concept', also called a 'target concept'. In other words: an analogy constitutes the use of a concept already well understood by the learner to facilitate the understanding of another that is being learned.

It is from this understanding that Francisco Júnior (2009) draws attention to the importance of evaluating the way they are being used, both in the classroom by teachers and in textbooks, since they have become relevant instruments in enhancing the learning of scientific concepts. Thus, for this scholar, it is necessary to observe, especially in these books, the number of them used, the level of understanding of the concepts worked on and the possibility of generating misinterpretations about the target concept to be learned.

In this dimension, Bozelli and Nardi (2006) emphasize the importance of promoting discussions about analogies in initial teacher training courses, especially those used in formal

education. This could avoid the continuity of the disorderly use of these instruments in the classroom without prior study. In other words, it is necessary to analyze the advantages and disadvantages that these devices can bring to the learning process. In the opinion of these researchers, it is of fundamental importance that the teacher knows how to use analogical reasoning correctly, minimizing the problems related to the understanding of the concepts worked on in the classroom.

Considering this important aspect for the work of teachers and, especially, for teachers who are in the process of training, Francisco Júnior (2009), based on the studies of Thiele and Treagust (1994), suggested a system composed of ten categories that has contributed significantly to a better understanding of analogies. This system makes it possible to understand how they can become important allies for the success of teaching and learning processes. The ten categories are summarized in Table 1.

Table 1

System of criteria for classification of analogies

ORDER	CRITERION	DESCRIPTION
1	Quantity and frequency of analogies	It determines the quantity and frequency of analogies identified in the analyzed work.
2	Content of the target concept	Defined by the content(s) or topic(s) of Chemistry, Physics or Biology that constitutes the target concept of the analogy;
3	Analogical relationship between the analogous concept and the target concept	It considers the type of similarities between the analogous concept and the target concept, which can be: - Structural: the similarities are of the structural type; the similarities are physical in nature; - Functional: the operation or behavior of the analog is similar to the target.
4	Presentation format	- Verbal: analogy presented only by text; - Illustrative: presented only through illustrations; - Verbal-illustrative: presented through text and illustration.
5	Level of abstraction of analogous and target concepts	It identifies the degree of materiality established between the analogue and the target, respectively. It can be: - Concrete-abstract; - Concrete-concrete; - Abstract-abstract.
6	Position of the analogy in relation to the target concept	Indicates the order of the analogy in relation to the target concept. It can be: -Before; -After; - During the presentation of the target concept; - In the margins of the textbook page.

7	Analogy Enrichment Level	It verifies the extent of the relationship between the analogue and the target, which can be: - Simple: the list does not highlight similar attributes; - Enriched: the ratio highlights similar attributes; - Extended: uses more than one analogue.
8	Analogy Mapping Level	It identifies whether the author presents a discussion about the correspondences between the analogue and the target.
9	Presence of pre-topic guidelines	It identifies characteristic terms and expressions announcing the presence of analogy.
10	Presentation and discussion of limitations	It verifies the existence of excerpts evidencing the limitations of the analogy. It can be: - Does not recognize the existence; - Recognizes the existence; - Recognizes the existence and discusses it;

Source: adapted from Francisco Júnior (2009).

Considering, therefore, the scenario outlined so far, the objective of this work was to present the results obtained from a study carried out on the analogies present in a textbook in the area of Natural Sciences and its technologies, adopted in high school classes in Brazilian public schools.

2 METHODOLOGY

The research was developed with the aim of identifying, discussing and classifying the analogies present in the volume 'Composition and structure of bodies', from the collection 'Being a Protagonist: natural sciences and their technologies'. Aimed at Brazilian high school students, the book covers Chemistry, Physics and Biology content.

This collection bears the signature of several authors and has André Zamboni and Lia Manguilhott Bezerra as editors. Its first edition was published in 2020, by the publisher SM Educação, from São Paulo.

The investigation conducted to produce the results presented here can be characterized from the perspective of a qualitative approach, without, however, neglecting its quantitative aspect, since the numbers obtained constituted important data for a better understanding of the phenomenon studied. From the point of view of its objectives, it can be classified as exploratory, as it brings important contributions to the collection of studies on analogies present in books adopted in High Schools (MALHEIROS, 2011).

