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The significance of the adolescent student's learning activity

Camille Bordin Botke Milani[a]
Manoel Oriosvaldo de Moura[b]

[a] Universidade de São Paulo, Faculdade de Educação, São Paulo – SP, Brasil.
[b] Universidade de São Paulo, Pós-graduação em Educação Científica, Matemática e Tecnológica, Faculdade de Educação, São Paulo – SP, Brasil.

ABSTRACT

Background: The period of adolescence is frequently understood through a predominantly biological lens, often disregarding the individual's specific sociocultural experiences. However, adolescence is a socially constructed phenomenon. When considered as a bio-social unit, one of the key factors influencing adolescent development is the school trajectory, which plays a significant role in developing higher psychological functions, particularly theoretical thinking. **Objectives:** Grounded in the principles of Cultural-Historical Theory and Activity Theory, this study aims to investigate the learning activity of adolescent students, focusing on how they construct meaning in the process of developing theoretical thinking. **Design:** The study was guided by the theoretical and methodological framework of the teaching guiding activity, which served as the basis for designing learning-provoking situations aimed at facilitating the understanding of fractions. **Setting and Participants:** The study involved a didactic intervention conducted with two seventh-grade classes at a private school in Curitiba, Paraná, Brazil. The intervention took place in person during the 2022 academic year. **Data collection and analysis:** Data were collected through audio recordings, the teacher's field diary, and students' written productions. These materials were analysed to identify meaningful units for in-depth analysis. **Results:** The students' processes of knowledge appropriation led to the construction of meanings for the learning activity. **Conclusions:** The findings indicate that the development of adolescents' theoretical thinking occurs through meaningful and personalised communicative activity. This supports the argument that concept formation is deeply rooted in the social and dialogical nature of the learning process.

Keywords: Cultural-historical theory; Activity theory; Adolescent student; Learning activity; Teaching guiding activity.

Corresponding author: Camille Bordin Botke Milani.
Email: camillebbotkemilani@alumni.usp.br

RESUMO

Contexto: A compreensão do período da adolescência, por muitas vezes, apresenta cunho biológico, sem considerar as vivências socioculturais particulares do sujeito. A adolescência é resultado de um processo de construção social, desse modo, ao considerá-la na unidade biológico-social, um dos aspectos determinantes para o desenvolvimento do adolescente é a trajetória escolar, que contribui para o desenvolvimento de seu pensamento. **Objetivo:** Dessa forma, à luz dos pressupostos da teoria histórico-cultural e da teoria da atividade surge a necessidade em investigar a atividade de aprendizagem do estudante adolescente em como ele constrói significados na direção do desenvolvimento de seu pensamento teórico. **Design:** Esta busca foi orientada pelos pressupostos teórico metodológicos da atividade orientadora de ensino, tomados como referência para a proposição de situações desencadeadoras de aprendizagem para a apropriação do conceito de fração. **Ambiente e participantes:** Estas situações foram desenvolvidas por meio de um experimento didático com estudantes de duas turmas de 7º ano, em uma escola da rede privada na cidade de Curitiba (PR), Brasil, de forma presencial no ano de 2022. **Coleta e análise de dados:** A captação do fenômeno foi realizada por meio de gravações de áudio, diário de bordo da professora e registros escritos dos estudantes que permitiram eleger isolados de análise. **Resultados:** Os processos de apropriação de conhecimento pelos estudantes constituíram significações para a atividade de aprendizagem. **Conclusões:** Foi possível apreender o desenvolvimento do pensamento teórico do estudante adolescente, que impele à defesa de que ocorre em atividade de comunicação íntima e pessoal para o processo de formação de conceitos.

Palavras-chave: Teoria histórico-cultural; Teoria da atividade; Estudante adolescente; Atividade de aprendizagem; Atividade orientadora de ensino.

INTRODUCTION

Human development consists of stages that shape a human being into a man or a woman, namely childhood, adolescence, adulthood, and old age. Those stages permeate the development of the subject, influenced by experiences in sociocultural moments of their lives and formed by relationships with other subjects. Because of this, adolescence can last longer in one person than in another. According to Article 2 of the Statute of Children and Adolescents — ECA (Law N. 8.069/1990, of October 2017), adolescence covers the ages of 12 to 18, but we understand that it can vary.

In light of the hypotheses of cultural-historical theory, we understand human development as a process that is markedly dependent on the social relations established by individuals with others in communities. These experiences present and constitute meanings that the subject appropriates. This

movement occurs over time, depending on the relationships that are established. For adolescents, sexual maturation, considered a determining biological factor in this phase, is also a constituent of their development.

Leal and Facci (2014) note that adolescence is a cultural construction that has been consolidated from the 20th century onwards, with material bases in society. With changes in society's mode of production, children and adolescents stop participating in the production process and become part of the universalisation of school education. Thus, new demands and conditions for the formation of human beings are introduced.

> The increase in the entry of adults into the industrial production process, the abolition of child labour in factories, and the greater availability of goods freed children from work, creating the space and the need for school education. […] with the need to provide employment for adults and reduce the tensions generated by unemployment, they favoured the increase in schooling time for children, bringing forward their entry into the production process, creating conditions for the formation of adolescence (Leal & Facci, 2014, p. 9).

