

Beyond prejudice and the celebration of everyday life: natural science teaching and the development of theoretical thinking in Youth and Adult Education students

Uma passagem secreta no beco sem saída:
O ensino de ciências da natureza e o debate sobre o desenvolvimento
do pensamento para alunos da Educação de Jovens e Adultos

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ABSTRACT

It is common in Youth and Adult Education (YAE) to suspicion about the cognitive capacity of students, assuming that they would not be able to learn natural sciences, as this would supposedly be a very abstract science. On the other hand, trying to combat this conception, many papers end up advocating that the teaching of natural sciences should be linked to everyday life and appeal to an appreciation of the spontaneous knowledge of YAE students, almost devaluing school knowledge, thus disregarding the importance that scientific knowledge has for the development of the subject beyond its immediate needs and uses. Understanding that none of these conceptions enhances the work in Youth and Adult Education, this work aims to discuss the role of scientific knowledge in the

RESUMO

É comum na Educação de Jovens e Adultos (YAE) uma suspeita sobre a capacidade cognitiva dos estudantes, assumindo que eles não conseguiriam aprender ciências da natureza, pois esta seria supostamente uma ciência muito abstrata. Por outro lado, tentando combater essa concepção, muitos trabalhos terminam por advogar que o ensino de ciências da natureza deve se vincular ao dia a dia e apelam para uma valorização do saber espontâneo dos estudantes da YAE, quase desvalorizando o conhecimento escolar, desconsiderando, assim, a importância que os conhecimentos científicos têm para o desenvolvimento do sujeito para além das suas necessidades e usos imediatos. Entendendo que nenhuma dessas concepções potencializa o trabalho na Educação de Jovens e Adultos, este trabalho tem como objetivo debater qual o papel

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thinking of adults and aims, from the foundations of historical-cultural psychology, to tension prejudiced views about students. of the Youth and Adult Education while showing the impact of scientific knowledge on the thinking of students in this segment. The article is divided into two parts, in the first, an analysis of the functioning and development of thought on the theories of Lev Vigotski and Vasili Davidov is presented, in the second part, in the mediation with the teaching of natural sciences, we deal with the contributions to the development of theoretical thinking in YAE.

Keywords: Youth and Adult Education. Development of Thought. Concept teaching.

do conhecimento científico no pensamento dos adultos e visa, a partir dos fundamentos da psicologia histórico-cultural, tensionar visões preconceituosas sobre os alunos da YAE, ao mesmo tempo que evidencia o impacto do conhecimento científico no pensamento dos alunos desse segmento. O artigo é dividido em duas partes, na primeira, apresenta-se uma análise do funcionamento e desenvolvimento do pensamento sobre as teorias de Lev Vigotski e Vasili Davidov, na segunda parte, na mediação com o ensino de ciências da natureza, tratamos das contribuições para o desenvolvimento do pensamento teórico na YAE.

Palavras-chave: Educação de Jovens e Adultos. Desenvolvimento do pensamento. Ensino de conceitos.

1 Introduction

Pedagogical acts are inherently linked to the conception of the learner, whether explicit or implicit. Within the context of an educational process, students are inherently complex beings with their histories and experiences. A comprehensive understanding of how these students learn and develop is imperative for the successful implementation of any education project that aims to shape a desired society. In the training of professors, the field of psychology plays a pivotal role in equipping educators with the necessary tools to understand the multifaceted nature of students they encounter in the classroom. However, the majority of psychology training programs tend to emphasize idealized student images, perpetuating prejudices and presenting a romanticized view of childhood, adolescence, youth, and adulthood. Consequently, it is common for psychology training programs to prioritize the development of abstract student concepts over the study of specific, concrete students. As Saviani (2004) points out:

In the realm of psychology, the emphasis on the empirical individual rather than the concrete individual has effectively neutralized its contributions to education. This is because educators in the classroom are not confronted with the empirical individual, as it is described in terms of the variables that allow for precise, statistically significant conclusions. Instead, they

interact with concrete individuals who are the synthesis of numerous social relationships. In contrast, students encounter professors as living, completely, concrete beings. Consequently, educators are compelled to act in relation to this individual, and the onus falls upon them to facilitate the educational process (SAVIANI, 2004, p. 47).

The absence of tools for understanding the unique characteristics of each student can have significant consequences. In the absence of knowledge regarding the factors that influence the individual student within a classroom setting, professors may be more likely to reproduce prejudices, superficial views, and meritocratic attitudes in their pedagogical practices. These attitudes may manifest in judgments regarding an individual's success or failure in history, as Patto (2008) notes.

The prevailing societal perception of the intellectual inferiority of economically disadvantaged individuals is a pervasive phenomenon. This bias often permeates even among researchers who possess a theoretical-critical framework, leading to the defense of the cultural deprivation theory despite the identification of factors that could explain the high failure and dropout rates in educational institutions. This perpetuates an incoherent discourse that ultimately reinforces the deficiencies of the student body as the primary cause of school failure (PATTO, 2008, p. 76).

