Imagery language and system of equations: semiotic representations and contextualization as theoretical contributions

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ABSTRACT
To address the difficulties involving algebraic knowledge, such as equations and systems of equations, it is important that studies and research be developed to propose ways to support the teaching and learning of Algebra and Mathematics. One of the difficulties is related to language, and the use of images can be a resource to facilitate the understanding of algebraic language. However, it is necessary for visual language to be supported by theories that can justify its use. Given the above, this work aims to present and highlight Multiple Representations, the Theory of Semiotic Representation Registers, and Contextualization as theoretical foundations for the use of visual language in the teaching and learning of mathematics and systems of equations. To achieve this, four chapters are developed, presenting, discussing, and interweaving these theories with visual language. Finally, it is inferred that these theories provide a foundation for the use of visual language in the teaching and learning of equations and systems of equations, where images can be valuable resources for learning Algebra and understanding algebraic concepts such as unknowns and variables.

Keywords: Learning and Teaching, Multiple Representations, Semiotic Registers.

1 INTRODUCTION

For many students, learning mathematics is considered difficult (GOULART *et al.*, 2018; PACHECO; ANDREIS, 2018), as well as Algebra (COSTA *et al.*, 2016; PEREIRA, 2017). In this area we find System of Equations, which uses algebraic language to solve problems. Studies have already pointed out that algebraic language can be the cause of students' difficulty in understanding and developing mathematical activities involving Algebra (ESTEVÃO, 2021; GIL, 2008) and, therefore, it is necessary to develop studies and research that can detect possibilities to overcome this difficulty, such as the use of different representations and languages, for example (OLIVEIRA; ROEHRS, 2023).

According to Pereira (2017), it is important that students, at first, are able to generalize and model situations, using natural language and pictorial representations to later use a more formal symbolic language. In this sense, even if still in an incipient way, potentialities are identified in a specific language, imagery, as a resource for a better understanding of algebraic language, which can facilitate the learning of Mathematics with regard to equations and systems of equations (OLIVEIRA;

ROEHRS, 2023). The language of imagery can be understood as the "communication made through images" (LÍNGUA IMAGÉTICA, 2013, n.p.) and that, as a symbolic capacity of the human being, is used to understand the world (OLIVEIRA; ROEHRS, 2023).

However, in addition to perceptions and indications of the potentiality of different representations and languages, it is necessary that studies and research have a theoretical basis that can sustain the intention of their use, that an approach is made that presents and relates theories that contribute their uses in Mathematics, with emphasis (for the purpose of this work) on the use of imagery language.

In this sense, two very fertile theoretical fields are identified that support the use of imagery language in Mathematics and for the study of equations and systems of equations: semiotic representations and contextualization.

Given the above, this work aims to present and signal the Multiple Representations, the Theory of Registers of Semiotic Representation and Contextualization as theoretical contributions for the use of imagery language in the teaching and learning of mathematics and system of equations.

To this end, three sub-chapters will be developed dealing with the theoretical bases, followed by a chapter that makes connections between the theories and the imagery language. Finally, some considerations are brought to reaffirm the inferences about this proposed relationship between theories and imagery language.

2 DEVELOPMENT

2.1 MULTIPLE REPRESENTATIONS: CONNECTING LANGUAGES

To address Multiple Representations, it is important to mention the theory that is understood, as well as Laburú, Zompero and Barros (2013), as a support for multimodes and multiplicity of representations, which is Semiotics. For Santaella (2017), Semiotics is the science of languages, which has as its object of investigation all possible languages, whose objective is to analyze the modes of constitution of phenomena regarding the production of meanings and meaning. In line with this concept, Semiotics is also defined by Nöth and Santaella (2017, p. 7) as "the science of systems and sign processes in culture and nature", presenting as an object of study types and systems of signs and their effects, as well as the definition given by Melo and Melo (2015, p. 11), who mention Charles Sanders Peirce in the title of their work, adjectivating semiotics, and presenting it as the "science of the sign, whose object of investigation is all possible languages".