The movement of the social construction of adolescence causes a change in the social place occupied by teenagers in society. In this way, the influence exerted by the adults on the adolescents also changes. The experiences adolescents engage in through interpersonal relationships with adults and peers allow for reflections on the behaviour and actions of the individuals involved. The biological processes specific to this phase and the relationships established in the concrete reality of life are intrinsic to the human development of adolescents. During this process, changes also occur in the main activity, from playing to studying. Elkonin (1987) considers the main activities of teens to be intimate personal communication and professional/study activities, as they no longer think like children. In this new period of development, they will form new interests from new content and a new way of thinking. The development of logical thinking will form their intellectual activity. In the process of concept formation, adolescents become an integral part of social groups that contribute to the development of their personality. The adolescent student we aim to study is an individual attending the final years of elementary and secondary education. According to their objective conditions, experiences, and participation in certain social groups, they are the subject of a sociocultural process that determines their school journey. The reality of the adolescent student and the relationships established

within school are relevant to the development of their thinking towards the appropriation of scientific concepts. Adolescents living in different cultures are subjects of different socio-historical experiences.

However, the teaching processes developed in schools for adolescent students often treat them as generic subjects, disregarding their particularities and needs as students and viewing scientific education merely as an instrument for their humanisation. Thus, we understand that the teacher occupies a position of co-responsibility in the development of the adolescent, albeit in a restricted way due to the objective conditions imposed by the structure of school education. The pedagogical activity mediated by the teaching guidance activity (TGA), due to its structure, has the potential to form a motive for the adolescent student's learning activity, contributing to their development. We assume that the adolescents' comprehension as students, the meanings already established, and others in the process of being constituted must be recognised, understood, and established in pedagogical activity. Following the research problem of how adolescent students construct meanings towards the development of theoretical thinking, we investigate how their process of signifying learning activities can be understood within the organisation of teaching as *activity* (Leontiev, 2021). We assume that this general way of organising teaching promotes the subject's psychic development in the formation of new qualities of thinking (Araújo & Moraes, 2017).

THE TEENAGE STUDENT

As in other phases of human development, ontogenesis highlights genetic aspects of the individual and their hereditary characteristics. Biological factors are evident and decisive in development. In adolescents, brain maturation promotes new neural connections, just as the human body undergoes significant changes, such as sexual maturation.

We understand that man has undergone a process of evolution in terms of the human body, as well as in ways of thinking and social and cultural development. Rubinstein (1972) states that the human brain is, at the same time, a condition and a product of socio-historical activity. The natural characteristics of the brain result from historical evolution. In this conception, man only becomes human by appropriating objectifications produced by previous generations through social relations. In the collective, the subject uses speech, gestures, actions, and thought in order to carry out an activity in the context of a social problem. This movement also occurs in the brain.

In this sense, we consider the biological and social processes as a unit in adolescent humanisation. Sexual maturation occurs in teenagers through the biological process of bodily development. They experience new things, form a new system of interests, and develop their personality through the relationships established in the groups they participate in.

> Development occurs through constant interactions with the social environment in which the subject lives, leading to more sophisticated psychological forms. In this way, the development of the psyche is mediated by relationships with others (who may be other people from the same cultural group). This mediation indicates and delimits the meanings that are constructed by humanity, and appropriated and signified by individuals (Tomio & Facci, 2009, p. 93).

The objective, social conditions of life, and the cultural groups of which the adolescents are a part provide concrete and real social and cultural experiences, contributing to the formation of their conscience and personality. This movement occurs over time, depending on the relationships established in cultural groups.

Adolescence is characterised by a primary activity (Leontiev, 2021) that governs this period of psychic development. Elkonin (1987) states that each stage of this development is characterised by a specific relationship. The passage from one stage to another is precisely the change in the type of activity, in the relationship established by the subject with reality. In adolescents, the guiding activities (Elkonin, 1987) are *study*—intellectual and cognitive training in assimilating knowledge—and *communication*, which highlights the intimate personal relationships between teenagers, and represents their activity. The difference between adolescent communication activity and other forms of interaction lies in its fundamental content: the other adolescent as an individual with certain personal qualities.

> The formation of relationships in a group of adolescents based on the "code of companionship" and, in particular, those personal relationships in which this code is given in its most evident form, is of great importance for the formation of the adolescent's personality. The "code of companionship" reproduces through its objective content the most general norms of interrelations existing between adults in the given society (Elkonin, 1987, p. 120).

Throughout the periodisation of psychic development, the sociocultural process is what determines human development movements. It is through social relationships that the individual becomes human. In this movement, the teenager uses intimate and personal communication through a *code of companionship* when interacting with others, enabling the formation of their personality.

At the transitional age, the adolescent abandons childhood interests and their main activity: playing. At this moment, as they no longer recognise themselves as children, and with the passage of time and the relationships that will be established, adolescents will form a new system of interests amid the biological process of sexual maturation. Faced with so many changes, the way of thinking is no longer the same.

Vygotski (2006) states that the relationship between the content and form of thought is not the same as the relationship of water to a vase. To appropriate new content, new stimuli must emerge to drive development and formal mechanisms of thought. In this sense, content and form mutually condition each other and are interconnected. Vygotski (2006) states that the adolescents develop a new and superior form of intellectual activity. That is: the thinking by concepts that will occur in relationships with others, based on new thought contents. This movement results from sexual maturation and sociocultural processes determined by the subject's activities.

We understand the concept as a product of humanity's cultural development, and in the process of human relationships, established to satisfy needs.

> The actual concept is the image of an objective thing in its complexity. Only when we come to know the object in all its connections and relations, only when we verbally synthesise this diversity into a total image through multiple definitions, does the concept appear before us. The concept, according to dialectical logic, includes not only the general but also the singular and the particular (Vygotski, 2006, p. 78).

