DOI: https://doi.org/10.23925/2175-3520.2022i54espp62-78

PRODUCING TRANSFORMATIONS TO STUDY THEM: CONCEPT DEVELOPMENT IN ACTIVITY CLINICS

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Abstract

Concepts are at the core of human psychological experience. By means of them, we can communicate, understand and collaborate with each other. Within each community, concepts have been learned and can be taught. They are of capital importance for education in every level and for work activities. Concepts have been the object of study of different disciplines and in different contexts for many years. Despite their importance and the attention they have received, both common sense and psychological science understand concepts in an oversimplified way that has consequences for research and teaching. Early in the past century, Vygotsky studied the phenomena of concepts and their development in what ended up addressing most of the loose ends that remain in current dominant psychological and educational perspectives. In this article, we review the main, hegemonic perspectives on concepts in psychology, particularly one of the mayor research fields in educational psychology (Research on Conceptual Change), to present later some cross-cutting criticisms to those approaches that will become our touchstone for a sound theory of concepts. Then we present the Vygotskian approach to concept development, and the methodological implications derived from the dialectical framework in which it is inscribed. Finally, extending the Vygotskian approach beyond child development, we present a method developed in French work psychology, the Activity Clinics approach, and its potential for studying the development of concepts in work activities.

Keywords: Concept; Concept formation; Cultural-historical psychology; Adult development, Methodology – Psychology.

Produzir transformações para estudá-las: desenvolvimento de conceitos na clínica de atividade

Resumo

Os conceitos estão no coração da experiência psicológica humana. Graças a eles, podemos nos comunicar, entender e colaborar uns com os outros. Dentro de cada comunidade, os conceitos têm sido aprendidos e podem ser ensinados. Eles são de fundamental importância para a educação em todos os níveis e para as atividades de trabalho. Os conceitos têm sido objeto de estudo em diferentes disciplinas e em diferentes contextos durante anos. Apesar de sua importância e da atenção que receberam, tanto o senso comum quanto a ciência psicológica compreendem conceitos de uma forma muito simplificada que tem consequências para a pesquisa e o ensino. No início do século passado, Vygotsky estudou os conceitos e seu desenvolvimento naquilo que acabaria por abordar a maioria das pontas soltas que permanecem nas perspectivas psicológicas e educacionais dominantes de hoje. Neste artigo, revisamos as principais perspectivas psicológicas sobre conceitos, em particular um dos principais campos de pesquisa em psicologia educacional que tem tratado do fenômeno (Pesquisa sobre Mudança Conceitual), e depois apresentamos algumas críticas transversais daquelas abordagens que se tornarão nossa "pedra de toque" para uma sólida teoria de conceitos. Apresentamos então a abordagem de Vygotsky para o desenvolvimento de conceitos e as implicações metodológicas derivadas da estrutura dialética na qual ela está inserida. Finalmente, estendendo a abordagem de Vygotsky para além do desenvolvimento infantil, apresentamos um método desenvolvido em psicologia do trabalho francês, a Clínica de Atividade, e seu potencial para estudar o desenvolvimento do conceito em atividades de trabalho.

Palavras-chave: Conceito; Formação de conceito; Psicologia histórico-cultural; Desenvolvimento do adulto; Metodologia – Psicologia.

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Producir transformaciones para estudiarlas: Desarrollo de Conceptos en la Clínica de Actividad

Resumen

Los conceptos están al centro de la experiencia psicológica humana. Gracias a ellos, podemos comunicarnos, comprendernos y colaborar entre nosotros. Dentro de cada comunidad, los conceptos se han aprendido y se pueden enseñar. Son de fundamental importancia para la educación en todos los niveles y para las actividades del trabajo. Los conceptos han sido objeto de estudio de diferentes disciplinas y en diferentes contextos durante años. A pesar de su importancia y de la atención que han recibido, tanto el sentido común como la ciencia psicológica entienden los conceptos de una manera sobresimplificada que tiene consecuencias para la investigación y la enseñanza. A principios del siglo pasado, Vygotsky estudió los conceptos y su desarrollo en lo que acabaría ocupándose de la mayoría de los cabos sueltos que quedan en las perspectivas psicológicas y educativas actualmente dominantes. En este artículo, revisamos las principales perspectivas psicológicas sobre los conceptos, en particular uno de los principales campos de investigación en psicología educacional que se ha ocupado del fenómeno (Investigación en Cambio Conceptual), para presentar enseguida algunas críticas transversales a esos enfoques que se convertirán en nuestra "piedra de toque" para una sólida teoría de los conceptos. Luego presentamos el enfoque Vygotskiano del desarrollo de conceptos, y las implicaciones metodológicas derivadas del marco dialéctico en el que se inscribe. Finalmente, ampliando el enfoque Vygotskiano más allá del desarrollo infantil, presentamos un método desarrollado en la psicología del trabajo francesa, la Clínica de la Actividad, y su potencial para estudiar el desarrollo de los conceptos en las actividades del trabajo.