By these definitions, Semiotics is understood as a basis for the study of languages. However, it is identified as a very broad theory that could direct the discussion to different directions, such as philosophical, linguistic, etc., taking the focus away from the involvement of languages and representations with the line of study of intentionality of this work, which is teaching and learning.

In this way, Multiple Representations are seen as a path more aligned with this writing proposal. According to Bica, Mello-Carpes and Roehrs (2018), the Multiple Representations line of research works with the use of different forms of communication and languages in the teaching and learning process. Furthermore, Klein and Laburú (2012, p 138) cite that multiple modes of representation

> It refers to the practice of re-presenting the same concept in various ways or in different languages, whether descriptive (verbal, graphic, tabular, diagrammatic, photographic, map or chart), experimental and mathematical, figurative (pictorial, analogical and metaphorical), gestural or corporeal.

When analyzing everyday life, the world is composed of several stimuli, such as sounds, images, texts, games, sports, etc. And each one of them reaches people carrying meanings, which are sometimes associated with the same concept. Distinct languages, sound, imagery, textual, many of which are inseparable as a form of communication, compose communication. Therefore, understanding that there is a contribution in which these multiple representations exist and are effective in the cognitive process is important in understanding the world.

In academic and school environments, where scientific language is very present, it is perceived that the appropriation of this language by the student is much more complex than one thinks. According to Lahore (2018, p. 9), apprehending scientific language "implies the acquisition not only of a new semantic system, but a new way of thinking and seeing reality."

However, it is notorious that in the dialogic process between the subjects of education, teachers and students, different skills are highlighted, such as cognitive, emotional, social, physical, and moral (CAMPOS, 2010). With them, the different forms of organization and expression, which make up language, also stand out and should be taken advantage of, "in the educational environment, in order to enhance individual cognitive skills and abilities" (BICA; MELLO-CARPES; ROEHRS, 2018, p. 2).

However, problems are identified related to the students' lack of appropriation and interpretation of these different languages, scientific, mathematical, among others, in addition to the lack of knowledge of the correlations of the representations and how to transform this into a scientific discourse (LABURÚ; BARROS; SILVA, 2011). This is where the role of the teacher becomes fundamental, as he will have the function of preparing his students to overcome these difficulties, presenting and working with them different signs and symbologies, through the use of more than one language in multiple representations. Teaching, from this perspective, can be more comprehensible, since both in Science and in Mathematics there is an understanding of the need for different ways of representing this scientific knowledge. (BICA; ROEHRS, 2015).

For Multiple Representations, a new form of representation can help to complement, rectify or ratify previous knowledge, and can limit and even refine its interpretation. New representations can enable students to be reexposed to information, but with other signs, which can generate new meanings to these previously formed concepts (BICA; MELLO-CARPES; ROEHRS, 2018), which are not necessarily dichotomous. For this reason, Multiple Representations "allow the formation of bridges between the subject's previous knowledge and new concepts, enabling the structuring of meanings and argumentative relations" (LABURÚ; BARROS; SILVA, 2011, p. 481) and, in this way, they can collaborate for the development of Meaningful Learning.

It is noticed, when relating previous and new knowledge, that there is an association of Multiple Representations with Meaningful Learning. Moreira (2016) describes that Meaningful Learning happens when the meaning of new knowledge is produced by the learner when he is able to relate it to specifically relevant knowledge pre-existing in his cognitive structure. This prior knowledge, the subsumers, are defined as "prior organizers that serve as a bridge between what the learner knows and what should be learned by him" (SILVA *et al.*, 2017, p. 48), and must already be present with a certain "degree of clarity, stability and differentiation" (MOREIRA, 2012, p. 5), serving as a kind of anchorage.

By highlighting the importance of subsumers in Meaningful Learning and that they depend directly on the student, Moreira (2016) emphasizes the student's protagonism in the process, not disregarding the relevance of the teacher's role, as it is up to the latter to organize the learning environment for the development of the subsumers' relationship with new knowledge.