New content emerges for the adolescent in interpersonal relationships in sociocultural processes in which he or she is involved. In this movement, everything contributes to the development of thought: relationships with others, personal communication, and a new way of thinking. Over time, the content of the concept itself undergoes modifications due to the new way of thinking.

We understand that the formation of concepts occurs in the content-form unit. In this movement of human development, the adolescent participates in spheres of cultural life also with the intention of understanding him/herself and seeking to be understood. “Thinking by concepts is a new form of intellectual activity, a new mode of conduct, a new intellectual mechanism” (Vygotski, 2006, p. 60, our translation).

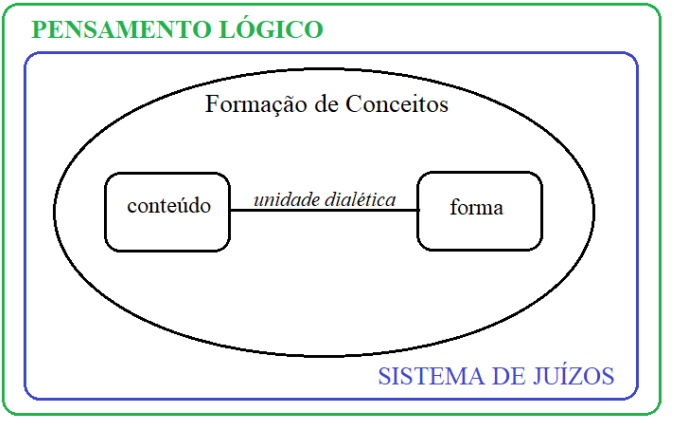
In the process of concept formation, which permeates the structuring of consciousness and the development of personality through social relations, the adolescent makes judgments about the concepts being formed in the relationship between content and form. According to Vygotski (2006, p. 82),

> [...] the structure of the concept manifests itself, in our opinion, in a system of judgments, in a complex of acts of thinking that constitute an integral, unique, powerful formation of its own laws. In this theory, we find embodied the main idea about the unity of form and content as the foundation of the concept.

The basis of judgment is the formation of a concept within the unity of content and form. Thinking with concepts promotes the emergence and attribution of judgments. Throughout the concept formation process, judgments will be part of a system that serves as the basis for developing logical thinking.

Figure 1

Formation of the adolescent’s logical thinking



Vygotski (2006, p. 82) reports that “If we recognise that the concept is a certain system of judgments, we will necessarily have to admit that the only activity in which the concept is revealed and the true sphere in which it

manifests itself is logical thinking." We understand judgment not as something fortuitous and arbitrary, but as dependent on interpersonal relationships in particular sociocultural spheres. That is, judgments are constituted in the relationships between subjects and the object when assigning values and establishing object relationships in specific contexts. This movement enables the formation of the concept through judgment in the content-form unit. In this movement, the way of thinking and the content are decisive — the development of thinking is intrinsically related to new content, which emerges in relationships established with others.

Understanding that adolescent human development occurs within the biological-social unit, sexual maturation and sociocultural processes contribute to the formation of consciousness and personality. With the gradual abandonment of the childhood interest system and the formation of new social relationships, it is possible to establish a new interest system.

We understand that the activity of intimate and personal communication, understood as the adolescent's main activity, is established in interest in the other, by also demonstrating judgment regarding the other in a given reality. This movement is understood in social groups that represent the relationships established in society, in a culture. In this sense, for the adolescent, relationships in intimate and personal communication presuppose the other as an individual. In this way, interests are formed during personality development, where the individual participates as a subject in society.

Understanding that the formation of interest occurs in the biological-social unit, relationships with others in sociocultural experiences enable the emergence of needs and impulses.

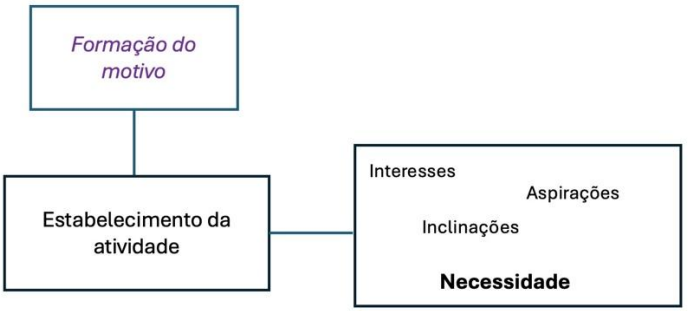
> Needs, inclinations, and interests are integral processes of greater scope than each isolated reaction. […] The driving force of human activity or aspiration is nothing more than a simple mechanical sum of instinctive impulses. It seems that these aspirations are located in special cells that we can call needs, since we attribute to them, on the one hand, a driving force for action. We consider them as a source that gives rise to inclinations and interests (Vygotski, 2006, p. 18).

The need can be understood as cultural or biological. Vygotski (2006) defends interest as a "higher cultural need," thus arising from a sociocultural movement. For the teenager, this occurs in the understanding of their sexual

maturation. In this sense, we understand that this movement enables the formation of the motive for the activity.

Figure 2

Formation of the motives



Motives stimulate and guide activities; thus, the actions that will be determined will respond to the motive, as it "[…] designates that in which the need is realised as an objective in the conditions considered and towards which the activity is oriented, which stimulates it" (Leontiev, 2004, p. 104). In the particular case of teenagers, we understand that the formation of the motive arises from sociocultural processes in which adolescents participate. This movement denotes the recognition of community relationships.

