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ARTICLE

MOTIVATION TO STUDY PHYSICS

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ABSTRACT:

Throughout this study, arguments are presented about the idea of Physics learning motivation. This discussion, raised in the undergraduate course of Physics, lead to the following question: Is the motivation something the students already have with themselves or is it a quality that they develop during the course? Considering this question, the purpose of this article is to discuss ideas about the motivation of human nature as a contribution for teaching activities. The discussion is based on studies about human activities and defends the idea that the motivation for scientific knowledge should be developed from very early school levels. The meaning of motivation is deepened through principle-based concept analysis. In conclusion, the study points to the existence of different motivations between high school and higher education students in Physics, indicating the need for Teacher Training and Scientific Initiation for this educational transition.

Keywords:
Motivation;
Teaching;
Physics.

LA MOTIVACIÓN PARA LOS ESTUDIOS DE LA FÍSICA
RESUMEN:

A lo largo de este estudio se presentan argumentos para la idea de motivación en el aprendizaje de la Física. Esta discusión en el contexto del curso universitario de Física conduce a la siguiente pregunta: ¿la motivación es algo que el estudiante ya debe traer consigo o es una cualidad que se desarrolla durante el curso de Física? A partir de esta pregunta, se discuten las ideas acerca de la naturaleza de la motivación humana como subsidio para la actividad educativa del profesor. La discusión se basa en estudios acerca de la actividad humana, defendiendo la idea de que la motivación para el conocimiento científico debe ser desarrollada desde los niveles escolares básicos. El estudio profundiza el significado de la motivación, a través del *análisis de conceptos basado en principios*, concluyendo que existen diferentes motivaciones entre jóvenes de la enseñanza media y estudiantes de educación superior en Física, así como la necesidad de formación docente e iniciación a la investigación científica para esa transición educacional.

Palabras clave:
Motivación;
Enseñanza;
Física.

A MOTIVAÇÃO PARA OS ESTUDOS DE FÍSICA
RESUMO:

Ao longo desse estudo são apresentados argumentos para a ideia de motivação de aprendizado de Física. As discussões no contexto de ensino superior nessa área conduzem ao seguinte questionamento: a motivação é algo que o estudante já deve trazer consigo ou é uma qualidade que ele desenvolve durante o curso? A partir dessa questão, o presente en-

Palavra-chave:
Motivação;
Ensino;
Física.

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saio busca discutir as ideias acerca da natureza da motivação humana como subsídio para a atividade educativa do professor. A discussão se fundamenta nos estudos sobre a atividade humana, defendendo que a motivação para o conhecimento científico deve ser desenvolvida desde os níveis escolares mais básicos. O estudo aprofunda o significado de motivo, por meio da *análise de conceitos baseada em princípios*, concluindo que existem motivações distintas entre jovens do Ensino Médio e acadêmicos do Ensino Superior de Física, indicando a necessidade de Formação Docente e Iniciação Científica para essa transição educacional.

INTRODUCTION

During the I Internal Seminar on Teaching Laboratories of the Institute of Physics at the Federal University of Bahia, held in 2019, a fruitful debate took place regarding the nature of the activity developed by teachers and students in such spaces. Many situations were discussed at the event, especially the recurring topic about the lack of motivation for the study of Physics. The opinions swing from one extreme to the other: some people point out the need to create motivating mechanisms to promote the student's engagement in the course tasks, whereas others argue that higher education students are supposed to present a sufficiently developed motivation to study Physics. Considering such divergent opinions, we discuss the nature of human motivation that enables further development of these issues.

Therefore, the selected theoretical framework addresses the educational aspect, connected to the topic "motive", within the Activity Theory, particularly Leontiev (1978; 1984) and Engeström (1987). Leontiev provides elements to comprehend basic level of motivation, during initial educational stages. Engeström discusses motive, associating it with a system of internal contradictions, from a primary nucleus of human activity. Such notions, then, join Freire's work (1987; 1996) to discuss extreme situations that imply the achievement of new knowledge in an engaged and collective search for a problem-solution.

In addition to these classical references, more recent studies also address the topic motive specifically in the context of science education. For example, Mattos and Gehlen (2009) connect the ideas of Motivation by Leontiev and Problematization by Freire. In another study, Silva, Gehlen, and Mattos (2017), based on Leontiev (1978) and Engeström (1987), analyze Educational Activity from the perspective of the Freirean Thematic Approach (FTA). They focus on the differences in the FTA axiological and epistemological dimensions, when compared to the scientific conceptual approach.