Another aspect related to Meaningful Learning is the relationship between meanings and feelings pointed out in Joseph Donald Novak's theory of education, since "any educational event is [...] an action to exchange *meanings* (thinking) *and feelings* between the learner and the teacher. In other words, an educational event is always accompanied by affective experiences" (MOREIRA, 2016, p. 56, emphasis added). It is understood that the contact with a multiplicity of representations, associated with the different teaching methodologies that can be adopted by teachers, can generate these experiences and, from them, promote a predisposition to learning, which is a condition for Meaningful Learning (MOREIRA, 2016).

Specifying a little the imagery language in the context of Multiple Representations, for Bica, Mello-Carpes and Roehrs (2018, p. 13), "A change that has been occurring over time is the presence and use of images as a form of conceptual representation, consolidating itself as a conceptual facilitator". The visual elements of the images, with their colors, shapes, depth, planes, effect of textures, etc., collaborate in the understanding of meanings as they help in the construction of meanings (SCOPARO, 2018).

In the case of texts involving written language and imagery, Luyten (2011, p. 6) points out that "images support the text and give students contextual clues to the meaning of the word". This is corroborated by the considerable presence of images in books to improve the understanding of the concepts covered, especially in the sciences (MARTINS; GOUVÊA; PICCININI, 2005).

In this perspective of indicating the benefits of Multiple Representations, Ainsworth (1999) mentions three main functions of Multiple Representations in learning situations: *to complement* previous knowledge, either by complementing information or cognitive processes*; to restrict interpretations* and improve them, through familiar representations or by exploring properties of a representation; and to *deepen knowledge*, being the sense of deepening given by an intention to seek abstraction, generalization and the relationship between representations.

From all the above, according to Bica and Roehrs (2015, p. 3), it can be said that multiple representations appear as "an instrument that facilitates and expands the teaching and learning process that occurs in the classroom".

Even though it is still incipient that it is possible to visualize multiple representations as a basis for imagery language, there is a theory that is more specific to Mathematics, within a multiplicity of representations, which is the Theory of Registers of Semiotic Representations, to be developed in the next chapter.

2.2 REGISTERS OF SEMIOTIC REPRESENTATIONS: A MATHEMATIZED LOOK AT SEMIOTIC REPRESENTATIONS

Although Multiple Representations are a good contribution to the use of imagery language, it is interesting to have a more specific look at the relationship between different languages and representations, and the teaching and learning of mathematics. This association is found in Raymond Duval's Theory of Registers of Semiotic Representation.

Due to its specificity, mathematics depends essentially on semiotic representations, which are generally considered "as a simple means of externalizing mental representations for communication purposes" (DUVAL; MORETTI, 2012, p. 269). However, they are "essential to the cognitive activity of thought" (ibid.), as they develop mental representations by performing different cognitive functions and producing knowledge.

However, in Mathematics, unlike other areas of knowledge, there is no sensory access to the object of study. For example, mathematical objects called *numbers* depend exclusively on their representations: written (in the form of numerals, or numerical expressions), or graphic (numerical line), or geometric (a line segment). This absence leads to what Duval (2010) called the cognitive paradox of mathematics, formulating two questions: how not to confuse object and representation if we do not have access to the object outside the representation?; If there are multiple distinct representations of an object, how do we know that they are not conceptually distinct objects, and not a single one?

This second question is considered by Duval (2010, p. 129) as "the first source of students' difficulties [which is]: how to recognize the same object in different representations?". Due to these issues of paradox and the difficulties arising from it, the importance of deepening and theorizing the aspects related to the multiple semiotic representations, which are found in the Theory of Registers of Semiotic Representation, is exalted.

In this theory, a semiotic system is "a set of signs, organized according to their own rules of formation and conventions, which present internal relations that allow the identification of the objects represented" (DENARDI, 2017, p. 5). As in Semiotics and Multiple Representations, semiotic systems have the capacity to communicate, by producing and transmitting information (DUVAL, 2010).

However, some semiotic systems perform other cognitive functions in addition to communicating, such as the objectification function, characterized by providing an understanding of the object to be apprehended, itself (DENARDI, 2017; FLORES, 2006); and treatment, which aims at processing through operations, but within the same semiotic system (DUVAL, 2010). When dealing with these more complete and specific semiotic systems of Mathematics, Duval (2010) used the term record.