The phenomenon of students' tendency to believe in their incompetence is particularly noteworthy in the context of Youth and Adult Education (YAE), a fundamental educational modality. The YAE demographic is predominantly comprised of individuals who are racially marginalized, economically disadvantaged, and often disenfranchised from educational rights (LIMA; MELO, 2019; SILVA, 2019). These individuals often perceive school as a platform that validates their perceived shortcomings or challenges their cognitive abilities. A substantial body of research exists that documents the assistentialist, light-touch, pragmatic, or certification-focused bias frequently exhibited towards YAE subjects

(see Machado, 1997; Haddad & Di Pierro, 2000; Paranhos, 2017). Paranhos (2017) offers a comprehensive overview of these approaches.

A discourse on the conceptions of YAE has emerged that resists comprehension of the modality, and it remains associated with the understanding linked to substitution. This results in streamlined training processes and undermines the notion that the YAE public comprises subjects with rights and not a public that requires processes to recuperate "lost time" (PARANHOS, 2017, p. 61).

However, studies that employ critical pedagogical or psychological references encounter impediments when addressing the YAE, the role of school, and the teaching of natural sciences in the psychic development of these subjects. On one hand, researchers contend that the school is responsible for the development of students' theoretical thinking, suggesting that those lacking formal education have not cultivated this capacity and remain confined to the empirical, sensory, and accidental aspects of reality. Consequently, this assertion implies that YAE students have not acquired a "mode" of abstract thinking and require compensatory strategies to transition to conceptual thinking. In their research, many authors employ a Vygotskian framework to posit that YAE students grapple with abstraction and conceptual thinking, citing their inability to respond to specific inquiries posed by the instructor as evidence of this deficiency. To illustrate this claim, let us examine an example from the teaching of natural sciences:

One of the aspects that we consider fundamental in the results of our research is the predominance of complex thinking in this audience, which is characterized by difficulty in abstraction. The intention to develop scientific thinking in young and adult students should be clear to all professors. Despite the difficulties that these students have in dealing with this level of thinking, since we have noticed that they have difficulty in developing true concepts and deal mainly with spontaneous knowledge, deliberate and conscious actions towards generalization must be carried out. (COSTA; ECHEVERRIA, 2013, p. 355)

The authors reached this conclusion based on the difficulty students had in answering questions related to the process of boiling water. They note:

In the course of the discussion, we can clearly see that these students are dealing mainly with complex thinking based on descriptive statements. The difficulty of knowing where the water goes when it evaporates or boils in a pan without a lid shows that their **capacity for abstraction, for dealing with something that is not in front of their eyes, is low** (COSTA; ECHEVERRIA, 2013, p. 354, emphasis added).

In the text, the authors rightly argue that schools need to teach students scientific concepts and reinforce that students' thinking is not indifferent to the concepts being taught. For example, Costa and Echeverria (2013) state that the fact that students supposedly do not think abstractly does not mean that the school should not teach the content; on the contrary, it should focus on the scientific content. However, to make this defense of school and what it teaches, the authors have to simplify the discussion about development and thinking, erase the history of the adult, and state without much ceremony that the subjects have a low capacity to deal with abstraction.

If we look at a concrete situation, we see that most workers are involved in imaginative processes and solving extremely complex problems. Construction, gardening, and cooking, for example, require them to visualize the result of the process, and this implies a high capacity for abstraction. It seems rash to say that these students "think in complex ways" or "have a low capacity for abstraction.

On the other side of the coin, we see researchers celebrating the ability of the working class to make abstractions from their daily work, but in the same discussion, they make school dispensable. They celebrate the everyday experiences and motivations of students, romanticize the experience of common sense, the history of workers' struggle, argue that the school of life would be less oppressive, and that school knowledge is almost a hindrance to the subject. Let's take the following example:

The boy is making a chair in the carpenter's shop and can't learn math at school... Making a chair is very hard (only those who have done it know how hard it is, and it's no wonder that so little wood costs so much). This is not just a concrete activity, rather than a mathematical activity at school. The wood in the shape of the chair is the manifestation of a project designed by the carpenter. In addition, the project is very abstract and requires a wide range of knowledge, including mathematical calculation. On the other hand, the exercise of mathematics is only an intellectual project through the play of words in language. (CAGLIARI, 1997, p. 198-199)

In this case, the author almost disdains school knowledge and basically says that the subject already knows mathematics because he works with carpentry in his daily life. Arguments like this have the power to respect the history of the subject, but they fail to justify the existence and importance of school for the working class and for the YAE, and at the same time, they understand that school knowledge wouldn't make much difference to the subject's thinking. Knowledge would just be "an intellectual project", "other knowledge", "a language game" that would make little difference to the way the student thinks about the world. We understand that this is a mistake because we know that knowledge plays a role in the way we see, interpret, and act in the world, and school knowledge can certainly contribute to this.

In short, if we were to adopt either of these conceptions, we would be at an impasse. On the one hand, a simplistic view of what the subject's thinking is how it develops, and how it relates to concrete experience, but with a legitimate appreciation of the school of school knowledge. On the other hand, a denial of the influence of scientific knowledge on the subject's life and its conception of the world, but a respect for its life history and everyday experiences.