For its development, we followed a schedule that consisted of practically two moments. The first consisted of a bibliographic survey, cataloguing and acquisition of the material to be analyzed, followed by a thorough and complete reading of the work, in order to identify the analogies present in it.

The second comprised some stages: 1) classification of the analogies identified in the book, we used a system composed of 10 (ten) categories established by Francisco Júnior (2009), according to the studies developed by Thiele and Treagust (1994); 2) organization of results and; 3) preparation of the final research report.

To facilitate the recognition of the presence of an analogical reasoning contained in the analyzed work, we used, during the readings, the definitions of analogy developed by the main researchers in the area: THIELE; TREAGUST (1994); DUIT (1991); MÓL (1999); GATES; JULIÃO (2016); MARTIN; JUSTI (2000); OLIVEIRA (2012), among others.

Still in the process of recognizing the analogies of the work, we used textual elements such as '... similar to ...', '... making an analogy ...', '... that's like...', '... analogously ...', which are characterized as indicators of analogies (FRANCISCO JÚNIOR, 2009).

3 RESULTS AND DISCUSSIONS

Throughout the process of careful reading of the work, we noticed that its texts do not make a clear and elucidative approach to the contents presented, despite the work being adequate both to the level of understanding of the student for whom it is intended, and to the level of work to be performed by the teacher. In other words, the authors do not delve into the subjects explored in a way that allows greater accessibility to the understanding of what is being explained. This will be demonstrated later.

Moreover, similar to other works, the book presents some vulnerabilities, such as, for example, the lack of references to contextualizing and specific circumstances of the contents, which could be related to the daily lives of students from different Brazilian geographic regions.

The analogies identified and classified, as well as the quantity and frequency in which they were arranged in the book are discussed in this article according to the proposal and criteria of Thiele and Theagust (1994). On the last page of this work, we present Table 2, which summarizes the results and discussions presented below.

3.1 THE ANALOGIES IDENTIFIED: DISCUSSIONS AND CLASSIFICATION

The first classification criterion, 'Quantity and frequency of analogies', refers to the result of the quantitative analysis of their presence throughout the work. Regarding this aspect, we find a very small number: only 03 (three) analogies are present in the entire book. Another observation that causes strangeness is the fact that it has a frequency of only 0.3

analogies per chapter, an extremely small amount when compared to other works (FRANÇA, 2017).

In addition, they are distributed in a very irregular way: the 03 (three) analogies are located in Unit 1 of the book. The first was found in chapter 1, the second in chapter 3, and the third is located in the section 'Specific guidelines and comments', intended exclusively for teachers, and refers to chapter 4. It is worth noting that the work contains a total of 10 chapters distributed by 3 Units, over 260 pages.

In her work, França (2017) observed that one of the works she analyzed, containing 20 (twenty) chapters, presents 11 (eleven) analogies, that is, a frequency of 0.55 analogies per chapter. The other criteria will be discussed as each analogy is presented individually.

3.2 FIRST ANALOGY

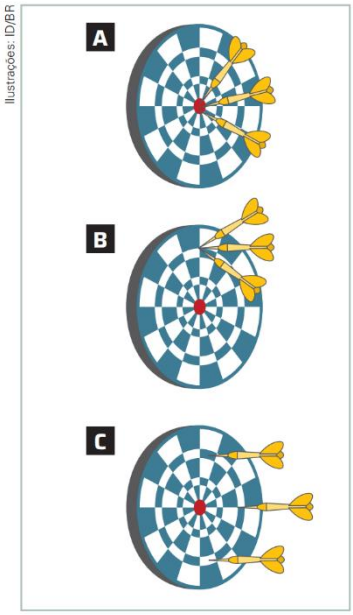
Figure 1 shows the first analogy identified in the book. Inserted on page 20, chapter 1 (Units of measurement and properties of matter) of Unit 1 (What materials are made of), this analogical reasoning addresses content related to the concepts of 'precision, correctness and errors'. The authors make a comparison of the results of darts thrown at a bullseye and the concepts of precision and accuracy: 'The concepts of precision and accuracy can be represented by the distribution of darts thrown at a bullseye, ...' (ZAMBONI; BEZERRA, 2020, p. 20).