The relationship between the subject and the motive is formed by the need, which is shaped by their sociocultural experiences. The formation of the motive for learning will be possible only if adolescents attribute meaning to the activity. We will present TGA as a possibility of generating needs in students, through a learning triggering situation (LTS), with the intention of mobilising them for learning.

ACTIVITY

In light of the assumptions of cultural-historical theory and activity theory, we take Leontiev (2021) as a reference regarding activity. When we consider beings in their process of humanisation, we understand the relationships they establish within their community in the cultural-historical movement in which they find themselves. The processes of signification and the experiences lived by the subject with others enable the development of their consciousness and the formation of their personality. What we argue is that these movements occur in the individual through activity; only through this does the subject become humanised and understand and transform reality,

thereby developing thinking. Thus, the interpersonal relationships formed during the individual's activity and the process of becoming aware of their object are integral to the development of their thought. According to Leontiev (2021), consciousness is determined by the social existence of people, by the real process of their life as a system of activities that follow one another.

Among countless human activities, pedagogical activity stands out due to the need to humanise the subjects involved in appropriating the human culture historically produced by previous generations (Moura et al., 2010). Therefore, school education must preserve and promote the socialisation of culture to understand how we have constituted ourselves as humans up to now. It should also continue transforming reality to promote new meanings that support human development.

In this way, teaching and learning activities follow the same general structure: need, motive, objectives, actions, and operations, as defined in the TGA. The teaching activity of the teacher has the need to teach, while the learning activity of the student has the need to learn. Through teaching activities, the teacher can create a need in the student, motivating them to search for solutions to a given problem.

> The teacher's teaching activity must generate and promote student activity; it should instil in them a special motive for their activity: to study and learn theoretically about reality. It is with this intention that the teacher organises his or her own activity and guidance, organisation, and evaluation actions (Moura et al., 2010, p. 213).

In this movement, the teacher searches for tools and methodological resources in an intentional process of engaging the student in activities so that he can deal with information and find ways to solve the problem. Thus, we understand pedagogical activity as a unity between teaching and learning.

The search for a solution to the problem is proposed collectively by the teacher. In this way, the relationships established by students are governed by the negotiation of meanings that enable the movement of awareness about the concept. The learning activity resembles the process experienced by men during the cultural-historical moment when the concept was being constituted. In collective activity, students mobilise themselves through their object, with the intention of determining actions that will help in finding a solution to the problem. In this process, the teacher's teaching actions can mediate students' conceptual learning process.

Thus, the teaching activity triggers the learning activity as the teacher organises the teaching so that the student acquires scientific concepts. This way of organising teaching is understood through the TGA developed by Moura (1996; 2001) in light of the assumptions of cultural-historical theory and activity theory.

The TGA is a way of organising pedagogical activity understood as a unity between teaching and learning activities. It presents the same general structure as the activity: it requires the appropriation of culture, with the motive of appropriating historically accumulated knowledge, with the objective of teaching and learning, and involves actions that consider the objective conditions of the school institution (Moura et al., 2010).

The TGA is a theoretical-methodological basis for organising teaching. According to this assumption, the teacher intentionally and systematically develops their teaching activity, enabling students to consciously engage in actions that promote the development of theoretical thinking. Thus, the teacher's actions when organising teaching must create in the students the need to learn the concept, making the motive for the activity coincide with the object of study (Moura et al., 2010).

A TGA action proposes this movement: the learning triggering situation (LTS). Through it, the teacher proposes one or more problems for interaction between subjects and the object: the scientific concept, understood in its logical-historical movement. Thus, to satisfy the need provoked in LTS, the student must seek solutions to the problem posed.

> […] The teaching guidance activity necessarily involves the unity of content and form. The content, human objectifications, is also the form; and the form, the reconstitution of humanity's social experience in situations that trigger learning, is also the content (Moura, Araújo, & Serrão, 2018, p. 427).

Every human objectification contains its process of signification; that is, there is only objectification through signification. Man's activity arises from a necessity in the cultural-historical moment in which they find themselves, and, in this process, they aim at the image established on the ideal plane. In this movement, the content cannot be understood without the form and vice versa.

We believe that the evolving meaning of the concept permeates the TGA by mediating the teaching and learning activities. The processes of signification carried out by the individual occur through relationships established by the subject with others and with instruments and derive from

singular socio-cultural-historical moments in the subject's life. Leontiev (2004, p. 100) states that:

> Meaning is what is objectively discovered in an object or phenomenon in a system of connections, interactions, and objective relations. Meaning-making is reflected and fixed in language, which gives it its stability. In the form of linguistic meanings, it constitutes the content of social consciousness; entering into the content of social consciousness, it thus becomes the 'real consciousness' of individuals, objectifying in itself the subjective meaning that reflection has for them.

At a given cultural-historical moment, subjects in collective activity undergo a process of signification in order to satisfy a need arising from a social problem. This movement occurs through practical object activity in their realities. In this process, meaning is a reflection of reality elaborated in the form of concepts or modes of action.

Each individual carries experiences from certain sociocultural moments in the relationships they establish. Therefore, the meaning can have a different personal meaning for each individual. The way in which each person appropriates a meaning depends on the subjective meaning that the subject attributes to it.