We understand that this text is looking for secret passages in this apparent impasse. We believe that if we had better study the development of thought and its relation to the learning of concepts, we will be able to find elements that will help science professors in their pedagogical work, in establishing a political commitment to the working class and to YAE students. We understand that it is

not a question of finding a supposed "middle way" between these two perspectives **but of understanding the role of scientific concepts in the development of the thinking of the subjects, to avoid simplifying conceptions or those that relativize the importance of school.**

To achieve the above-mentioned objective of this article, we assume that this research is theoretical in nature, within the foundations of historical-dialectical materialism. Procedurally, we follow what Ligia Márcia Martins and Tiago Lavoura (2018) teach us:

Once the theoretical field of research has been delimited, its analysis can be guided by the following procedures: a) explaining the meanings of the concepts presented in the selected works and their correlations in order to formulate a primary synthesis in relation to the material under analysis; b) identifying the guiding idea(s), i.e., the assertions and the ideas explaining them (reasons) present in the texts, i.e., uncovering the fundamental assertion/reason relationship(s) in the works; c) differentiating and comparing the guiding ideas among themselves to determine the relative importance of each of them in the set of productions. c) the differentiation and comparative analysis of the guiding ideas among themselves to determine the relative importance of each of them in the set of productions of the author(s) in focus and d) the operation of synthesis, that is, the rational integration of the data discovered in the organized set of productions on the subject under study and in response to the announced problem. (MARTINS; LAVOURA, 2018, p. 223)

Specifically for this work, we revisited Vygotsky's and Davidov's texts on conceptual development and theoretical thinking, in particular the works *Construction of thought and language* (2009) and *School teaching and psychic development: theoretical and experimental psychological research* (1988). With the help of other authors and commentators on these works, we made claims by reviewing what these authors of cultural-historical psychology say about the development of thought and comparing it with the ideas they bring to the field of YAE. We then moved to an analysis in which we explained the relationship between the concepts studied and the teaching of science and

youth and adult education. The synthesis operation involved the construction of this text, in which we point out the contributions to thinking about a more humanizing science teaching for the development of thinking in young people and adults returning to school.

The synthesis is presented in this text. Therefore, in addition to the introduction and the concluding reflections, we're going to divide this synthesis into two parts. In the first, we will show how the process of thought development takes place, taking up the studies of Vygotsky and Davidov. In the second part, we will look at the implications for the teaching of science in the YAE modality, trying to address more specific issues for pedagogical work committed to the working class and the overcoming of class society.

2 The development of thought: contributions from Vygotsky and Davidov

The aim of this theme is to clarify the conditions and processes under which thought is formed and develops throughout our existence, as well as to reveal some important peculiarities about aspects and ways of thinking.

Lígia Márcia Martins (2013) points out that the genesis of thought forms an inseparable unity between the culture in which the human being is embedded, and the biological development inherited from nature. According to the author:

On the one hand, it is the result of a biological evolutionary process that led to the appearance of the species *Homo sapiens*, and on the other hand, it is a process of historical development thanks to which primitive man became a culturalized being. While the separation between these processes was present in phylogeny, ontogenetically they appear united, forming a single whole through their intertwining. (MARTINS, 2013, p. 119)

Thus, "the system of human activity is determined at each stage by the degree of its organic development and the degree of its mastery over cultural objectifications" (MARTINS, 2013, p. 119).

As human beings develop biologically and enter into activity with these cultural objectifications, thought, as a process of the psyche, acts to form the subjective reflection of objective reality (MARTINS, 2013). This reflection is far from being a mechanical copy, and its quality will depend on our greater or lesser capacity to understand and intervene in reality. In this sense, we can say that we develop our psyche as we comprehend reality in its historical movement, and these qualitative changes resulting from our development increase our capacity to understand and intervene in reality.

However, these "qualitative changes" that occur in the psyche and in thinking should not be analyzed as a dissociated part of the social-historical individual who thinks. There are no loose thoughts floating in people's heads. There are people who are immersed in social practice, acquire culture, and develop their way of thinking through various activities. Therefore, throughout life (from birth to old age), thinking takes on its relative character of dependence on the relationship of human beings to the social activities they perform.

It is up to thinking, in the construction of the subjective image, to create a generalized reflection of reality, aiming to establish connections between phenomena and objects that are not given in our apparent sensitivity. This is why Martins (2013) states that:

Thought has the task of overcoming these conditions in which the relations between objects are superficial and apparent, advancing from the incidental to the necessary, from the appearance to the essence, and promoting the discovery of general regularities, multiple connections, and mediations that sustain their objective existence. The product of this discovery, in turn, is established as a generalization, so that thought sets in motion a transit from the particular to the general and from the general to the particular (MARTINS, 2013, p. 191).