Rodrigues and Mattos (2007) propose a category of axiological analysis by amplifying the ontological and epistemological dimensions of Mortimer's (1995). In the ontological dimension, the method is to explore the concept in multiple contexts. In the epistemological dimension, the focus is on second order ideas of the concept, i.e., a historical and philosophical category in order to achieve a deeper knowledge about it. The axiological field is distinguished by the reasons that lead to choices and ends, that is, the motives that guide subjects to their preferences for on a given concept.

When the concept of motive itself is in force, its axiological analysis presents a circular difficulty, since it involves the necessity of elucidating "the motive of motivation". Therefore, the category of ontological analysis—from which the objective meaning expands among the other dimensions– is the category that enables the opening of this circle. This plain clarity leads the multiple possibilities of relating the topic motive to difficulties in understanding its destination: human activity. Within this scope, the bases that support such discussion also embrace Leontiev, Engeström, and Freire's ideas.This study, however, is not focused on discussing the reason for choosing a concept, but the concept of motive and its implications in teaching activity.

Consequently, this work is based on the *Concept Analysis* designed by Penrod and Hupcey (2005), with the following principles: *Epistemological*, for checking if the concept is clearly defined in the literature; *Pragmatic*, for assessing if the concept is capable to explain or describe phenomena found in a given area of knowledge; *Linguistic*, for checking if the concept meanings are appropriate, which here is related to the theoretical context; *Logical*, for analyzing the coherent integration between the concepts.

Therefore, this study analyzes theoretical frameworks through which the concept of motive is evidenced. In contextual terms, "motive" is initially examined in its definitions of classical origin (Leontiev, 1978; 1984), which related to Engeström's guidelines for researchers seeking to explore the field of Activity Theory:

> Such a multivoiced theory should not regard internal contradictions and debates as signs of weakness; rather, they are an essential feature of the theory. However, this requires at least a shared understanding of the character of the initial cell and a continuous collective attempt to elucidate that cell as well as the multiple mediating steps from the cell to specific concepts. (Engeström; 1999, p. 20)

Our basic thesis that guides this study relies on the following: motives undergo qualitative transformations throughout the student's life, including the highest levels of education. Based on this interpretative genesis, the contradictory and developmental aspects of motivation are addressed on two fronts: a) characterization of the main motive of young students' activity who graduate from high school; b) discussion about the commitments expected from students in Physics higher education courses.

One hypothesis is that the main motive of high school students is directed towards collective activity, together with close classmates. The activity of Physics higher education students is expected to be closer to commitments to knowledge involving science and how it works. Such notes are based on the ideas of El'Konin (2012), in relation to the ontogenetic stages of human motivational nature. Additionally, arguments defended by Freire (1987; 1996) are used to reinforce the transformative educational feature of motives, derived from problematization.

The debate in the Teaching Physics context is relevant, considering that this subject is traditionally internalist. Consequently, Teaching Physics must make the topic motive more visible, moving it from a stable condition of intrinsic exclusivity of the individual to an external issue that can be taken into discussion. Taking this scenario into account, we aim to provide an insight to the importance of producing new motives as a factor to reduce the distances between Teaching Physics in high school and higher education levels, considering the teachers' strategic role as mediators in scientific initiation.

THEORETICAL ARTICULATIONS

Leontiev's studies (1978; 1984), linked to the Cultural-Historical Psychology within the Activity Theory, substantiate the discussion suggested here. He defines that every activity is generated by a motive, explaining that this aspiration works as a psychic function of orientation in the subject. Therefore, "motive" does not mean a feeling of need, it indicates what the need becomes objectively in the given conditions, to which the activity is oriented, that is, what stimulates it Leontiev (1978).

The concept of motive is thus explained by its ability to stimulate the subject's action toward a given purpose. In the same work, however, Leontiev admits that activity processes (actions) and motivations do not coincide in human beings. When explaining more basic aspects of motivated activities, he uses "primitive hunts", affirming that the action of scaring off the prey, performed by the beater, is not coherent with the interest of the hunt (food or fur). To demonstrate the social nature of motive that orient human activity, Leontiev finds the coherence of the beater's action in the connection between its immediate goal and that of the other participants', that wait for the running prey. There is a relationship where one individual receives their share of the collective labor, that only happens by means of the activities of the other men, which

conveys the objective material basis of the activity of the human individual –in history, the relation between motive and objective reveal social and objective connections, not natural (Leontiev, 1978).