The analogous concept or domain (known concept) of this analogy is represented by the distribution of darts thrown at a bullseye, as shown in the illustration in the book, presented here in Figure 1. The target or unknown concept refers to 'precision' and 'accuracy'. When discussing the location of the data released in the three sets (A, B and C), the authors show the association between the results of the launches and the target concepts. This discussion is highlighted in the red rectangle in Figure 1.

With respect to the third criterion, analogical relationship between the analogous concept and the target concept, we observed that the domains share structural attributes, which allows us to classify the analogy as 'structural', since the aspects used by the authors to explain the target concepts refer to the physical form with which the results are presented.

Figure 1

Presentation of the first analogy, Chapter 1, Unit 1, p. 20



Fonte de pesquisa: Kotz, J. C.; Treichel, P. M. J. *Química geral e reações químicas*. 5. ed. São Paulo: Pioneira Thomson Learning, 2005. v. 1.

Precisão, exatidão e erros

A **precisão** ou **repetibilidade** de uma medida indica o quanto as medidas repetidas estão próximas umas das outras. Os cientistas tentam obter valores mais precisos realizando muitas medidas e calculando a média dos resultados.

A **exatidão** mostra que o valor de uma medida está muito próximo do valor comumente aceito como referência (também denominado **valor real**).

Contudo, medidas precisas podem resultar em valores inexatos. Erros desse tipo ocorrem quando, por exemplo, um resíduo sólido fica no prato de uma balança. Se esse resíduo não for percebido e retirado, todas as pesagens posteriores apresentarão um **erro sistemático**: os valores obtidos serão precisos (ou seja, próximos entre si), porém a massa média obtida será inexata (distante do valor real), pois incluirá a massa do resíduo.

Há também os **erros aleatórios**, que podem ter várias causas. Leituras incorretas executadas pelo operador do instrumento de medição e mudanças nas condições experimentais, por exemplo, podem levar a medidas imprecisas e inexatas.

Os conceitos de precisão e exatidão podem ser representados pela distribuição de dardos lançados contra um alvo, como nas figuras ao lado. A figura **A** mostra que o atirador foi preciso e exato, porque todos os dardos atingiram o centro do alvo. A figura **B** mostra que o atirador foi preciso, mas não foi exato, pois os dardos não atingiram o centro do alvo (apesar de todos eles acertarem o mesmo ponto). A figura **C** indica que o atirador não foi nem preciso nem exato.

Algarismos significativos

Source: Zamboni and Bezerra (2020, p. 20).

The format of the presentation (fourth criterion) can be characterized as being 'illustrative/verbal', as the analogy is presented (Figure 1) through a text accompanied by an illustration, which enriches the authors' explanation of the target concepts.

As for the fifth criterion, level of abstraction of the analogous and target concepts, this analogy can be classified as being of the 'concrete/abstract' type, because the analogous concept, exposed by means of an illustration showing the way in which dice thrown against a target were distributed in three situations, has a concrete nature, while the target concepts (precision and accuracy), exposed by the authors in the first two paragraphs of Figure 1, they concern abstract entities, that is, they subsist thanks to the concrete entities represented by the analogous concept.

In the sixth criterion, we analyze the position of the analogy in relation to the target concept. In this case, we observe that this concept was presented before analogical reasoning, so that the position of this analogy is characterized as 'after'.

The seventh criterion refers to the level of enrichment of the analogy, and in the case of this analogy, we can classify it as being of the 'enriched' type, although the connections between the analogous and target concepts have not been exhaustively explored. The authors forgot to mention that each javelin thrown represents a measurement made by

scientists in their research. By comparing these measurements (positions of the darts), the researchers would be able to evaluate the precision and accuracy of their measurements.

As for the eighth classification criterion, the level of mapping done by the author, we can say that the authors showed the existing correspondences between the elements of the analogous and target concepts, as an attempt to familiarize the student with the target concept. However, this mapping could be more substantial if the correspondences between the darts and the scientists' measurements had been highlighted.

Regarding the ninth criterion, the presence of a pre-topic orientation, this analogical reasoning does not present it. At no time do the authors call attention, through a characteristic expression, to the presence of analogy, that is, it fails to strategically introduce the reader to the understanding of analogy.