Thus, in the process of the development of human thinking, it is up to it to be able to operate from a psychic perspective and not only with what it sees, feels, or perceives, in other words, with a general representation of the object. It is thanks to thinking that when we say the word "sofa" we do not refer to a single

sofa in our house but to a generalized image of this apparatus, whose examples of different types and different singularities can be recognized. This ability to generalize and make increasingly complex and general connections (we think of atoms, cells, planes, molecular geometry, etc.) between things and phenomena is not born in us, and until we can actually construct profound generalizations, there is a long process that has its origins in sensations and perceptions. Thus, as we acquire language and its social meanings, we gain this ability to generalize and make connections. The process of developing these acts of generalization was studied by Vygotsky and, we believe, further developed by Davidov when he looked at the formation of concepts and forms of thought.

For those who have read Vygotsky's (2009) discussion of concept development, it is common to characterize thinking in three major "stages" of development: syncretic, complex, and conceptual. These stages are characterized by the way in which subjects can generalize and how these stages of generalization are related to language.

In syncretic thinking, objects or phenomena are connected without any logical order; the image created is a mental grouping without any meaning, changeable, and without any relation to the word that could help in the act of generalization.

The first stage of the formation of concepts, the one that is most often manifested in the behavior of young children, is the formation of an uninformed and unordered plurality, the discrimination of a heap of different objects now when this child is confronted with a problem that we adults solve by introducing a new concept. This heap of objects to be discriminated by the child, to be unified without sufficient internal foundation, without sufficient internal similarity, and without relationship between the parts that constitute it, presupposes a diffuse and undirected extension of the meaning of the word (or of the sign that replaces it) to a series of elements that are externally linked in the child's impressions, but completely dispersed. (VIGOTSKI, 2009, p. 175)

The second stage of thinking would take a long time and would be characterized by complex thinking. In this stage of thought, the generalizing

connections between objects and phenomena are no longer accidental and subjective; they are already grounded in reality, but in immediate reality. Thus, we have a subjective reflection in the psyche, but one that is subordinate to immediate empiricism. In the words of Vygotsky (2009):

The complex is based on factual connections that are revealed in immediate experience. It therefore represents, first and foremost, a concrete association with a group of objects based on their physical similarity. All the rest of this way of thinking follows from this. **The most important is the following: since this complex is not on the level of abstract-logical thinking, but on the level of concrete-factual thinking**, it is not distinguished by the unity of the links that serve as its basis and are established with its help. (VIGOTSKI, 2009, p. 180, emphasis added)

The final "stage" is concept formation. At this stage, the subject can relate objects by common characteristics and demonstrates a high degree of abstraction, revealing the generalization of essential determinations of relationships between objects and phenomena, that is, the development of conceptual thinking. In the words of Martins (2016b, p. 1583), "having reached this level of development, at which all psychic functions operate, conceptual thinking becomes the guide for the most decisive transformations of the psyche and, consequently, of the individual's personality". Therefore, at this stage, the subject can construct a truly conscious reflection of reality and then make logical connections between the phenomena perceived in reality.

The formation of true concepts goes from the phase of immediate and spontaneous concepts, acquired in the daily practices of the individual's personal experience, to the phase of scientific concepts, formed through formalized and systematized meanings about certain knowledge (CAZEIRO; LOMÔNACO, 2011).

Thinking in terms of concepts, based on historical-cultural psychology, is the most appropriate way to know reality. We say that it is the most appropriate way because it allows us to understand the essence of objects, insofar as their nature is not revealed through the direct comparison of one or another isolated

determination of that object, but through the links and relationships that are manifested in the dynamics of the object and in its development linked to the rest of reality. This internal connection of things is discovered with the help of conceptual thinking, so that elaborating a concept about an object means discovering a series of connections and relationships between this object and the whole of reality. It means including it in the complex system of real phenomena, emphasizing its materiality in the world.

However, the essential links between objects or phenomena can be found partially way, without actually finding a historical movement in these links and without recognizing the existing contradictions that move what is being studied in reality. The distinction between capturing more static and partial characteristics and others that are more dynamic is something that Davidov (1988) seems to have clarified more clearly. For this author, the logic by which we capture the internal connections of the object also makes a difference in the process of appropriating reality. Thus, thinking that generalizes essential issues but is limited to classifying, numbering, listing, and perceiving differences and similarities, understanding them as mutually exclusive, is **empirical thinking**. In other words, it is thinking that is supported and rooted in formal logic.

In the case of **theoretical thinking**, the essential connections and relations are reflected in the thought, but they gain movement and are recognized in their historicity, in the contradictions that constitute them, in the multiple determinations to which this concept is subjected. For Davidov (1988), theoretical thinking is thinking that uses dialectical logic to reveal the essential links between phenomena and objects; it is thinking that manages to understand the universality of the object and at the same time recognize its singular manifestation; it is thinking that operates, in fact, in the transit from the general to the singular and from the singular to the general.

In the words of Martins (2013),

[Theoretical thought aims to represent reality as it is formed, to achieve the complexity of the manifestations of the whole. Consequently, it aims to reproduce the process of development and formation of the system of which the object of thought is a part, expressing chains, laws, and, fundamentally, the necessary relationships between singular things and the universal. This way of thinking, based on dialectical materialist logic, is a condition for a form of knowledge capable of penetrating and identifying the tendencies of movement in reality. (MARTINS, 2013, pp. 208-209)

Thus, strictly speaking, theoretical thinking does indeed operate with the (true) scientific knowledge described by Vygotsky (2009) because it is capable of finding the most essential connections of the object in its movement. Scientific concepts are the way to understand reality in its most universal connections.