Palabras clave: Concepto; Formación de concepto; Psicología histórico-cultural; Desarrollo del adulto; Metodología – Psicología.

Introduction

Concepts are at the core of human psychological experience. The knowledge produced by communities as well as by sciences gradually settle within them. Both for living in society and for mastering any practical domain, developing the conventional meanings hidden behind concepts is fundamental and is, therefore, one of the main tasks of education at all levels. Within each community, concepts have been learned at some point and can be taught to newcomers. It is by means of them that members in a community can communicate, understand, and collaborate with each other. Concepts not only carry within them the progress of humankind and the history of that progress. It is also by means of them that communities and disciplines move beyond what was previously conceived. Concepts are extremely important for psychological science and education, yet their study is trapped in an oversimplified fashion that undermines the research itself and its potential impact.

As we discuss below (in section 2 of this paper), these main perspectives are criticized for overlooking (1) the specific psychological operation involved in the use of concepts, (2) the role that symbolic and material artifacts play in the formation and use of concepts, (3) the way in which concepts are formed from, and change in meaningful social activities, and (4) the complex dynamic, dialectic relationship that exists between the latter and the psychological aspects.

While sociocultural approaches, as we will discuss in section 3, attempt to overcome these criticisms with mixed results, we will go one step further in section 4, revisiting Lev S. Vygotsky's perspective on concepts and concept development, aiming at a dialectic approach that satisfies the evoked criteria for a sound theory of concepts. In his work, Vygotsky carefully treated the phenomena of concepts, firstly, as a higher psychological function governed by the general law of cultural development and, secondly, as the basic units of language-mediated thought. As a whole, we will argue, such an approach will account for the criticisms addressed to the mainstream perspectives to concepts.

However, adhering to a complex understanding of a phenomenon requires the development of complex tools to grasp it in all its richness and complexity. Accordingly, sticking to the Vygotskian understanding has important methodological implications, which we will explore in section 5 of this paper. These methodological considerations were not overlooked by Vygotsky. On the contrary, his project of Marxist psychology explicitly addressed the challenges of a

dialectic epistemology. In that exercise, Vygotsky proposed the experimental-genetic method: a method that seeks to restore the dynamism of the process under development. Characterized by its orientation not to the results, but to the process of development, and for subordination of the phenomenological aspects to the genetic ones, the method set up a framework for the study of psychological development. Following such guidelines, although in an arguably non-experimental way, we propose in section 6 the Activity Clinics methodology of cross self-confrontations as a candidate for a genetic study of the development of concepts. An interventionist perspective developed in the tradition of work psychology, Activity Clinics has proven to be a fertile approach for the analysis of concepts in everyday and work activities.

Current studies of concepts and their development has been overlooking features of the phenomena that are essential to understand them fully. While the Vygotskian approach seems to fulfill the conditions that a sound theory of concepts should possess, it is mostly absent in current discussion on concepts, concept development, and conceptual thinking. Adopting such a theoretical perspective, however, supposes taking account for several methodological considerations. The aim of this article is to operationalize these methodological challenges and propose an interventionist research methodology to study concept development in work activities.

Concepts, Conceptual Change and Concept Development

Concepts in Cognitive Psychology

Concepts have been under study in both philosophy and psychology for a long time. However, the matters that concern them are different. While philosophical questions address how human beings are able to have propositional attitudes about the objects of their attitudes, psychological ones attempt to explain how knowledge underlies higher cognitive abilities, as analogy making and categorization (Machery, 2010, 2013). It is still a matter of discussion, which is beyond the scope of this article, if both disciplines actually deal with the same object (e.g., Löhr, 2020; Machery, 2010). Even in psychology, there are several ways in which concepts have been treated. The approaches are as diverse as psychology itself. Yet, we will refer here to Cognitive Psychology, the hegemonic perspective to concepts in psychology (Blunden, 2012).