> […] [the] conscious sense is created by the objective relationship that is reflected in the human brain, between that which incites it to act and that towards which its action is oriented as an immediate result. In other words, the conscious sense translates the relationship of the motive to the end. We should only emphasise that we do not use the term 'motive' to designate the feeling of a need; it designates that in which the need is realised as an objective under the conditions considered and towards which the activity is oriented, what stimulates it (Leontiev, 2004, p. 104).

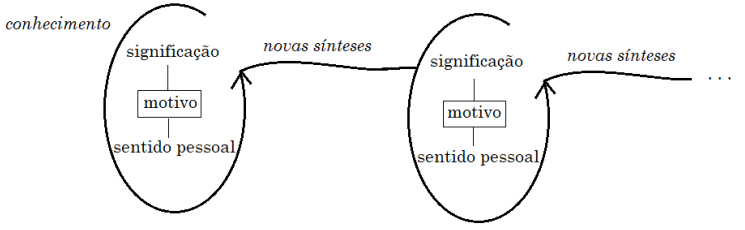
The subject's activity is closely linked to particular meanings. Thus, the subject will attribute a unique personal meaning to each of them. Let me give you an example. For someone who aspires to be a chef and studies for that purpose, a specific meaning is attributed to knowledge about spices. For another person who is taking the same course, but, by imposition, will attribute another meaning to learning the same knowledge.

We can also understand this movement in the teaching and learning process. When engaged in a learning activity, the student will interpret a particular concept through the LTS, which will provide them with a personal understanding of that concept. This movement occurs collectively by mediating the concept in the relationships between students and the teacher, as well as through concrete experiences with other social groups. At other times, the student went through processes of signification that enabled the constitution of knowledge. In the future, students may undergo new processes of signification that will provoke new syntheses about this knowledge. This movement triggers new qualities in the subject, who becomes humanised in this process.

Thus, we agree with Moura (2013) that, when carrying out new syntheses, the subject acquires new knowledge, based on the personal meaning that links them to the activity in which they participate. "The motive is the link between the meaning and the personal sense that will enable the new synthesis, the point of arrival for the instituted knowledge and the starting point for the new knowledge that will be created, that is, the instituting" (Moura, 2013, p. 133).

Figure 3

The process of meaning of the concept



The subject acquires knowledge throughout their experiences and in relationships with others in specific sociocultural contexts. Based on this knowledge, when going through processes of signification, the subject attributes a personal meaning to the meaning according to the motive that guides their activity. This process, collectively, enables the subject to develop new syntheses regarding knowledge, promoting new qualities of thought. Thus, new processes of signification may occur according to the motive that will stimulate the subject's activity at that moment. This process can occur many times or not, depending on the subject's experiences and the personal meaning that forms a motive.

School, in its social role of teaching scientific concepts, must convey the meaning of these concepts. In teaching activities, the teacher must act intentionally to enable students to appropriate meanings. In this understanding, the teacher also undergoes processes of signification related to teaching and the knowledge to be appropriated by students, through the historical-logical movement of the concept.

PEDAGOGICAL ACTIVITY IN DEVELOPMENT

Pedagogical activity develops in the relationships established between teaching and learning activities. When proposing a teaching method for adolescent students, the teacher seeks resources and strategies for their teaching actions. The term *general way of carrying out teaching*, according to Moura, Sforni, and Lopes (2017), occurs through pedagogical activity, so that pedagogical actions promote the shaping of new qualities in the subjects who participate in the activity, enabling modifications in their higher psychological functions, through the appropriation of scientific concepts.

With a focus on investigating the development of adolescent students in the conceptual appropriation movement, we seek to understand them in learning activities within an environment designed to promote maximum human potential: the school, through the process of conceptual appropriation. Through pedagogical activity, we aim to figure out adolescent subjects as students, and the teaching activity takes into account the particularities of their development. In this movement, we want to identify the meanings the adolescent students attribute to the learning activity. Thus, we use the concept of TGA to organise teaching with a view to developing theoretical thinking.

By considering the didactic experiment in *practice* through LTSs and understanding this movement in pedagogical activity, we developed a didactic experiment with adolescent students as a research method for studying and analysing our object. The situations were developed in 2022, with two 7th-grade classes taught by the researcher in face-to-face mathematics classes at a private school in Curitiba (PR), Brazil. The choice of these classes was due to the content—fractions—because of the need to use the school's teaching material, and because it was the first academic term[1].

[1] The Free and Informed Consent Form (FICF) developed by the researcher was read and signed by each student's guardian, confirming their participation or not in the research. The terms were filed by the researcher, who maintains responsibility and confidentiality for the data collected.

The situations were developed with the students during the first two semesters, totalling 20 meetings per class. Eight of these meetings focused on the development of the first triggering situation, while the remaining 12 addressed the second situation, which will be presented shortly. Each meeting corresponds to one hour/class. The distribution of the number of meetings by triggering situation occurred spontaneously, according to the development of the students in the groups. Voice recorders, a logbook, and written records from students about the resolutions of the triggering problems were used to document the development of the LTSs. Each class was divided into groups of four to five students based on affinity criteria chosen by the students. The groups were maintained until the conclusion of the experiment.

We used an adaptation of the virtual story *Cordasmil* created by Moura[2] for the concept of fractions as the first LTS to be developed. This adaptation, produced by participants of the Mathematics Pedagogical Workshop (Oficina Pedagógica de Matemática - OPM) at the Federal Technological University of Paraná (UTFPR), is available in video format: https://www.youtube.com/watch?v=I7lt_294ems. We use it by presenting it to the class, after which we propose three problems:

"Imagine that when measuring the land, the rope stretcher, called Cordasmil, realised that after stretching the rope four times, there was a piece of land left to measure that was smaller than the rope. How do you think he represented the total measurement of the land to Pharaoh?"