Leontiev believes that such social relations produce the human singularity, and generate the psychic reflection of reality, that is, the human conscience. Therefore, specific actions that intertwine motive and its goal should not be operations devoid of meaning, because they would not have any psychic reflection of orientation otherwise. Consequently, a motive is necessary to make concrete actions effective and demonstrated in humans as conscious operations. In addition to this social aspect, he also conveys that motives are not transmitted to future generations through some kind of biological inheritance, but through culture. According to (LEONTIEV, 1978) human psychism is not a result of innate aptitudes or environmental adaptation of behavior, it actually comes from socio-historical development and experience through generations of individuals, in a way that progress of thought depends on the assimilation of such experiences.

If a motive can be socially created or formed, if it can be transformed historically, then this is an educational issue. The problem regarding whether a student should enroll in a Physics undergraduate course already motivated implies unraveling how such motives are transformed in the subject throughout life. Leontiev himself points to these motivational stages of the individual, when discussing the concept of Dominant Activity in children. Their consciousness is developed by a change in the activity motivation, as previous motives are replaced by new ones that allow for the old actions to be reinterpreted (LEONTIEV, 1978, p. 333).

When Leontiev defines Dominant Activity as a special quality that conditions the main changes in the psychism, he interprets that a child's motivation is different from an adult's motivation, even if the child imitates the adult or is subjected to their typical tasks. In either condition, the Dominant Activity in a child is motivated by play, by "childish colors" that coat their personality. Leontiev's ideas on this topic are presented in four systematic steps:

> 1)Along with the subject's dominant activity (for example play), there is a culturally valued motive for a more advanced activity (for example studying). In the subject's consciousness, the latter exists as an 'understandable' motive only.
>
> 2) The representatives of culture induce by some means (e.g., rewards) the subject to engage in selected actions or components of the more advanced activity within the motivational framework of the earlier activity.
>
> 3) The 'understandable' motive of the more advanced activity begins to be 'effective' as the selected actions representing it begin to produce results that exceed the limits of the motive of the earlier activity. This transition manifests itself in disturbances –for example, the selected actions are temporarily terminated because the subject senses acutely their inadequate quality in relation to the emerging more advanced motive.
>
> 4) Eventually, the new motive and activity take over the leading role. (Engeström,1987, p. 140)

According to Engeström (1987), Leontiev believes that motivation is transmitted by culture, without taking internal contradictions into account. Therefore, he dedicates himself to expanding Leotiev´s ideas, using an Activity System composed of four levels of contradictions. In the following paragraphs we associate their definitions with typical situations of educational activity.

The book used by a student, for example, has multiple added values: market value, the value of use to succeed in college entrance exams, in a professional career, even the value of its artistic and scientific content. Consequently, Engeström (1987) considers that the primary contradiction of activities in capitalist socioeconomic contexts is established in the internal conflict between exchange value and use value.

On the other hand, there are tensions about the current activity format, no longer compatible with the demands of a new era. The virtual laboratory, for instance, is increasingly present in Physics higher education courses, requiring new concepts and laboratory practices. This is an example that we place in the secondary contradictions, according to Engeström (1987), who describes this category as showing rigid hierarchical division of labor, and being backward and resistant to the possibilities opened by advanced instruments.

The learning object and the way students behave when facing it belong in the tertiary contradictions of teaching activity.

> The tertiary contradiction appears when representatives of culture (e.g., teachers) introduce the object and motive of a culturally more advanced form of the central activity into the dominant form of the central activity. For example, the primary school pupil goes to school in order to play with his mates (the dominant motive), but the parents and the teacher try to make him study seriously (the culturally more advanced motive). The culturally more advanced object and motive may also be actively sought by the subjects of the central activity themselves. (Engeström,1987, p. 103)

Finally, quaternary contradictions imply "neighbour activities" by which the object and immediately apparent results of the central activity are incorporated, as pointed out by Engeström (1987). If a new learning situation affects the students' motivations, conformed in a given activity system, a reaction emerges as resistance. This induces a complex, short or long-term expansion, causing qualitative changes in the student's motivation. There are tensions at the edge of such teaching-learning activity as well, and through them the central activity of knowledge production is resignified.