In the last criterion of classification, presentation and discussion of limitations, this analogy can be framed as not recognizing the existence of aspects and attributes that converge for a good understanding of the target concept. Among some that we could list, and which were not explored by the authors, are: the shape of the darts (numerical values), the target (real or correct value), the way the data is manipulated (the way scientists obtain their measurements), etc.

3.3 SECOND ANALOGY

The second analogical reasoning (Figure 2) is located on page 44, chapter 3 (Quantum Physics) of Unit 1 (What Materials Are Made Of). It addresses the content related to the 'wave-particle duality', comparing experiments. The authors seek to show the relationship between the 'Interference patterns of an electromagnetic wave' (analogous concept), observed from Young's experiment, with the 'Distribution patterns of spheres launched in a double-slit experiment' (target concept), carried out by De Broglie. The main purpose of this comparison is to make the reader understand the wave-particle duality, a property inherent to the nature of the behavior of matter.

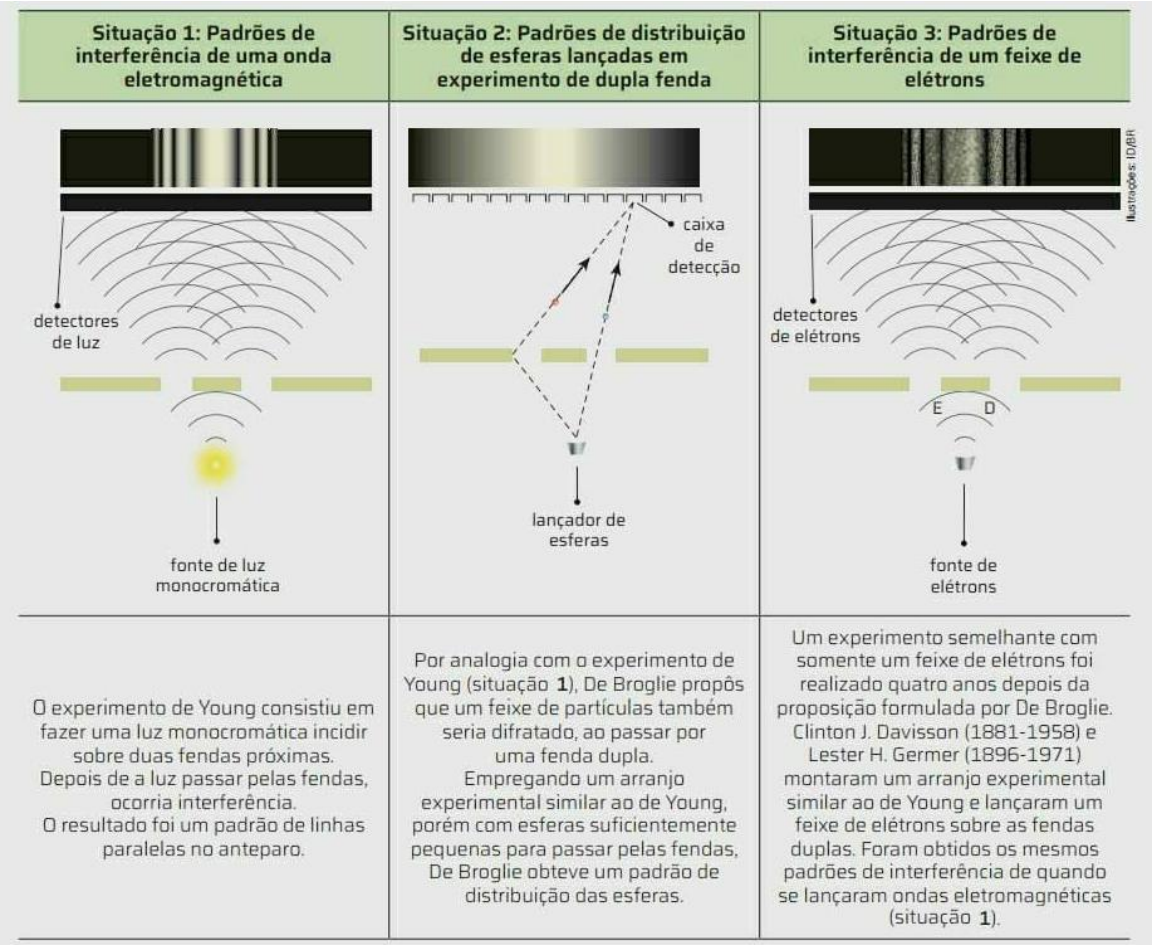
The analogous concept worked on it refers to the "double-slit experiment for electromagnetic radiation carried out by the British physicist and physician Thomas Young (1773-1829), as represented below" (ZAMBONI; BEZERRA, 2020, p. 44). Here, this is shown in Figure 2.