"The Pharaoh warned Cordasmil that Unopapiro (one of the land tenants) will also pay the tax on another leased land on the other bank. According to the measurements already taken, there are seven ropes and another piece of rope, which is divided into three parts. Suggest a way for Cordasmil to communicate the sum of the measurements of the two pieces of rope from the measured land. Make a representation of the solution."

"The Pharaoh warned Cordasmil that another subject would pay the tax on two leased plots of land on the riverbank. According to the measurements already taken, one bank has six cords and another piece of the rope, which was divided into two. The other bank has five cords and two additional pieces of rope, which are divided into three smaller parts. Suggest a way for Cordasmil to represent the sum of the land measurements. Make a representation of the solution using numbers."

[2] https://disciplinas.stoa.usp.br/mod/resource/view.php?id=155570

The triggering problems were written on a sheet of paper given to each student in the group, allowing them to present their solutions in written, numerical, or drawing form. The purpose of developing LTSs is to appropriate the concept of fractions and their operational processes in the historical-logical movement of the concept. In both situations, the theoretical-methodological assumptions of the TGA were established in line with the understanding of the didactic experiment.

To solve the problems, representing the resolutions in fractional form was necessary. The first problem requires only a fractional representation. The second involves fractional representation and the addition of fractions with equal denominators. Finally, the third and last problem addresses the fractional representation of the problem as well as the addition of fractions with different denominators.

Due to the researcher's need, an emerging situation from everyday life was created—a form of manifestation of the LTS—with a view to using fractions to calculate surface filling. This situation includes aspects of a real problem that occurred in the city where the research was conducted at the beginning of the year. It is presented as follows:

"At a certain point in the summer, heavy rains occurred due to climatic events. As a result, in a neighbourhood of the city, many residences and commercial spaces were affected, causing significant damage. In homes where there is laminate flooring, it will need to be replaced. Therefore, Cecília, the owner of a house in this neighbourhood, will install ceramic flooring in one of the rooms. Imagine you are the shopkeeper. Show Cecília how you calculated the number of pieces needed to cover the area of the room, so as not to have any excess."

The problem was read to the class using the projector installed in the room. To solve the problem, each group was given a rectangle of white cardboard and square pieces of coloured cardboard to simulate the placement of the ceramic pieces in the established area. The goal of the resolution is to use the pieces to cover the entire area.

To resolve this situation, it is necessary to cut out pieces to fill the surface. In other words, to determine the total number of pieces, it is necessary to add whole pieces and cutouts, which are understood as fractions, meaning adding whole numbers and fractions with different denominators.

Reflecting on the possible solutions students could present, and with the concern that the solution would be given only by whole pieces, without the use of fractions, we propose another triggering problem:

"For the installation, Cecília will hire a covering installer who will charge R$50.00 per square metre. How much must she pay, knowing that each square piece has a side measuring 60 cm?"

The records obtained during the development of both LTSs enabled the investigation of the adolescent students' theoretical thinking in learning activities.

THE PROCESS OF ANALYISING THE PHENOMENON

A phenomenon reveals part of the concrete reality in which we intervene and seek to interpret. Since it is not possible to understand reality in its entirety, we look for a snapshot. The researcher intends to go beyond merely revealing the phenomenon studied; they aim to understand it, discover its causes, and seek generalisations.

Caraça (1951, p. 109, author's emphasis) reports the interdependence in which "All things are related to each other; the World, all this *Reality* in which we are immersed, is a living, single organism, whose compartments all communicate and participate in each other's lives." In this sense, the phenomenon as part of concrete reality needs to be studied and investigated from the different perspectives that constitute it. To that end,

> […] the observer *cuts, highlights*, from this totality, a set of beings and facts, abstracting from all others that are related to them. We will call such a set *isolates*; one *isolate* is, therefore, a *section* of reality, arbitrarily cut out from it (Caraça, 1951, p. 112, author's emphasis).

We understand that isolates are formed in the research movement. Thus, the researcher will make the necessary cuts to cover all the determining variables of the phenomenon. "This only becomes an isolate because it is part of a human need to master actions or phenomena that enable better understanding or appropriation of the phenomenon that was previously misunderstood or that requires coordination of actions to be carried out" (Moura et al., 2016, p. 112).

In this sense, the choice of isolates is made intentionally and in a targeted manner. In this research, we used isolates to portray an analytical approach to the phenomenon. From this understanding, the use of the concept

of *episode* both structures and reveals the isolates. The episodes portray the logical-historical movement of the research and the modes of action for understanding the object, so that the exposure of the data constitutes a product of analysis (Araujo & Moraes, 2017). They can be organised through *scenes* that seek to reveal multiple determinations for understanding the phenomenon. Scenes can be understood as data snippets for composing episodes. This analysis process provides an understanding of the phenomenon in the investigation process.

The scenes consist of data excerpts established by relationships and determinations of a concrete reality, delimited by a moment and place. We will call this clipping *context*. This presents the landscape in which the subjects find themselves at that moment, resulting from an established situation. In the context, we report the time and place where the subjects involved are and what relationships are established. The context is formed by *representations*, which can be in the form of speech, drawing, writing, gestures, or body movements. It is intrinsic to the logical-historical movement of analysis, as it presents reality in movement with its multiple determinations. Through dialectical logic, we understand this analytical process as establishing relationships between scenes to reveal the episode.