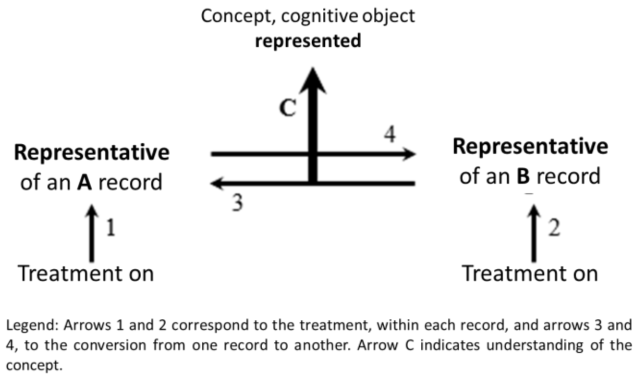
Thus, a register of semiotic representation "is a semiotic system that fulfills, in addition to the function of communication, the cognitive functions of objectification (understanding for oneself) and treatment" (DENARDI, 2017, p. 5), and can be classified into 4 types: "natural language, writing systems (numerical, algebraic and symbolic), Cartesian graphics and geometric figures" (ibid., p. 6).

Regarding mathematical activity, Duval (2010) points out that two types of transformations are necessary: conversions, which involve transformations from one representation register to others; and processing, which are the operations within the registry itself.

Duval (2010, p.130, emphasis added), in the intention of describing and analyzing mathematical activities, defines what he calls semiosis as "the mobilization, implicit or explicit, of *at least TWO registers to* PRODUCE, *externally or mentally*, semiotic representations of an object, and to be able *to TRANSFORM THEM.", pointing out that the multiplicity of representations* is very important for semiosis to occur.

The main idea of the Theory of Registers of Semiotic Representation is that the comprehension and learning of Mathematics presupposes the existence of semiosis, that is, "the integral comprehension of a conceptual content rests on the coordination of at least two registers of representation" (LABURÚ; BARROS; SILVA, 2011, p. 471), and the ability to change records and/or process a record. More simply, by coordinating only two records, this can be seen in the schematic in Figure 1.

Figure 1 – Coordination of two registers of semiotic representation.



Source: Duval and Moretti (2012), adapted.

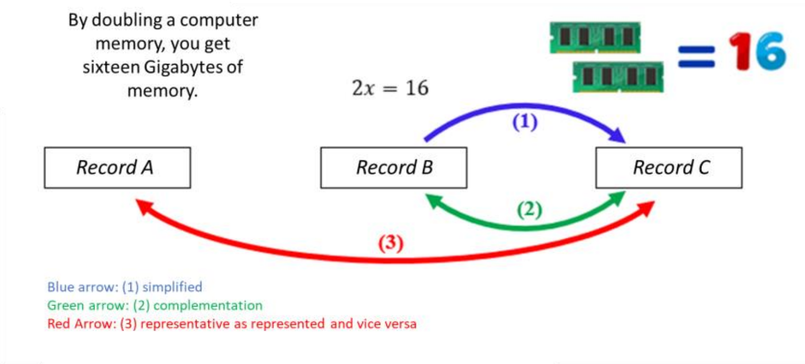
For example, the ability to represent a mathematical function by an equation or by a graph, mobilizing them in both directions, denotes a change of register, a conversion; while the rewriting of this equation, simplifying it through the addition of similar terms, is an example of transformation within the same register.

The need for the existence and coordination of at least two registers of representation comes in the direction that the recurrence to the diversity of registers is a "necessary condition so that mathematical objects are not confused with their representations and that they can also be recognized in each of their representations" (DUVAL; MORETTI, 2012, p. 270). In this way, one has effective access to the represented object for a conceptual apprehension of that object.