Engenström (1987) describes learning activity in three levels. He argues that in addition to "school--going" and learning at "work", learning is also about searching for truth and beauty, pointing to science and art as activities devoted to finding such values. He also states that "the difference between science/art and learning is commonly seen in that the former *produce* truth and beauty while the latter *reproduces* them" (Engenström, 1987, p. 108).

This argument validates the suspicion regarding a very echoed discourse in the educational environment, that the student's lack of commitment results from their natural unwillingness to face the rigor of scientific knowledge. In the professional context of Teaching Physics, the lack of commitment is associated with the lack of will, the lack of interest and with the lack of knowledge necessity, which translates into absence of cognitive motive.

But if scientific motivation is related to the enthusiasm directed to its cultural value of discovery or construction of the truth, the lack of motive would mean the lack of curiosity. This idea is opposed by the argument that such imagination stimulus is present in every stage of school life, whether in relation to the main motive of the Dominant Activity or not. Curiosity, as Freire points out, helps understanding such premise:

> For me, in the difference and in the "distance" between naivety and critical thinking, between the knowledge of pure experience and the one that results from methodically rigorous procedures, there is no rupture, there is actually an overcoming. Overcoming, and not rupture, occurs insofar as naive curiosity, without ceasing to be curiosity, on the contrary, still curiosity, criticizes itself. By criticizing itself, then becoming, I allow myself to repeat, epistemological curiosity, methodically "rigorizing itself" when approaching the object, connotes its most accurate findings (Freire, 1996 p. 15, our translation)

The rupture mentioned by Freire becomes a problem when it is seen where it does not exist: in the opposition between pleasure in learning and the methodological rigor of the search. He argues that the more people learn, the more they admire the beauty of the scientifically rigorous process that makes it possible to broaden their understanding of reality. What makes a Physics higher education course distance itself from the aspirations of certain marginalized communities? Would that be the lack of cognitive motive of the young people who live in these areas, or the lack of contact with the academy? Such questions are useful to illustrate the kind of commitment that Freire's arguments imply. In connection with Dialogical Theory, his ideas associate the cognitive aspect of motive, not to a mere intellectual exercise, but to the overcoming of social inequalities.

The "aspirations" of a social group that compose the "thematic universe" or " meaningful thematic" in Freire (2005) are interpreted as motivations. They are coded and decoded by problematizating this collective reality. Critical awareness of the existential limits challenges the subject to search for answers, not only

theoretical ones, but with collective actions aimed at overcoming such conditions. Problematization, while agglutinating the driving force of a given social group's aspiration, leads to critical reflection and transforming actions. In such scope, naive curiosity also becomes epistemological curiosity. Therefore, motives or aspirations are not solely cognitive, they are fundamentally historical and political.

Whether due to Dominant Activity exceeding, or an internal contradiction of this activity, or the overcoming of limiting social practice conditions, this theoretical discussion suggests that motivations change throughout life. Although they are diverse and developed in a complex way, this study aims to investigate the ways that a specific motive stands out, guiding the student's main activity at some point in his/her life. Therefore, next section explores the characteristics of this activity, how it arises and to what extent it occurs or develops in students.

PATHWAYS AND ARGUMENTATION DEVELOPMENT

First of all, a deeper discussion on motivation in Physics higher education courses imposes two questions: a) what kind of commitment is expected from students in Physics higher education courses? and b) how can high school graduates' motivation be described? There is a clear relation between the two questions. If commitment begins and develops earlier, that is, in high school activity, then more engagement can be expected in higher education courses.

To further develop these questions, we articulate the theoretical framework focused on students' motivation. Leontiev (1978), for instance, invokes the example of a student that stops reading a book, after finding out that the book will not be required for the college entrance examination, showing that the student's motivation to learn that subject is not effective. Resorting to Engeström (1987), this kind of situation is contradictory, related to reward systems derived from the value implied in the book reading. Finally, Freire (1987; 1996) understands that the students' aspiration to solve a problem of social practice context will encourage them to overcome challenges in this reading, which, presumably, should include the meanings of the "thematic universe". Anyway, if the student stops reading the book, there is still the question relating to what end his or her next activity will be oriented.