In the cognitive tradition, propositional thought is believed to be constructed of concepts; these *elements* would be "*used* to interpret our current experience by *classifying* it as being of a particular kind" (Hamptom, 1999, p. 176, our emphasis). Around such a perspective, different theories have proliferated. The main ones are the classical theory of concepts, the prototype theory of concepts, the exemplar theory of concepts, and the theory-theory of concepts (Blunden, 2012; Laurence & Margolis, 1999; Machery, 2013). Briefly, the classical theory states that a concept has a definitional structure that encodes the necessary and sufficient conditions for its application. For the prototype theory, concepts are representations whose structure encodes a statistical analysis of the properties their members tend to have. According to the exemplar theory, concepts would consist in bodies of knowledge about specific individual members, samples or instances of the class. Finally, in the theory-theories of concepts, they are embedded in relatively coherent mental structures, or theories.

As Blunden (2012) points out, despite their diversity, these theories share a set of core assumptions that derive from a common philosophical base. Among these assumptions, we can mention, firstly, the Cartesian dualism by which concepts are mental representations, entities or images of some kind inside the head. Secondly, an atomistic conception of the objective world, which is composed of individual entities that, in turn, can be conceived as objects, which are exhausted by their attributes. Finally, these theories would share the idea that the contexts and situations in which people acquire concepts throughout life, although acknowledged, do not inform the nature of the concepts themselves.

Conceptual change in education

Perhaps one of the most fertile approaches of the mainstream psychology of concepts in education is the research on Conceptual Change. It studies how concepts change in learning and development, focusing on the content and structure of early conceptions, the different representations held by learners and experts, the mechanisms involved in change, and instructional strategies that can promote it (Amin &

Levrini, 2018; Vosniadou, 2013a). Such a discussion on conceptual change also plays an important role in the understanding of concepts themselves (Keil, 1999). The origins of this trend can be found in Thomas Kuhn's book *The Structure of Scientific Revolutions* (e.g., Amin & Levrini, 2018; Vosniadou, 2013a). For Kuhn, beliefs, assumptions, commitments, and practices that are shared by scientific communities constitute paradigms. The accumulation of findings that cannot be explained (i.e., anomalies) within the current paradigm will conduct to a period of crisis that eventually will result in a profound, revolutionary change of paradigm. This change would give birth to a new theory with greater explanatory capacity, under which new concepts are formed. Not long after, Susan Carey (1985) and Michael Posner et al. (1982) applied Kuhn's ideas to developmental psychology and science education respectively. Kuhn's ideas proved to be a fertile approach to understand why students' previous and alternative explanations of physical phenomena were robust and hard to change, and often hindered the appropriation of the new, scientific understandings.

Over the last five decades, a growing body of research expanded beyond physics and physics education, to make a larger claim on learning in diverse domains from the natural sciences and mathematics, to history and the social sciences (Vosniadou, 2013a). Even if researchers in the field tend to avoid the questions on the nature of concepts (Vosniadou, 2008), nowadays there is some agreement that concepts change and evolve gradually and are embedded in more or less coherent larger structures that have some explanatory capacity and functional value. Different accounts in this research will explain the difficulty of conceptual change in different ways: as a consequence of new scientific knowledge being interpreted in terms of their previous knowledge (e.g., Vosniadou, 2013b, 2018); as a product of ontological miscategorization of concepts (e.g., Chi, 2005; Henderson et al., 2018), or as a result of the lack of initial organization of subconceptual units (e.g., diSessa, 2013, 2018). Lately, other factors, like values and identity (e.g., Levin et al., 2018), metacognition and epistemic thinking (e.g., Smith, 2018), and cultural epistemological orientations (Marin et al., 2018), have been added to account for the complexity of conceptual change.