ANALYSIS OF THE DIDACTIC EXPERIMENT

For the analysis process, we delimited three isolates: (1) the development of theoretical thinking in the process of meaning of the concept; (2) the understanding of elements of the adolescent student's learning activity for the pedagogical activity; and (3) the formation of the motive for the learning activity.

To investigate the development of theoretical thinking in adolescent students regarding the appropriation of concepts, we argue that the formation of a social conscience is also made possible by the moral and ethical values and ideals present in the groups and individuals with whom the adolescent interacts. This movement contributes to forming judgments about others, situations, and objects. In these interactions, the adolescent understands concrete reality, and the formation of concepts occurs within a system of judgments. In this way, the adolescent student, in relationships with other students, presents and constructs judgments as he or she engages in a dialogue centred around a concept. This process, presented and discussed in isolate 1, is identified by the LTSs developed, where students, through a learning action, present questions and promote discussions to find solutions to the triggering problem.

Table 1

Context 5, in isolate 1, of the analysis process

Context 5: On 04/29/2022, during the development of *How many ceramic pieces fit*?, the students in group 4 called the teacher to ask if the R$50.00 is the value per piece. The teacher explained that this is the amount charged for installation per square metre.			
N.	Timing	Author	Representation
1.1	00:01:03	Student D	[Student C] You did it wrong.
1.2	00:01:09	Student D	It's the square metre that costs 50.
1.3	00:01:13	Student C	What do you mean?
1.4	00:01:13	Student D	It's the square metre by 50.
1.5	00:01:17	Student L	It means that this here, this here is the square metre.
1.6	00:01:25	Student L	Each square metre costs 50.
1.7	00:01:28	Student D	You have to do it again.
1.8	00:01:30	Student C	The bitch has money! So each centimetre is 1 m?
	00:01:39	Student I	Hm? Each centimetre is
1.9			equivalent to 1 m?
	00:01:40	Student L	No, it will be a very big
2.0			account. She'll be rolling in cash, right?
	00:01:47:18	Student I	But it's not cheap!
2.1	00:01:49	Student C	Ah, now just do the math, we
2.2			did it right, but then... [stopped talking to start the calculations]

Numbers 1.8 and 2.0 depict the assignment of judgment in relation to carrying out the calculation, due to the monetary value that will be found. Because it is of high value, students question the conversion of the unit of measurement from centimetres to metres. This movement suggests that judgments serve as a trigger for developing logical thinking and forming concepts. In other words, the system of judgments determines a kind of 'scale' for logical thinking; the measure established by the subject will determine his/her actions. This can be understood in N. 2.2, where the student defines new actions, demonstrating the development of thought in forming the concept.

During the process of analysing this isolate, through other contexts, we understand judgment as a trigger for the development of logical thinking. Through it, the adolescent student can determine actions, or modes of action,

that correspond to their motive. The student uses social relationships with other students, considering the moral and ethical values portrayed in adult life as a representation of life in society. In these relationships, judgments are attributed and constituted in the development of logical thinking. These processes occur in intimate and personal communication activities, also through the code of companionship in the collective.

By isolate 1, we recognise that the relationships adolescents establish with others are determining factors in forming judgments over time, contributing to the process of concept formation. They are constituted and used collectively as a foundation for the content-form dialectical unity in the formation of concepts, as well as in acquiring new qualities in these relationships. This movement triggers the formation of the concept in an intrinsic relationship with the collective, where judgment is present.

Through isolate 2, it was possible to grasp the movement in the collective, where group actions facilitated the understanding and appreciation of collective work. In a learning activity, students sought collective actions and operations with the participation of everyone involved. Thus, each subject presents actions corresponding to the sociocultural conditions and experiences of their life reality. This movement within the collective constitutes a cutout of relationships in society.

Table 2

Context 2, in isolate 2, of the analysis process

Context 2: On 04/28/2022, during the development of *How many ceramic pieces fit*?, students in group 4 questioned each person's participation in the group and asked everyone to contribute to solving the problem.			
N.	Timing	Author	Representation
1.1	00:05:22	Student C	Wow, you guys are good for nothing, aren't you?
1.2	00:05:24	Student I	It's true.
1.3	00:05:25	Student L	I'm waiting here.
1.4	00:05:27	Student C	Yeah, me, [Student L] and [Student D] are doing it all, man. Ah!

In statements N. 1.1, 1.2, 1.3, and 1.4, the students state that their classmates neither contributed to solving the problem nor acted collectively. The intention for all students involved to participate in the development of the

LTS is evident in all student groups, indicating the representation of moral and ethical values in collective work as a reflection of societal relationships.

In the emerging situation of everyday practical activity, the relationship between the adolescent student and the object of knowledge is demonstrated by students' concern in filling the surface with the best use of pieces, using a ruler to take measurements and verify the fraction corresponding to the size of each piece. These operations carried out by the students demonstrate concern with solving the problem. At various times, we noticed students discussing learning actions, demonstrating the relevance of the resolution process and not just finding the final answer to the problem.

Throughout the development of the learning activities, we noticed that students in all groups sometimes proposed personal conversations, guided by the interest and judgment of others. We call these periods "of intimate and personal communication", also depicted in context 3.

Table 3

Context 2, in isolate 2, of the analysis process

Context 3: On 03/29/2022, during the development of *The Cordasmil problem*, students in group 4 discuss the section of the piece that is missing to complete part of the surface, understanding that it corresponds to a third of the piece.