The pathway is in El'konin's (2012), who defends the existence of two ontogenetic stages for the development of Dominant Activity. The first one refers to the development of human motives, goals, and norms that take place in the sphere of necessity by which intersubjective relations prevail. It is a preparatory stage to develop technical-operational skills that are enhanced by the relations between the subject, the instruments, and the objects, which become dominant in the second stage. Therefore, when a school student stops reading the book, it is more likely that his or her activity is oriented to immediate tasks, connected to partial motives –usually commitments related to the family circle. However, these partial actions are still felt as tasks that, once accomplished, make room for of media and social entertainment. Thus, a more fundamental motive chains a series of actions in the student's direction. This motive is oriented towards a fulfillment with peers, such as going to the movies with friends.

Therefore, the research problem does not focus on students as autonomous individuals with intrinsic motivation to learn. Rather, students are perceived as individuals whose autonomy is gradually developing, by the expanded circles of objective and social interaction.

After all, as Leontiev (1984) perceives, humans experience a reality that seems to be increasingly expanding. Initially, they interact with, develop a sensory perception of, assimilate knowledge about and learn new meanings of a restricted circle of people and objects. Later, they face an activity that exceeds the limits of their practical activity and its direct contact: the change of limits in a world that they can recognize and represent.

Culturally, playing is a strong motivational influence on children's activity. These motives no longer play a major role during adolescence, although they never completely disappear. What changes is that ado-

lescents become more autonomous. Emotional ties do not disappear; they just move to other social spheres. When a person becomes an adolescent, the motivation for games, its connection with "understandable motives", affectionately stimulated by parents and the elementary school teacher receive a new guiding need: the need to belong to a group of mates, that is, their "tribe".

> In the classroom, young people stay in close contact, create an affective bond, and establish an *ethos* as a common way of thinking arising from shared emotion or passion and from a collective sense of belonging. (Dias; March, 2012, p. 7, our translation)

Just as it happens with a child, motivated by playful activities, it is expected that a secondary student, motivated by belonging to a group of friends, has not yet developed a long-lasting motivation for scientific knowledge. Cognitive motive, even if not governing the Dominant Activity in adolescents, increasingly participates in their social relations. A student hangs out with friends not only to go to the movies or have an ice-cream; they are also interested in studying together, even if only to spend time together. Therefore, the motive to learn, influenced by basic or secondary school and oriented to a need of belonging, leads the adolescent toward a more autonomous dimension of learning by the time they become higher education students. This relates to:

> [...] the ontogenetic emergence of learning activity, at least in present-day capitalist societies, may with the highest probability take place in adulthood or adolescence, when the subject faces historically and individually pressing inner contradictions within his or her leading activity - be it work, schoolgoing, science or art. (Engeström,1987, p. 144).

In terms of metacognitive motivation, linked to self-regulation of learning, we understand that prior development is also necessary here: "If for some reason the children is deprived of a constant history of such interaction, the development of a battery of self- regulatory skills is unlikely, to occur" (Brown, 1987, p. 103). In other words, if school education does not develop motivation with self-knowledge, it will hardly arise spontaneously in a Higher Education student.

Cognitive and Metacognitive motives are the main commitments that govern students' activity during the Physics higher education courses. At that level, it is more likely to find students going through the night, trying to solve a problem that will not be on a test. It is also reasonable to expect students who, instead of spending time with friends, would rather study in the Physics lab, then recognized as their favorite place for testing theories and constructing meanings. For undergraduate teaching degrees, in addition to motivations directed to the science object, it is expected that the students show interest for epistemological aspects related to the way that they learn a particular content. Whether in Physics Teaching or Bachelor's degrees, the main commitment expected from students is related to learning and its nature, and no external motivation should be necessary.

However, if a high school student is not initiated in such higher education protocols, we can only expect that s/he reaches this level already inspired by a natural epistemological curiosity or instigated by the historical-cultural sphere itself. The first hypothesis is ruled out using the notion of primitive hunts (Leontiev, 1978), discussed here. Whether high school students' motivation of belonging fulfills the motive of learning Physics expected in higher education is an issue that we discuss next.

In this sense, choosing a Physics degree may be more related to the values that the media, school, peers and people closest to the high school student credit to this knowledge and less directed towards the autonomous motive of learning Physics. If high school students interact with their peers, motivated by the feeling of belonging, there is little chance that cognitive or metacognitive motivation would appear spontaneously under the influence of their social circle. Regarding the role of family members in the formation of motives, Silva and Barbosa (2019) present data indicating that choosing Physics undergraduate courses is related to the cultural and economic capital of the parents, and few students know the reality of undergraduate or graduate courses. This relation supports the notion that motive depends not only on a will, but on external and social conditions to be effective.