The research on conceptual change, however, is far from being a unified field. As Amin and Levrini (2018) point out, the expansion of the field over the decades has produced a theoretical and methodological pluralism: different perspectives sometimes use similar constructs; often they use the same terminology to refer to disparate constructs; their methods differ and, at the end, they lay on fundamentally distinct epistemological assumptions (Amin & Levrini, 2018). Although some of them have been recognized for a long time, there are still open controversies in the field: the very nature of concepts, the way conceptual structures are organized, the processes behind concept transformation, the role played by social factors, and the differences between spontaneous and instruction-induced conceptual change (Amin & Levrini, 2018; Vosniadou, 2008, 2013b).

Some criticisms to main approaches

As we have shown, the literature in both concepts and conceptual change is quite diverse and is far from being a unitary body of theory or research. Although each of the different approaches has tried to overcome the problems of its predecessor, the main currents in the hegemonic psychology of concepts shares common philosophical principles that keep them from becoming satisfactory accounts of concepts and concept development (Blunden, 2012). These perspectives have been criticized for overlooking (1) the specific psychological operation involved in the use of concepts, (2) the role that symbolic and material artifacts play in the formation and use of concepts, (3) the way in which concepts are formed from, and change in meaningful social activities, and (4) the complex dynamic, dialectic relationship that exists between the latter and the psychological aspects. In what follows, we will elaborate on these criticisms.

Following Blunden (2012), the notion of concepts sustained by the mainstream approaches (i.e., mental representations or thought-forms) cannot grasp the attributes that make them meaningful, this is, the way in which they are "a guide to reality in terms of what matters, in terms of the organism's *real-life activity*" (p. 78). In that way, and as Larraín and Haye (2014) point out, by stressing the process of categorizing—shared with other animals—, this notion of concepts as mental representations overlooks the specific psychological operation involved in the use of concepts. On the other side, the way the cognitive sciences conceive concepts says very little about the specific role that artifacts, including language, play in

the formation and use of concepts as well as the way in which concepts are formed from, and change in meaningful social activities (Blunden, 2012).

On the other hand, Castorina criticizes the reductionism in the explanatory models of developmental psychology in general, but also in conceptual change, that would not be able to account for cognitive novelty (e.g., Castorina, 2005, 2006, 2010, 2020; Castorina & Carretero, 2012). Every theory operates under a certain framework, whose philosophical underpinnings define the context in which constructs are produced and methodologies are chosen, affect the research questions that may arise, and delimit what constitutes adequate explanation (Castorina, 2020, Castorina & Carretero, 2012). Accordingly, the author describes two opposing epistemic frameworks (i.e., sets of underlying philosophical assumptions) that would affect research and the knowledge it produces (Castorina, 2010, 2020).

In a nutshell, the epistemic framework of the split assumes the dissociation of the components of situated and embodied experience in the world (Castorina, 2020). This dissociation, which is dominant in psychology, is mainly expressed in dualist theses that state a sharp division between mind and body, or individual and society. These dualist perspectives presuppose "the splits between brain and mind, a subject and his/her context, and the syntax and the semantics of representations" (Castorina, 2020, p. 157). Among these, we can find the *learner-in-context* (Volet, 2004) approaches or those grouped under Sfard's (1998) *acquisition metaphor of learning*, which recognize the influence of context and materiality, but rather as factors that would affect an essentially different and previously constituted reality. Accordingly, in these approaches conceptual change is understood as an individual achievement, resulting in internal and the external factors that have affected the mental apparatus, both of which are constituted beforehand.

These criticisms would constitute our *touchstones* for a sound theory of concepts and concept development. Such a theory should account for the processual nature of concepts; this is, *for the very process of conceiving, beyond a categorization enabled by mental representations*. A satisfactory explanation of psychological development, conceptual change included, should also be situated in the dialectic epistemic framework, in which "each element of the experience with the world only exists because of its constitutive connection to its opposite" (Castorina, 2020, p. 158). This is, it should account for the social, discursive, and material conditions in which concepts are produced, used, negotiated, and transformed; understanding them not as a set of preformed factors affecting or influencing psychological development or knowledge formation; neither neglecting nor collapsing these different realities, but understanding them as mutually constituted.

Sociocultural approaches on conceptual change

Nowadays, probably no psychologist, educator, not any researcher in conceptual change would deny the importance of the contexts and situations in which concepts are formed and change. Moving forward from a *cold cognitive* perspective (Pintrich et al., 1993), a "warming trend" in conceptual change highlighted the multi-dimensionality of the phenomenon under study (Sinatra, 2005). However, in this learner-in-context perspective (Volet, 2004), both the social interactions and the discursive practices in which learning occurs constitute merely a background that exerts some influence on the process. As pointed by Inagaki and Hatano (2002/2013), "most leading investigation studying conceptual change have [sic] been too cognitive and too individualistic" (p. 217). But, to be fair, more than a few authors have moved the social to the center of the debate.