N.	Timing	Author	Representation
1.1	00:07:19	Student C	[Student B], stop being bipolar.
1.2	00:07:29	Student R	A bipolar person is one who changes...
1.3	00:07:31	Student B	Yes, I am.
1.4	00:07:34	Student C	Someone who is always against something?
1.5	00:07:35	Student R	No, it's someone who changes moods very quickly.
1.6	00:07:39	Student C	You're angry now, then you're happy and then suddenly you're sad.
1.7	00:07:45	Student G	Then you start to cry.

In N. 1.4 and 1.6, student C is curious to understand his colleague's behaviour and reports his perceptions about him. The time for intimate and personal communication is evident in all groups of students when they

demonstrate interest in others as individuals, consider their actions and psychological characteristics, and make judgments about them.

Through a quantitative analysis of the data, we noticed that, in all groups of students, this time is shorter in the emerging situation of everyday life. Students are more involved, dedicating most of their time to learning activities. Intimate and personal communication occurs and persists, but less frequently.

Through isolate 3, we understand that the mobilisation, or lack thereof, of students for learning is influenced by the interests involved in forming the motive, provoked by sociocultural movements in relation to others in society. Interest has a certain meaning for the teenager, depending on the context considered. Therefore, we understand that the motive is presented according to the meaning attributed by the adolescent, within the reality they are part of, which is understood in interpersonal relationships. Leontiev (1983, p. 230, our translation) states that "[...] the development of the motives of activity itself is determined by the development of man's real relations with the world, conditioned by the objective-historical circumstances of his life".

Interests may trigger the formation of a motive depending on the personal meaning attributed by the adolescent student. In this way, personal meaning can generate a motive for one's activity. Both meaning-forming motives and stimulus motives (Leontiev, 1983) derive from sociocultural experiences of the objective circumstances of the adolescent student's life. The motive, when linked to a personal meaning, can trigger actions directed at the meaning-forming motive, potentially provoking meanings in a learning activity. Thus, the motive is conscious. The adolescent student plans and carries out actions intentionally, responding to their motive. On the other hand, the stimulus motive does not promote conceptual learning because it lacks a personal meaning. The motive does not move the subject because it is devoid of meaning.

Table 4

Context 1, in isolate 3, of the analysis process

Context 1: On 03/25/2022, during the development of *The Cordasmil problem*, students in group 3 talked about various topics, unrelated to the triggering situation, while student L looked for solutions on her own. Student M had already shown interest in understanding what had been done and in understanding that the piece of rope corresponded to 1/3.			
N.	Timing	Author	Representation
1.1	00:35:30	Student L	Okay, guys, did you understand?
1.2	00:35:34	Student M	She didn't understand, please, repeat. [Speaking of Student V]
1.3	00:35:37	Student M	Pay attention!
1.4	00:35:37	Student VM	No need to know, just get the result.

N. 1.4 shows disinterest. This was the first class focused on developing the initial triggering situation with the students. In this case, we understand that the personal sense cannot enable the formation of the motive for the learning activity. The student demonstrates a stimulus motive: the intention to carry out the situation. The paper they received, which had the triggering problems printed on it, was filled in with the appropriate resolutions. The student's motivation lies in the obligation to resolve the situation without attaching personal meaning to it.

The absence of personal meaning linked to a learning motive prevents the establishment of a meaningful learning process. Therefore, it is not possible to objectify the development of theoretical thinking, as there is only objectification through meaning.

FINAL CONSIDERATIONS

The relationships established in the adolescent's objective reality are decisive for their development, especially for the development of their theoretical thinking as the system of judgments is formed. Our study provides evidence of the significance of adolescent students' learning activities within a given objective reality, particularly under specific social conditions, which may constitute different movements of significance in other realities.

We understand that the development of an adolescent student's theoretical knowledge occurs as they form the logical thinking necessary to carry out activities collectively. Collectively, adolescent students make judgments when making deductions to solve the proposed problem. The content-form relations made possible by the system of judgments determine the formation of the concept, which, in this movement, can acquire new qualities. Thus, logical thinking comprises the adolescent's main activity, the learning activity, and intimate and personal communication in relationships with the object.

The adolescent's mobilisation for learning in the emerging situation of everyday life is enhanced by traces of practical activity linked to cognitive interests in objective activities. Adolescent behaviour refers to the values, acts of conduct, and norms of adult life in society. Hence, the emerging situation of everyday life is linked to real activity in the objective circumstances of life. In this way, intimate and personal communication is a key activity for adolescents, which is why it is present in their relationships. We understand that the formation of groups based on affinity—at the students' discretion—is important for collective relationships.

Figure 4

Summary of learning activity for the adolescent student

We observe the relevance of the motive linked to personal meaning for the realisation of conceptual appropriation. This movement occurs in the meaning of the concept that can promote the development of theoretical thought, as the subject is thus able to carry out new syntheses of the concept. Thus, the learning activity of the adolescent student is considered in relation to the object for conceptual appropriation and understanding. In this sense, the biological-

social unit is intrinsic to the development of the adolescent and the adolescent student in the process of giving meaning to the concept.

AUTHORSHIP CONTRIBUTION STATEMENT

The work presented was developed by the first author under the guidance of the second author.

DATA AVAILABILITY STATEMENT

The data supporting the results and conclusions of this research are stored with the first author, in accordance with ethical principles.

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