Although the authors explain Young's experiment, this analogous concept is quite complex, making it difficult for students to understand the target concept. Possibly, a simple

experiment carried out by the teacher in the classroom could contribute to a better understanding of the phenomenon and meaning of wave-particle duality.

Figure 2

Presentation of the second analogy, Chapter 3, Unit 1, p. 44



Source: Zamboni and Bezerra (2020, p. 44).

This difficulty in understanding the analogous concept leads us to two questions: Does the student master the analogous concept used by the analogy? If not, how will he be able to understand the target concept?

When making use of an analogy, it is necessary to consider that the student (re)recognizes and understands the analogous concept. Thus, if the student does not master the content studied before the analogy is presented, that is, he is not familiar with the analogous concept, he may not be able to understand the target concept, since the two domains will be worked on in an associated way. This means that analogies of this nature can compromise the understanding of the concept they propose to clarify (FRANCISCO JÚNIOR; FRANCIS; OLIVEIRA, 2012).

As for the third criterion, analogical relationship between the analogous concept and the target concept, we can classify this analogy as being of the 'structural/functional' type, because the analogous and target concepts share both structural (existence of slits in the equipment of the experiments) and operational (passage of light and spheres through the slits) aspects.

In the fourth criterion, presentation format, we again have an analogy of the 'illustrative/verbal' type, since the authors use texts and illustrations to try to familiarize the reader with the target concept (Figure 2).

'Concrete/concrete' would be the type of classification of this analogy in relation to the fifth criterion of analysis, level of abstraction of analogous and target concepts. The analogous concept briefly describes an experiment carried out by Young, and the target concept uses the description of "an experimental arrangement similar to Young's, but with spheres small enough to pass through the cracks" (ZAMBONI; BEZERRA, 2020, p. 44).

Regarding the sixth criterion, the position of the analogy in relation to the target concept, it is certainly of the 'after' type, because, as in the first analogy studied, it was positioned after the description of the target concept, that is, the authors explain the behavior of a wave from electromagnetic interference and only then describe the analogy to 'reinforce' the understanding of the target concept.

Analyzing the seventh criterion, the level of enrichment of the analogy, it was possible to see that this analogy portrays a 'simple' type. Although the authors present a text that seeks to explore the association between the concepts worked, no additional relationship was shown between the analogue and the target, which could denote an extension of their similarities, which demonstrates the lack of enrichment of this analogical reasoning.

Unfortunately, it was not possible to identify any kind of discussion, debate or description, promoted by the authors, listing and explaining the elements existing in the analogous and target concepts that share similarities, in an attempt to familiarize the reader with the target concept. Thus, we can say that this analogy does not contemplate the eighth criterion of analysis: level of mapping done by author.

Regarding the ninth criterion, the presence of pre-topic guidance, the existence of the term used by the authors when presenting the analogy, "... By analogy..." (ZAMBONI; BEZERRA, 2020, p. 44), allows us to say that 'yes', this analogical reasoning has a pre-topic, since this term announces the existence of an analogy.