In the same vein of explaining the interest of coordinating multiple semiotic registers for the functioning of human thought, and thus for the teaching and learning of Mathematics, Duval and Moretti (2012) highlight three points: **(1)** distinct registers allow simplifying the understanding of concepts by streamlining processes; **(2)** different registers complement each other, since "every representation is cognitively partial in relation to what it represents" (ibid., p.280), with semiotic drawbacks of the register; **(3)** the condition that a representative is the represented, and vice versa, favors later transfers and learning, making the acquired knowledge usable in other situations.

In an example of an algebraic problem, it is possible to indicate these points by means of the coordination between registers of mother tongue *(A)*, algebraic writing (*B*) and symbolic writing (*C*), presented in the diagram in Figure 2. In symbolic representation, the use of imagery language is employed.

Figure 2 - Coordination between semiotic representation registers.



Source: The author.

The simplification (blue arrow) can be seen *in the representation of register C, with the collaboration in the understanding of the unknown by using the drawings of memories; the complementation (green arrow) comes in the sense that* register C, being visual, with two drawings, complements the idea of double associated with 2x *(algebraic) in register* B, *just as register* B *complements the understanding of* C for the possibility of facilitating the treatment in solving the equation. The representative/represented situation (red arrow), insofar as one can move between the records in the mother tongue and the written language, in which either one can be the starting point (representative) in relation to the other representation (represented). It is worth noting that other coordinations are possible, with an indication of the points that highlight these associations, even more so due to the fact of the representative/represented relationship of point (3).

2.3 CONTEXTUALIZATION: MORE MEANING THROUGH REPRESENTATIONS

By observing the difficulties with Mathematics, with Algebra and its language, as well as the possibility of using another language, imagery, to transpose the difficulties, another contribution can be linked to this use in order to assist and facilitate the teaching and learning of Mathematics, equations and systems of equations: contextualization.

According to Barbosa and Mendes (2016), Mathematics goes through problems that are reflected in the students' understanding of this science, one of which is related to the static and nonsensical way in which the contents are worked.

In relation to Algebra, even though they have mentioned this aspect for some time, Miguel, Fiorentini and Miorim (1992, p. 40) are still very current when they state that most teachers work with algebraic contents "in a mechanical and automated way, dissociated from social and logical meaning, simply emphasizing the memorization and manipulation of rules, tricks, symbols and expressions". In other words, due attention is not given to contextualization for the teaching of algebraic content.

For Tiesen and Araujo (2020, p. 2) "the reason why students do not excel in the discipline [of mathematics] is the lack of contextualization". The same authors also state that scientific studies show that contextualizing the content of mathematics is important, enhancing the teaching of mathematical concepts, which are often abstract, precisely because it allows a relationship with the student's daily life (Ibid.). Neto (2013, p. 9) complements this statement by pointing out that contextualization can be used as a "starting point and motivating element of learning".

Regarding contextualization in teaching, Neto (2013, p. 11) understands that it "refers to the elaboration of any and all situations capable of boosting the construction of meanings in the learner", and that it is necessary to consider the "interactive processes that promote the socialization of the knowledge mastered by its members, promoting its sharing" (ibidem, p. 12). It is evident the emphasis given by the author in relation to the dialogical relations between all subjects in the classroom. This is corroborated by Pedrosa (2014, p. 19), when he states that "to contextualize is to provoke a need to communicate something to someone, it is to provoke the need to represent a situation, to discuss it and what is involved".

Schons *et al.* (2017, p. 21), addressing contextualization more focused on teaching and learning, mentions that it can be generalized as "a resource in the search for meaningful learning in which daily experiences are associated with scientific concepts of school knowledge". This view related to science and meaningful learning is very interesting and meets the understanding for the teaching and learning of mathematics.

According to Pessano *et al.* (2017) The definition of contextualization is not unique and, in any situation, the teacher should act as a mediator in the process, since the protagonism should be given to the student, who should have a more active position in the teaching and learning process. The same authors mention that context and knowledge must be in a dialectical relationship, and point out that "contextualization is based on the non-fragmentation of knowledge, situating specific contents within a meaningful context" (ibid., p. 83).