Even if there is this dilemma concerning "what comes after high school", such contemplation is not enough to show young students what a Physics higher education course really is. Therefore, we can observe this "quaternary contradiction" when the Physics student confronts reality and stereotype. If there are no contradictions demanding that such students overcome their own interests, they remain connected to the motives related to the previous dominant activity. Consequently, enrolling in Physics undergraduate courses might prompt the motive of learning and remaining interested in the immediate relation of belonging. In any case, the contact with academic culture is where cognitive and metacognitive explanations are. Without these experiences, there is only the preexisting motivation of belonging, which we identified as the sociocultural cause of the main activity of young high school students.

Even if the activity is peer-oriented, the most important stimulus given to students does not come from such interaction, but from the school tasks. Engeström (1987) defends that the school is a socially central and organized institution that proclaims human learning as its objective. Therefore, the school is essential to promoting new motives linked to knowledge.

Grouped together based on some kind of affinity, young people have a great opportunity for open conversation about what to do with their lives. Although apparently spontaneous, these discussions are not totally free of external influences. Several channels feed the expectations of students enrolled in Physics degree courses, including the media, which influences the student's ideas about what a physicist does. There are also labels which, due to the socialized image of scientists, link the subject's figure to a knowledge profile –it is not uncommon for people to say: "you are a nerd, you look like you are going to study Physics".

Such representations, often twisted, of what students do in Physics, are among the reasons of conflict between the learning commitments of higher education and the motivation of high school students. The lack of scientific initiation programs in many Brazilian schools is a key reason, as demonstrated by Costa and Zompero (2017). Such deficiency leads to the persistence of twisted beliefs on the activity developed in Physics courses. Disappointment is one of the consequences and it produces high dropout rates or change of courses, which also implies waste of government investment.

On the other hand, a potential aspect for motivational development lies in the fact that students do not enter undergraduate courses totally disoriented in relation to high education activities. This "bridge" between cognitive motivation (higher education) and motivation of belonging (high school), becomes real by means of the work of those who experienced commitments from the two contexts: teachers.

Professional education is part of the culture of "teaching knowledge", consolidated in the educator's practice. Their initiation into the teaching profession is different from other careers. In general, it is a process throughout their school life, involving the images they have created about their teachers since childhood. In Physics undergraduate teaching degrees, this activity becomes formal when undergraduates are faced with the subdivided curriculum and with the didactic and pedagogical subjects. Those aspects are articulated with laboratory practices, methodologies and mandatory supervised practicum. Eventually, teachers return to school, bringing their experiences from school and higher education to the classroom. Teachers are thus the main mediators of the collective motivation of belonging in high school students and the cognitive motivation, more frequent in higher education.

Clearly, developing cognitive motivation is not the same as developing knowledge. The concept of motivation is more connected to the functions that form personality (desire, will, need, meaning of life etc) than to school duties. In motivational terms, it is both possible to "get a taste" of the knowledge and become excited, or to show no change in motivation when exposed to cognitive flows. Although some specific knowledge within a given area may become a motivated activity, such knowledge itself is not the main driving force of students' activity in basic or high school education. Consequently, among the various stimuli that influence students to enroll in undergraduate courses, in terms of their Dominant Activity, we note the relevance not only of the motive of learning more, but more of the motive of learning.

The motive of desiring knowledge and its nature must be developed. Therefore, teachers have an active role in the process of education and development of the student's motivation to the point where they become committed to their own intellectual development. This has direct implications for the subjects' autonomy, since they are stimulated to commit to their own learning, as they start to have the desire, the will, that is, a true motive of knowledge that guides them to a certain epistemological field of knowledge.

IMPLICATIONS FOR TEACHING ACTIVITY

The complex structure in which motivations develop are related to a diverse nature, notably, in a dynamic way, an affinity with an epistemological field. This is why not every student is inclined to study Physics. However, the wrong notion that "becoming an undergraduate in Physics" derives from a natural talent erases the fact that, most of the time, students have no experience with scientific initiation to safely make such a choice.