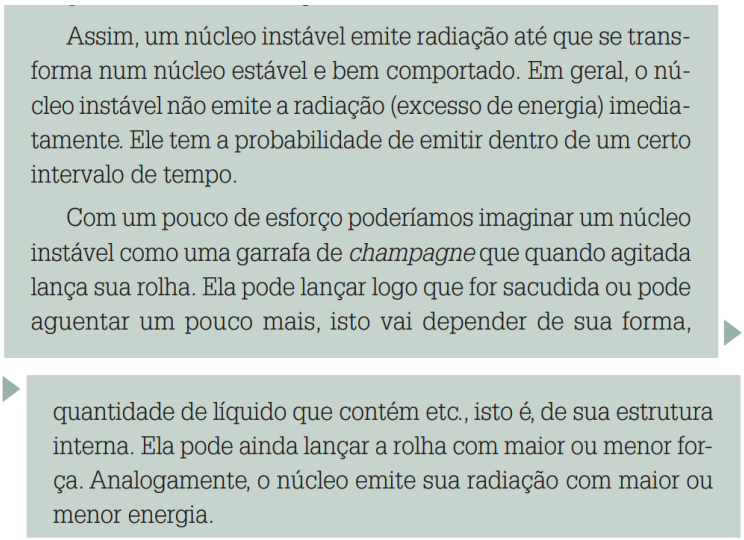
Regarding the tenth criterion for analysis, presentation and discussion of limitations, we can say that there are no references to the existence of these elements in the information provided by the authors. Thus, we must consider a certain negligence in this aspect, since the analogous concept uses light as an element that propagates, while the target concept uses small spheres. Certainly, different behaviors will have to be observed, starting with the fact that light will propagate in all directions, while each sphere will move in a single direction.

3.4 THIRD ANALOGY

The third analogy (Figure 3) is located in a complementary text on the subject explored in chapter 4 (Nuclear Physics) of Unit 1 (What materials are made of), and addresses the content 'Radioactivity'. In this analogical reasoning, the authors make a comparison between 'a bottle of champagne that when shaken releases its cork' (analogous concept) and 'instability of an atomic nucleus' (target concept).

Figure 3

Presentation of the third analogy, Chapter 4, Unit 1, p. 201-202



Assim, um núcleo instável emite radiação até que se transforma num núcleo estável e bem comportado. Em geral, o núcleo instável não emite a radiação (excesso de energia) imediatamente. Ele tem a probabilidade de emitir dentro de um certo intervalo de tempo.

Com um pouco de esforço poderíamos imaginar um núcleo instável como uma garrafa de *champagne* que quando agitada lança sua rolha. Ela pode lançar logo que for sacudida ou pode aguentar um pouco mais, isto vai depender de sua forma, quantidade de líquido que contém etc., isto é, de sua estrutura interna. Ela pode ainda lançar a rolha com maior ou menor força. Analogamente, o núcleo emite sua radiação com maior ou menor energia.

Source: Zamboni and Bezerra (2020, p. 201 and 202).

With respect to the third criterion, analogical relationship between the analogous concept and the target concept, we can classify this analogy as being of the 'functional' type, because its use explores the similar functional and behavioral aspects between the concepts worked, that is, the way in which the release of a cork by a shaken bottle of champagne and the emission of radiation by an atomic nucleus behave. There are no common and explicit structural elements that can be used for a better understanding of the target concept.

In the fourth criterion, presentation format, we classify this analogy as being of the exclusively 'verbal' type, since it is presented only through an explanatory text. It is worth highlighting the appeal exposed by the authors, evoking the use of the reader's imagination: "With a little effort we could imagine an unstable nucleus like a champagne bottle that, when shaken, releases its cork" (Figure 3).

Considering the fifth evaluation criterion, level of abstraction of analogous and target concepts, we consider this analogy to be of the 'concrete/abstract' type, since it uses an analogical concept of concrete aspects (a bottle of champagne that when shaken drops its cork) to explain an abstract target concept (the instability of an atomic nucleus).

In the sixth criterion of analysis, position of the analogy in relation to the target concept, similar to the previous analogies, we classify it as 'after', that is, it was presented after the concept to be learned had been explained.

As for the seventh criterion, level of enrichment, this analogy was considered 'simple', because we did not observe the presence of elements that would explain the similarity of their attributes. For example, the authors did not exploit the fact that, in the atomic nucleus, the agitation promoted in the champagne bottle would correspond to the energy needed by the nucleus for the emission of radiation to occur.

When considering the level of mapping done by the authors, the eighth criterion used to study these analogies, we did not identify discussions showing the possible correspondences between the concepts, whose objective would be to familiarize the reader with the target concept. The text shown in Figure 3 even denotes a certain intention in exposing a mapping, "She can still throw the cork with greater or lesser force. Analogously, the nucleus emits its radiation with greater or lesser energy" (ZAMBONI; BEZERRA, 2020, p. 202), however, the authors chose not to prosper.