Contextualization in Mathematics, for Barbosa and Mendes (2016), is seen as a pedagogical resource in solving problems such as the lack of connection of content with other knowledge, and situations of rote learning unrelated to the construction of meanings. Tiesen and Araujo (2020), in an analogous characterization, cite mathematical contextualization as a pedagogical principle, with the objective of improving student learning by involving knowledge with the student's life, providing them with the junction between learning and reality, considering their previous knowledge.

With a view to the teaching process, Barbosa and Mendes (2016, p. 370) define that "contextualizing in the teaching of mathematics is to lead the student to understand the historical, social and interdisciplinary aspects that permeate a certain content".

It should be noted that, for Mathematics, the understanding that to contextualize is to place in a context (BARBOSA; ARAÚJO, 2014) is well regarded, since understanding linked to students' daily lives is not always possible due to the specificities of some mathematical contents. For Boemo and

Roos (2016, p. 4) "although day-to-day situations can contribute to the teaching of Mathematics, the contextualization of mathematical content cannot be restricted to them", making it necessary to consider internal issues of Mathematics so as not to discard content that would not be connected to the reality of the students (SANTOS; NUNES; VIANA, 2017). For Luccas and Batista (2008, p. 9), the "contextualization of mathematical objects can stimulate students to feel motivated to learn, especially when it involves a context other than the purely mathematical one".

In the search to elaborate a conceptualization for contextualization that takes into account the definitions already addressed, the relationship between the subjects of the process and Meaningful Learning, the following wording was formulated: Contextualization, from a comprehensive and less formal point of view, can be seen as the moment in which teacher and students dialogue about previous knowledge, students' daily lives and reality, so that relationships of meanings with new knowledge are developed.

To facilitate the understanding of this concept, reducing and simplifying the text a little, thinking about a possibility of employment for Basic Education students, for example, the following can be written: moment in which teacher and students dialogue about previous knowledge, daily life and reality of students, so that relationships of meanings with new knowledge are developed.

It should be noted that the term *dialogue,* used here, is much broader than its etymological meaning. Dialogue, from a more qualified perspective, can be seen as "a form of conversation aimed at strengthening connections and deepening the perceptions we have of them" and also as a "joint investigation in the direction of more understanding, connection or possibilities" (SOBRE DIÁLOGO, 1998, n.p.). It is in these senses that dialogue is understood in contextualization, involving the interlocution and interaction between teacher and student, between the students themselves, and also between students and teacher with didactic materials and means of communication, such as the internet, for example, in the search for this joint investigation.

Although a reference to Meaningful Learning is not explicit in this last proposed concept, it is noticeable that when dealing with contextualization as a space for dialogue involving previous knowledge, this learning is mentioned, as well as Schons *et al.* (2017) and Pessano *et al.* (2017) also do. In this sense, Neto (2013) points out that when working with school knowledge in a contextualized way, it is expected that their learning will be significant, valuing the knowledge brought by students and developing knowledge, reflecting and promoting a true change in their realities.

2.4 INTERWEAVING THE CONTRIBUTIONS TO THE IMAGERY LANGUAGE AND SYSTEM OF EQUATIONS

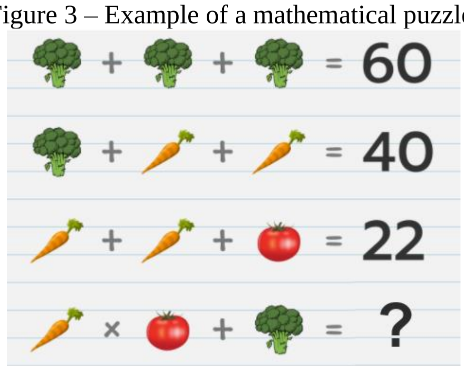
Part of the school community still undervalues the importance and influence of images, which are seen as less qualified means of communication (GUALBERTO, 2013) or "mere contemplative objects" (PERALES, 2008, p. 20).

Exactly in the opposite direction of this understanding, in line with (Biasi-Rodrigues and Nobre (2010) when they state that images are omnipresent and loaded with senses and meanings, it is intended, based on the theories and some *insights* about the imagery language developed in the previous chapters, to highlight the use of this language in mathematics and how these theories can serve as a basis for it to be understood as a facilitating resource in the process teaching and learning of Algebra, equations and systems of equations.