While a scientific culture can stimulate motives, it can also produce significant barriers to this transition. The existing confusion between the development of new motives and the linear development of content leads to a distancing between what is in the student's field of motivation and what is in the teacher's field of motivation. A change in motivation happens through the gradual appropriation of new reasons that are ultimately judged by the student. A possible solution is to provide the conditions for its reasonable emergence, considering that a direct change of motive is impossible because of its subjectively integrated and dynamic aspect.

In fact, some students develop more cognitive-motivational features than others. However, this fact just confirms the theoretical arguments that motivation is not equally developed for everybody. Addressing motivation to learn Physics as a given (or innate) ability of the subject is damaging, since it suppresses its qualitative enhancement in students, seen as uninterested at first, but with potential to become great physicists in the future. Ideally, the efforts should focus on trying to develop, in every student, the pleasure in learning scientific knowledge, and at the same time, seeking to increase material conditions so they can feel motivated to pursue such knowledge.

The material conditions may limit or favor teachers in the course of institutional practice, committed to motivational development. For example, a teacher who, in a project of scientific initiation, wishes to take high school students to visit a Physics course in order to stimulate their interest in this area. Even in the case of a teaching cooperation between these different teaching levels, the teacher may be faced with external and adverse situations, in which many arrangements have to be made, such as transportation, food and accommodation, for example. This shows that overcoming, as well as motives, are not only an internal matter of knowledge, and social engagement actions are required. Thus, the educational activity, aimed at the development of new motives, is connected with the political dimension, as in Freire's ideas (1987).

FINAL REGARDS

This study questioned whether motivation is something students possess or something that should be stimulated. This problem leads to a theoretical debate that enlightens the topic motive. Previous approaches have pointed to an ontological problem of motivation, which has enabled a better comprehension of the motivational profile expected from Physics students and the role of educational activity in the transition process of motives.

Indeed, it is desirable that students are already motivated when they become Physics undergraduates. Our arguments suggest that there is no reason whatsoever for students to leave high school with no clue regarding their main motivation in terms of an epistemological field. The fact that students' Dominant Activity are motivated by the necessity of belonging should confirm the cognitive motive of science, introduced with the help of educational activity. The motive of knowledge in a certain area, closer to the professor's

activity, can be developed and valued by students, when they reach the final years of the basic or high school education. Therefore, this should be one of the goals during high school in relation to motivation.

As for motivation to learn Physics, we should consider leaving the idea that the methodological rigor required by this subject clashes with the enjoyment of learning. Since curiosity develops very early in individuals, there is always a possibility that their naïve stage is eclipsed by the apprehension of an epistemological curiosity, as defended by Freire (1996).

Therefore, the mistake regarding students' motivations comes from the distorted notion regarding readiness of the subject. Expecting that freshman Physics undergraduates show immediate commitment to learning implies a presupposition that such students are ready in terms of motivation, without experiencing the existing contradictions between the different educational stages, as Engeström (1987) points out. On the other hand, such expectation is a result of the ontology that assigns to motive a natural and spontaneous cause in humans.

This reflection supports the belief that students choose to take a Physics course because they are inclined to, due to individual reasons or to reasons related to their basic educational sphere, which are expected to be equivalent to those of the specialized level. According to Leontiev (1978; 1984), this natural development is not sustainable, since the student's motive for learning flourishes in connection with the aspirations in their sociocultural context.

The existence of cultural limits, determined by social circles shared by young students, is also evident, and such limitations can be transformed by social and instrumental stimuli connected to the motive of scientific knowledge. This understanding leads to the importance not only of the school but of the interrelation between high school and higher education, which helps identify the mediator role of the professor during this transformational process of the motives of belonging into cognitive motive in Physics.

The notion that the motive for learning in Physics comes from a spontaneously vocational culture may crystallize another reality: the justification for the lack of scientific initiation actions in high school education. In accordance with this logic of spontaneous demand, it would be necessary to wait for the motive of learning to emerge from the depths of the psychic universe so that a material condition could be subsequently offered to young high school students.

Opposing the notion of naturalization of motives, Freire (1987) evokes the need to problematize this issue. Young people's aspirations to attend Physics undergraduate courses, even if commanded by naive or distorted motivations, should be problematized and the material conditions of mediation between the different motives within these levels of education need to be claimed as a public policy. Consequently, we point to the importance of investing in the education of High School Physics Teachers, whose resulting qualification will guide the initiation of motives related to the activities of Physics undergraduate courses.

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