Perhaps the text has become a bit abstract in these discussions of theoretical and empirical thinking. Surely, an example can help the reader. Imagine a student learning the concept of rain. They might think of rain from an immediate nexus of their experience and thus evoke traces of complex thinking to think about this phenomenon. When students enter school and understand the water cycle and the processes that make it up (evaporation, condensation, precipitation...), they do not necessarily learn to think theoretically, using scientific concepts. This is because, although this knowledge is essential for thinking about rain, it can be learned in a descriptive logic whose terms even make sense to the student (and they can even answer the professor's questions in the classroom), but theoretical thinking must ensure that this student understands the concrete water cycle, recognizing that it rains with the same cycle, but that its effects depend on social class; that this cycle has effects from the wind, from the terrain; that understanding the water cycle was a historical achievement for humanity to be able to think about its planting, etc. In other words, the water cycle becomes a psychic tool for thinking about a concrete reality that goes beyond their immediate daily lives and beyond the abstract universalism of the water cycle presented in didactic books.

With this example, we would like to make an important point: the scientific concept is not necessarily the one that is taught in school today. Scientific knowledge is scientific insofar as it explains reality in its multiple determinations, and school has become the place where this should be done. Therefore, we shouldn't reverse the vector: the concept is not scientific because it is in school, but on the contrary, it should be in school in its scientific form.

Another important observation we need to make here, which sometimes causes confusion in Vygotsky's work, is that no concept is spontaneous or scientific in itself. The concept of a chair, for example, becomes scientific when a professional, such as an architect, studies the history of the chair, recognizes its essential features, its various manifestations beyond everyday life, and its various uses in humanity. Similarly, the concept of the atom can be learned spontaneously by the child of a chemist father or mother through unsystematic learning and not reflected on during conversations with the parents at home. Let's see, then, that it is the nature of the generalization and the way in which this generalization was learned, as well as its scope in relation to reality, that makes this concept be recognized as complex, as a spontaneous concept, or as a scientific concept.

Finally, before moving on to another part of the text, we need to make another methodological point. Although Vygotsky (2009) talks about "stages" in the development of thinking, this does not mean that the development of thinking is linear and that it moves naturally from syncretic thinking to conceptual thinking. In fact, these forms of thinking do not disappear, as we will see below:

Here, even after the child has learned to work with a higher form of thinking - concepts - he does not abandon the most elementary forms, which for a long time still qualitatively predominate in many areas of his thinking. Even adults do not always think in terms of concepts. Their thinking very often takes place at the level of complex thinking, sometimes descending to the most elementary and primitive forms. (VIGOTSKI, 2009, p. 228)

We will develop this idea further below, with the aim of overcoming prejudicial conceptions of the YAE and pointing out contributions to a historical-critical teaching of the natural sciences in this segment of education.

3 Historical-Critical Nature Science Teaching: contributions to the development of theoretical thinking in the YAE

As we saw in the previous topic, the development of the functional process of thought is multifaceted. Understanding how "thought thinks" requires overcoming the dichotomy of form and content. And what does that mean? A detailed analysis by Vigotski (2009) shows that thought is not an empty structure in which knowledge is housed. There is no such thing as thinking by concept or thinking by complex as a ready-made structure completely independent of content; it is a dialectical movement of the psyche. This is why Vygotsky (2009) states:

In adult thought, we also observe a significant phenomenon at every step: although adult thought has access to the formation of concepts and operates with them, this thought is not filled with such operations. (...) In adult thinking, we observe at every step the passage from thinking through concepts to concrete thinking, through complexes, to transitional thinking. (VIGOTSKI, 2009, pp. 217-218)

Thus, all of us, if we have experienced human culture and have reached the necessary psychophysical bases of adolescence, think to some extent conceptually, complexly, and in a more or less syncretic way. The scope of our thinking will be different for different objects of knowledge, and will always depend on the theoretical-practical relationship we have with certain contents and on the extent to which our activities require a more reliable image of the object we are analyzing. This doesn't mean, however, that we can't transfer the logic of a way of thinking from one object to another, since this certainly facilitates our grasp of reality, but even this transfer must be carried out with caution, since certain objects have their own internal logic. This logic must always be carefully analyzed so that

transpositions don't cause distortions that may seem reasonable and correspond to a reliable image of the object under study.

Now imagine a man who has mastered the principles of materials engineering so that he can work in a team that sends robots to Mars. They will have to have a deep psychic reflection on the nature of the materials, their functionalities, and, if they have mastered theoretical thinking, they will have to understand the historical conditions in which these materials were created, the class struggles involved in the production of these materials, whose interest it is to send the rocket to Mars, which country it is in so that this is allowed, etc.

It is possible, however, that when faced with a forest where medicinal plants need to be found, this engineer will rely on sensory images or complex thinking, such as the memory of a plant used by his grandmother or something he has seen in a book, but he may be operating with a less accurate picture of reality than a botanist who specializes in medicinal plants.