Langwinski and Bassoi (2019), addressing mathematical objects, state that access to them is through representations. By describing steps for the elaboration of a first understanding of Algebra, it presents the possibility of not using letters to represent numbers in the writing of an equation, but rather of blank spaces and the connective E for an addition: For example: (-2) E (+5) = ___. This description of the procedure for the initial comprehension of algebraic equations and their language, allows precisely to look at the use of representation by means of images, with the language of imagery.

When dealing with this use, we are talking about the use of images to replace the unknowns and variables present in equations and systems of equations, as well as the use or not of operation signals linked to these images. This type of representation is found in mathematical challenges, as in Figure 3, which are easily found on the internet, including *in online* games, and can be defined as puzzles in the form of symbolic equations, whose objective is to find the value of each symbol and, with that, find the final answer (GONZÁLEZ, 2021).

Figure 3 – Example of a mathematical puzzle.



Source: González (2021), adapted.

The link of contributions by the Multiple Representations begins. Its role is understood as a support for the use of imagery language in equations and systems of equations because it deals with the development of the same concept in different representations, including figurative, pictorial, photographic (KLEIN; LABURÚ, 2012), which can enhance both the learning of these concepts and the methods involved in the process (LABURÚ; BARROS; SILVA, 2011).

By using imagery language, one can perceive the benefits that this multiple representation can bring to the understanding of equations, complementing previous knowledge and refining interpretations. An example is the presentation of an image linked to a number, such as a fruit, for example (Figure 4).

Figure 4 – Image language as multiple representation.

 = 12

Source: Author's own.

It should be noted that this number may be representative of a more concrete concept, such as the mass of a fruit, in the case of the example the fig with 12 grams.

According to the Multiple Representations, this reexposure to information can contribute to the understanding of the representational function of the sign, specifically the fruit of the example, with the representational function of a letter in an equation, in the concept of unknown and variable, in addition to the collaboration in the understanding of the concept of equality, through the relationship of the representation with a concrete situation.

In this same example, the relationship between the image and previous knowledge is highlighted, as well as the possibility of outcropping feelings and emotions related to this image, indicating that with the use of imagery language, evidence of a Meaningful Learning may arise, which occupies its space within the Multiple Representations.

In the mathematical puzzles, in addition to the representational issues of the images, the playfulness proposed by the fact that it is a challenge, a game, stands out. All this can arouse the student's interest in better understanding an equation system, initially proposed in an image representation, to then be able to understand and use solving techniques in algebraic language.

With regard to the Theory of Registers of Semiotic Representation, it is understood that it is a theory associated with Multiple Representations since it deals with semiotic representations. Therefore, it can be considered as an equally solid basis for the use of imagery language, and even more specific to Mathematics.

Identifying the imagery language in the Theory of Registers of Representation, it can be seen in the transformation of conversion, specifically in a more focused look at representations in writing systems. Just like algebraic writing, the language of imagery, within a symbolic writing register, can be the representation of a register in the mother tongue, of a problem, with the use of images, and thus characterizing the conversion. It can also facilitate the understanding, by means of another conversion, between the registers in algebraic language and the imagery. With figures, the representation of multiples, e.g. double, would not need plus signs or coefficients, although they can be used. This can be seen in Figure 2, when the capacity of two memories is associated with the value of 16.

This conversion is restricted to linear equations, since equal images, placed side by side, would represent the idea of sum. If it were necessary to multiply images, a specific symbology would be needed, which could be predetermined and adapted, depending on the equation.

On the other hand, in the transformation of treatment, the imagery language can support some of the difficulties of understanding in relation to representations of situations that confuse students in Algebra when operationalizing letters and numbers. For example, the difference between double and square. Using imagery language, double a number can be more understandable because there are two images present there, in which it is more natural to think that both values are equal. Figure 5 compares the understandings of the treatment of records in algebraic (left) and imagery (right) on the question of double, shown in Figure 2, which suggests that the understanding that each memory has 8 *Gigabyte is more direct in the* imagery language than in the algebraic one.