Regarding the ninth criterion, presence of pre-topic orientation, in this analogy an expression and a term were identified that characterize his text as containing this type of didactic strategy: 'With a little effort we could imagine [...]' and 'Analogously, [...] (Figure 3). In this sense, Gonçalves and Julião (2016) highlight the importance of using pre-topics in textbooks, as it allows the reader a certain 'preparation' for reading the text containing the analogy, contributing to the promotion of the functionality of this instrument and, consequently, a better understanding of the target concept.

Like the analogies discussed above, this analogical reasoning does not recognize the existence of its limitations, and it is therefore up to the reader to identify them. The absence

of this element, according to Francisco Júnior (2009), can generate obstacles during the process of using analogy, causing the student to understand the target concept in an unsatisfactory way or even in a completely mistaken way.

4 FINAL CONSIDERATIONS

The results of this research brought to light some important aspects concerning the analogies presented in the volume 'Composition and structure of bodies', from the collection 'Being a Protagonist: Natural Sciences and their Technologies'. One of the most significant refers to the small number of analogies identified in the book, only three, meaning a very low frequency. This observation reveals a certain lack of interest on the part of the authors in the use of these didactic tools, which can be of great help in the learning of Chemistry, Physics and Biology, whose contents are, in general, considered difficult to understand.

The first analogy was considered to be of the enriched type, although the authors have promoted an almost insignificant discussion about the relations between the concepts worked. The other two, being of the simple type, do not present any reference to this criterion. The book does not explore the aspects of the analogous concept attributes that contribute to the understanding of the target concept. In other words, the authors do not highlight the relationship between similar attributes or use another analogue to familiarize the reader with the target concept.

When it comes to mapping, the first analogy presents it, but in a very stunted way. On the other hand, the two other analogies are highly deficient in this criterion, since their texts do not discuss or show the similarities and dissimilarities between the analogous and target concepts worked. This shows that the book did not adequately explore the potential of these instruments, which may mean difficulties in understanding students.

In none of the analogies do the authors discuss the limitations related to their uses. The absence of these discussions allows for misinterpretations by readers, which can make the understanding of the target concepts difficult or distorted. However, the enrichment, mapping and limitations of these analogies can be explored by the teacher who adopts this book and uses them in the classroom. For this, it is necessary for the teacher to do a previous study and planning, in order to ensure success in the use of these instruments.

In the third analogy, the authors evoke the use of the reader's imagination to understand the text that presents it. This leads us to the question: and if the student does not know the analogous concept, can he understand the target concept? We highlight here a

certain precariousness in the choice of this analogy, since in order to achieve its objectives in a satisfactory way, it is imperative that the analogous concept be very familiar to the learner.

Finally, we highlight that, from this study, it is evident the need to foster, in teacher training courses, discussions about the choice of the textbook to be adopted by future teachers and the appropriate use of analogies, which are very present in books in the area of Natural Sciences and their Technologies. These discussions can contribute to a better performance of these professionals, making the learning of Chemistry, Physics and Biology content less complicated for students.

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APPENDIX

Table 1

Classification of the analogies found in the book 'Composition and structure of bodies' from the collection 'Being a protagonist: Natural Sciences and their Technologies'

Nº analogia	Capítulo	Conteúdo	Conceitos (análogo-alvo)	Relação analógica	Apresentação	Nível de abstração	Posição	Nível de enriquecimento	Mapeamento	Pré-tópicos	Limitações
1	1	Precisão, exatidão e erros	Distribuição de dardos lançados contra um alvo – Precisão e exatidão	Estrutural	Ilustrativo/ Verbal	Concreto/ Abstrato	Depois	Enriquecida	Sim	Não	Não
2	3	Dualidade onda-partícula	Padrões de interferência de uma onda eletromagnética - Padrões de distribuição de esferas lançadas em experimento de dupla fenda	Estrutural/ Funcional	Ilustrativo/ Verbal	Concreto/ Concreto	Depois	Simples	Não	Sim	Não
3	4	Radioatividade	Uma garrafa de champagne que quando agitada lança sua rolha - um núcleo atômico instável	Funcional	Verbal	Concreto/ Abstrato	Depois	Simples	Não	Sim	Não

Source: Authors.