Of course, given a specific need and specialized help, the engineer, if he has developed theoretical thinking, will be able to mobilize this way of thinking to learn the content related to plants, and thus, given the objective conditions, will learn more than someone who can never handle an object from theoretical thinking. The closer the object is to this way of thinking, the faster the subject will be able to grasp it, and this is easy to see, like learning a third, fourth, or fifth language after having learned a second language, or another type of dance after having conceptually mastered a certain style⁴. Thus, we affirm that, from the perspective of cultural-historical psychology, speaking about thought can only be done by considering the dialectical relationship between form and content. **There is no such thing as thought without content, so it's not possible to talk**

⁴ Again, we are aware that these comparisons will have specific nuances. For example, knowing one Latin language makes it easier to learn another, but it doesn't necessarily guarantee that it will make it easier to learn Mandarin. Although, as we know, the general principles of language learning are the same regardless of the language. The same goes for the natural sciences: learning chemistry doesn't guarantee learning physics, but the principles of learning one science can be transferred to another, mobilizing the same structure of thought.

concretely about the act of thinking without being clear about the content of thinking.

Understanding the above statement has pedagogical implications for science education. There is no point in looking at our adolescents and/or adults and saying that they think in terms of complex concepts. We have to recognize the characteristics of complex thinking, spontaneous concepts, and scientific concepts that the student mobilizes with and in the face of this object, and thus work from there, so that through this content they can develop their theoretical thinking, which will obviously serve other elements of reality not limited to this object.

Understanding this relationship between form and content in the dynamics of each subject's thinking will also help professors/researchers in the natural sciences not to make abstract comparisons. It is not a matter of rushing to say that those who are schooled think conceptually and those who are not don't think. The discussion of the type of thinking in relation to an object must always have as its horizon what the subject's thinking achieves today and what it could achieve tomorrow. In this way, we don't compare the knowledge of Mrs. Abigail, who has mastered the art of making remedies with teas, with an abstract, educated subject who has attended biology and chemistry classes. We must compare Dona Abigail today, who knows teas, with what she could do with the same teas and so many other manipulations of matter if she knew the universalized knowledge of chemistry and biology. Thus, in the face of universal knowledge, Mrs. Abigail's particular knowledge could be surpassed by incorporation, and she could, given the right material conditions, be, for example, a great pharmacist, contributing to humanity in terms of her practical daily experience. So, as an educator, I don't look at Ms. Abigail because of the lack or type of thinking she allegedly doesn't have, but because of the possibility that school and scientific knowledge can offer her more than the particular limits of her life, allowing her to understand the objects of reality in their complexity in the most diverse areas and in their richness.

A professor/researcher will be wrong if he compares an abstractly studied subject with another abstract subject that doesn't go to school. You have to go to the concreteness of the subject and the object, and only then look at these subjects and see what they know about what you want to teach, what they don't know and need to know, and what they know but which is actually a bourgeois ideological veil. Knowing this, you can then work to ensure that they learn this knowledge in its maximum determinations, emphasizing its common-sense content while making use of the valid core of their knowledge. As Saviani (2009) tells us:

The way in which education is inserted into the hegemonic struggle has two simultaneous and organically articulated moments: a negative moment, which consists in criticizing the dominant conception (bourgeois ideology); and a positive moment, which means: working on the common sense in such a way as to extract its valid core (common sense) and to give it elaborated expression to formulate a conception of the world that corresponds to the popular interests. (SAVIANI, 2009, p. 4)

In this way, it's not just about teaching water in school because it's an everyday topic or because it's part of the student's daily experience. It's about looking at water, teaching how to recognize it, thinking about the general principles that explain this matter (it can appear as a liquid or a solid, it has a boiling and melting point, viscosity, properties explained by intermolecular interactions, etc.), and realizing that this water, and the lack of it, only exists in the concreteness of the classroom reality. The water that doesn't reach the backlands due to public neglect; the water that is used in abundance by the industries; the water in the pot that is boiling; the water in the rain; the water in the tears of the black woman who cries for her son killed by the police; the water that flows in the blood of every worker who gives his sweat; the water that is used in different crops around the world; the water that has made the difference between the historical civilizations that lived on the banks of the river, etc. This is the concrete water that we must have as a horizon. It is this concrete water, rich in determinations, that allows us to move away from the lack of generality typical

of water as a spontaneous concept and prevents us from having a verbalized version of the scientific concept, in which water is repeated as H₂O, which forms hydrogen bonds, but which means nothing from the student's perspective's theoretical thinking in relation to objective reality. As Asbahr (2020) tells us:

In other words, we can't be satisfied with the formation of a subject who, from an individual standpoint, seems to be in full command of the concepts learned at school and can verbalize them precisely, but who can't "use" them to understand and transform the world. This means understanding the ethical dimension of our pedagogical action from the perspective of the formation of a "class consciousness", a consciousness as a working class, which means, among other things, seeing the totality of society in its contradictions and the constitution of a collective social project organized from the interests of the working class. (ASBAHR, 2020, p. 86-87)

It is clear that, given the objective conditions, it would be impossible to work on the multiple determinations of all concepts, but it seems to us that having this as a horizon will help professors not to keep proposing actions based on an approach that stops at abstraction (talking only about general laws) or an approach centered on empirical appearances that are purely a slave to the daily lives of YAE students. They will be able to organize their teaching, as far as possible, by moving between the general laws, specificities, historical movements, and contradictions of the concept they are teaching, considering the methods available, the students, and their specific contexts, as well as the amount of time they have at their disposal. Strictly speaking, what we are arguing is that, within the conditions of the professors, they must propose a teaching that is developmental; they must create suspicion and doubt about immediate reality.