Figure 5 – Comparing registers in writing in algebraic and imagery language.

$$2.x = 16 \Rightarrow x = \frac{16}{2} \Rightarrow x = 8$$

Source: The author.

By moving between the signs of the algebraic language, the letters of the alphabet, which can sometimes confuse the student due to the same use in the mother tongue, and the use of images, an environment can arise for the simplification and complementation of concepts, mainly related to unknowns and variables, favoring learning and making knowledge usable in other situations.

For all this, it is understood that the Theory of Registers of Semiotic Representation is a basis for the use of imagery language, and that by employing it, by means of mathematical puzzles, for example, it is using another register of representation for a system of equations, which can collaborate in the student's learning.

With a look at contextualization, a question that is always very present in math classes is: "*why learn this*?" It is accompanied by the phrase "*I'm not going to use this in life*" or "*these 'things' are not part of my day*." But thinking about contextualization, according to the concepts addressed in this work, leads to the understanding that it supports the use of imagery language in the teaching of Algebra, responding to some of these sentences.

The use of image refers to previous knowledge of the learners' realities. Here is a parenthesis, of why use the word reality, because people have several realities linked to the environments in which they live, such as the family, the school, the social, the virtual reality. And among all these realities, there are representative images that can contribute to the understanding of problems and the role of unknowns and variables in equations, for example.

Of course, great care must be taken in this regard. To contextualize an equation through images, it is necessary that they have the real meaning of what it represents. Although this is not a precaution that can be observed in mathematical puzzles, there is the possibility that they are adapted and used in such a way as to actually represent numbers linked to the representational reality of their images, as in the examples shown in Figures 2, 4 and 5, in which the values 16 of the memories and 12 of the fig, mean the actual capacity and mass of the same, respectively. In other words, using imagery language to address problems involving equations and systems finds a basis, as images can contextualize the situation and thus make more sense of the problems.

At the end of this chapter, it is noticeable that Multiple Representations, the Theory of Registers of Semiotic Representation and Contextualization form a theoretical contribution that supports the use of imagery language in Mathematics. Although the focus has been on the contents of equations and systems of equations, it is believed that with other studies the imagery language can collaborate with teaching and learning in other areas of Mathematics, due to the representational potential of images.

Even with the emphasis given to imagetic language, it should be noted that there is no apology in this work for algebraic language not being useful or that it can be replaced by imagery, since both language and algebraic thinking are significant for a more complete mathematical education (PEREIRA, 2017). The emphasis is precisely on visualizing another representation, a record, which, aided by contextualization, can facilitate the understanding of unknowns, variables, equations and systems of equations.

3 FINAL THOUGHTS

It is believed that from the presentation and linking of conceptions and perceptions highlighted in this work, the objective of pointing out Multiple Representations, the Theory of Registers of Semiotic Representation and Contextualization as theoretical contributions to the use of imagery language related to the study, teaching and learning of Mathematics, especially equations and systems of equations, has been achieved.

By using imagery language to approach and recognize scientific contents, students can be provided with a better development of their cognitive capacities, by employing different representations that complement each other and can mobilize previous knowledge, including those related to their realities.

In addition, the imagery language is characterized as a record of semiotic representations, within symbolic writing, and therefore can compose the coordination with another register so that students can effectively access mathematical objects and learn their concepts, in this case those related to the study of equations and systems of equations.

Being supported by these theoretical frameworks, the imagery language is an interesting resource that can contribute to the teaching and learning of Mathematics. Specifically, on the algebraic themes treated, the mathematical puzzles are shown as an imagery material that is already conveyed by the internet, with a direct relationship to a system of equations and that can be used with the necessary adaptations to correspond to the needs of the planning and objectives of the classes.

Furthermore, in addition to mathematical puzzles, images can be used in situations of learning (or retaking) initial concepts of Algebra, such as understanding unknowns, variables and equality, for example. Consequently, these concepts can become more interesting and meaningful to students, and learning can take place with greater meaning.

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