In the words of Martins (2016a),

[...] The tension between the empirical and abstract does not arise spontaneously. It must be provoked, instigated, which allows us to affirm schooling as an important condition for the creation of this tension, and the teaching of scientific concepts

as the creation of "mistrust" in relation to what is immediately evident in concrete reality. We understand that reasoning is "born from the womb" of this "mistrust". Reasoning, through its logical operations, is then imposed as a necessity for knowledge of the object when this knowledge, rooted in sensory perception, proves to be partial and insufficient; in other words, reasoning begins when sensory knowledge proves to be insufficient to satisfy the motives of the activity. (MARTINS, 2016a, pp. 19-20)

When Martins (2016a) informs us that reasoning begins when sensory knowledge proves insufficient in the activity, she points to another essential element in thinking about the teaching of science: the category of need. The teaching of concepts that aims to develop theoretical thinking (developmental teaching) must reconstruct in each individual the historical need that humanity has and has had to work with these elements of reality. Humanity's historical need for what is taught is therefore the guiding principle of any pedagogical practice that claims to be historical-critical. Looking at the history of science and realizing that the concepts we are going to teach meet a historical need and come up against the limits that humanity has in the face of reality is something that seems fundamental when we talk about teaching science for development. From a psychological perspective, by learning to work with this notion of historical necessity, it is possible for students to make sense of what is being studied in class and to recognize themselves as human beings beyond their immediate needs.

Through the appropriation of the concept in its movement in the face of historical reality, YAE students can deepen and give new meaning to their lives, even their daily lives, as they become aware of a world that is bigger than them, broader, richer in determinations, marked by the material inequality that situates them in history and places them as working-class human beings. This material inequality has allowed much to be stolen from him as a human being, not through any individual fault, but because of the way, society is constructed. Therefore, the teaching of the sciences, which aims to develop theoretical thinking, must be based on an understanding of this reality in its affective-cognitive relationship, and to achieve this, it must arouse in YAE students an indignation at what is happening and the urgent need to create a new world.

This is, of course, an arduous task that can only be done collectively, that can only be achieved if we overcome the ideological impulse to belittle the working

class and begin to look at it from the perspective of power, of someone who sees in it the possibility of participating in the construction of a class for itself⁵.

Since we are dealing with the specificity of the YAE in this text, we need to make two points that have already been made here. So, at the risk of being repetitive, we think it's important to emphasize them. The first relates to the relationship between education and the world of work, which is obvious when we talk about the YAE. As a rule, the working-class people in the YAE carry the marks of society's alienated work on their bodies, minds, and hearts and they come back to school wanting to improve their lives. It doesn't seem immediately helpful to ignore their desire to get out of a precarious situation and improve their lives.

However, we also understand that it is inhumane to make promises and illusions from the perspective of transforming the school, which could lead to another conception that naturalizes the failure of the subject. It seems to us that the school must act in the sense of revealing the real and pointing out, whenever possible, material alternatives so that the subject has better conditions for survival. However, it must also point out the limits of this society and show how much human knowledge is stolen from us every day, clarifying that this society will not allow everyone to be completely free, and for this very reason, it must end.

Thus, we argue that if we want to develop theoretical thinking in students, we need to speak to their most pressing needs, without limiting ourselves to them. In other words, in a difficult but necessary dialectic between the immediate needs and the broader needs that are present in all educational segments and that pulsate strongly when we discuss the YAE and its urgency to sell its workforce to survive.

⁵ Marx's concept of class for itself refers to the process by which workers recognize themselves as individuals who make up the working class and begin to act as political subjects. In Marx's words (1982, p. 159): "[...] this mass is therefore already a class in relation to capital, but it is not yet a class for itself. In the struggle [...] this mass comes together, it constitutes itself as a class for itself. The interests it defends become class interests. But the class struggle is a political struggle.

The second consideration that we must emphasize in this text relates to a difficulty often reported in the practice of science professors in teaching scientific knowledge to YAE students, due to the crystallization of a supposedly everyday way of thinking that tends to want to solve scientific problems quickly and practically, which sometimes makes it difficult to understand and grasp certain scientific concepts. We understand that this is an arduous task, but cultural-historical psychology also gives us a clue as to how to deal with this supposed difficulty. In his studies on defectology⁶, Vygotsky (2011) pointed out that for subjects with atypical development, differences in cultural adaptation should never be seen solely as an obstacle, but rather the opposite because it is a matter of using what the subject has as a power and, from there, tracing a path through which we find elements to create actions that generate development.

Therefore, it's about finding ways of thinking, feeling, and acting in the activities that these students have built up throughout their lives and professions, ways of teaching the scientific concept so that they can re-signify their experiences and go beyond them, broadening the conceptual framework. It's about finding alternative ways of teaching in their experiences.

Thus, the new perspective prescribes that we consider not only the negative characteristics of the child, not only his faults, but also a positive portrait of his personality, which is first a map of the complex indirect paths of development. (VIGOTSKI, 2011, p. 869)

This is more than considering so-called preconceptions, as common sense in the teaching of science usually says. It's about looking at the accumulated life material of each student, as well as those forms and contents of thought already rooted in life activities, as a force to be worked on, to be improved, destroyed, or denied through dialectical overcoming. The material of thought,

⁶ We're not saying that YAE students have a disability or anything like that, we're just pointing out that the path pointed out by Vygotsky (2011) is not restricted to defectology, but points to general laws that help us to think of various alternative methodological paths, paying attention to the specificities of all students.

memory, feeling, etc., brought by the YAE student is more than a starting point; it is also the middle of the road and an arrival, but a different, re-signified arrival.

Here we hope to have emphasized that instead of looking at an idealized working class in books, or assuming a priori the weakness of a supposedly complex thought, a scientific education that wants to be revolutionary must see the problems of the students, but not rush to diagnose them as this or that type of thinking, since this is methodologically impossible and not the most important thing. It's a question of looking for the best strategies, given the objective conditions, for a teaching that promotes, through the objects of science, the development of theoretical thinking and helps the working class to understand the world in its concreteness - and to want, from the depths of their affective-cognitive framework, to transform it.

4 Final considerations

As this theoretical study shows, understanding the role of scientific concepts in the formation and development of thought is not only an important way to help science professors in their pedagogical practices, but it also highlights the fact that YAE students cannot be reduced to complex thinking or any other type of thinking. And whenever we work with, talk about, or study YAE, we must overcome our prejudices that treat students as incapable or with little symbolic reach.

We affirm in this text that the defense of YAE education is not a matter of welfare because when young people and adults have to go through late schooling, it is a direct reflection of the way education is organized in class society. Education is a right that everyone has, not only from the perspective of work but as an essential form and right of every human being to understand reality to understand the world, in which they live, its entirety. In this way, our commitment to the YAE, which understands the strength of the working class as a revolutionary class, is also a class commitment.

In this sense, this text has tried to expose the own reflections of cultural-historical psychology on thought, to understand how it works and, above all,

how it evolves. This moment was essential for us to escape the traps that devalue the school and/or the workers who attend it. We understand that the school is essential in the process of humanization and education, but its progress must always be compared with itself and with what humanity has achieved, without separating the dimensions of manual and intellectual work. In this way, professors of natural sciences who are committed to the working class will look at the student through the eyes of a person who is not dehumanized but who has latent humanity. A humanity that has to be produced and that will always have as a reference what the subject knows and has experienced, and that at the same time has to overcome conceptions rooted in common sense. A humanity that longs for a more radical and holistic reflection on the world.

We truly hope that this text will help those who reflect on YAE to find secret passages in the dead ends that we educators will always encounter in our pedagogical practice. The way to find secret passages, as magical literature already teaches us, is to always question the obvious, the natural, what is presented to us as unchangeable, and to believe that there is something better behind the door that we don't always see immediately. We will find collective secret exits.

Un pasaje secreto en el callejón sin salida: la enseñanza de las ciencias naturales y el debate sobre el desarrollo del pensamiento para estudiantes de Educación de Jóvenes y Adultos

RESUMEN:

Es común en la Educación de Jóvenes y Adultos (YAE) asumir que los estudiantes son incapaces de aprender las ciencias naturales por suponerlas muy abstractas. Mientras tanto, tratando de combatir esta concepción, muchos trabajos terminan defendiendo el vínculo de la enseñanza de las ciencias naturales con la vida cotidiana y sostienen la valorización del saber espontáneo de los alumnos de la YAE, lo cual va en detrimento del saber escolar y desconoce la importancia que tiene el conocimiento científico para el desarrollo del sujeto más allá de sus necesidades y usos inmediatos. Entendiendo que ninguna de estas concepciones potencia el trabajo en Educación de Jóvenes y Adultos, el presente trabajo tuvo por objetivo debatir el rol del conocimiento científico en el pensamiento de los adultos. Además, se pretende, a partir de los fundamentos de la psicología histórico-cultural, explorar críticamente visiones prejuiciosas respecto de los estudiantes de la YAE, al mismo tiempo que se destaca el impacto del conocimiento científico en el pensamiento de los estudiantes de este segmento. Se ha dividido el trabajo en dos partes: en la primera, se presenta un análisis del funcionamiento y desarrollo del pensamiento según las teorías de Lev Vigotski y Vasili Davidov; en la segunda parte, en relación con la enseñanza de las ciencias naturales, se busca abordar los aportes al desarrollo del pensamiento teórico en la YAE.

Palabras-clave: Educación de Jóvenes y Adultos. Desarrollo del pensamiento. Enseñanza del concepto.

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