While cognitive and socio-cognitive perspectives can be ascribed to what Sfard (1998) calls the *acquisition metaphor of learning*, some approaches have gone further. These perspectives have emphasized, in different degrees, that learning is rather a situated and interactional process consisting of "taking part in" or "being part of" the discourses and social practices of scientific communities (Mason, 2007). This is what Sfard (1998) groups under the *participation metaphor of learning*. For example, Greeno and his colleagues (e.g., Collins & Greeno, 2011; Greeno, 1997; 1998; Greeno et al. 1996; Greeno & van de Sande, 2007), adopt a situative perspective that focuses on the level of systems of activity that includes participants interacting with each other, as well as with material and representational systems (Greeno, 1997). Accordingly, this perspective conceives conceptual understanding as an achievement of discourse in activity systems, and conceptual growth as changes in common discursive practices or in the distribution of participation among

individuals in the activities that a community undertakes (Greeno & van de Sande, 2007). In a similar vein, rejecting the cognitive assumptions on thinking and inspired in Vygotsky's work, Ivarsson, Schoultz, Säljö, and Wyndhamn (e.g., Ivarsson et al., 2002; Säljö, 2018; Schoultz et al., 2001) take a sociocultural and discursive perspective that conceives cognition as a matter of how people use conceptual/discursive and physical tools that, in turn, form an integrated part of it (Ivarsson et al., 2002, p. 78). Such a perspective understands conceptual change as the gradual process of appropriation of mediational means (i.e., physical artifacts and conceptual constructions), through the exchanges that individuals have with each other and with surrounding tools (Ivarsson et al., 2002). Similarly, Roth and colleagues (e.g., Duit et al., 1998; Roth, 2008; Roth et al., 2008), approach conceptual change from a discursive perspective that considers discourse as situated action, rather than a window to underlying cognitive representations (Duit et al. 1998). Accordingly, they focus on the inter- and intra-situational changes in students' language organization (Duit et al., 1998), which would be produced by individuals from situational resources at hand (e.g., uttered questions, gestures, accepted modes of explanation, representations and artifacts) and borrowed conceptions that are available in language (Duit et al., 1998; Roth et al., 2008).

These sociocultural perspectives undoubtedly address the criticisms (1), (2), and (3). By rejecting cognitive assumptions and adopting a situated, discursive, action-oriented stance that emphasizes the mediated, socially grounded, and artifact-dependent nature of concepts, they successfully overcome them. However, as Castorina (2020; Castorina & Carretero, 2012) shows, the framework of the split also shows itself in the apparent opposite theses that collapse the distinction by rejecting one part of these dualities. That would be the case of radical sociocultural approaches: by suppressing the subject in favor of understanding knowledge development as the transformation of participation in social practices, the most radical contextualist perspectives collapse the duality individual-society. Without resorting to individual constructive activity, these perspectives would not account for how social relations concern individuals, for individual differences in levels of knowledge (Castorina, 2020, p. 157), nor would they explain the difficulty of learning new knowledge (Castorina & Carretero, 2012). It is not possible to explain the cognitive novelty, including conceptual change, within the epistemic frame of the split.

Whether being a function of accomplished in activity systems, the progressive appropriation of material and symbolic artifacts, or evolving and situated ways of taking, the sociocultural perspectives we have sketched understand cognition in an essentially different way from the mainstream approaches. However, in being able to participate better in a collective discursive practice or to perform a better use of cultural tools, there is a notion of learning that risks of overlooking a necessary constructive activity of the individual. In the next section, we will revisit Lev S. Vygotsky's perspective on concepts and concept development, aiming at a dialectic approach that satisfies the evoked criteria for a sound theory of concepts.

Revisiting Vygotsky's concept of Concepts and their development

There are two main entrances to the problems of concepts and concept development in Vygotsky's work. In the first one, concepts are treated as higher psychological functions (Vygotsky, 1930/1999, 1930/2007, 1931/1997), while in the second one concepts are considered the basic units of language-mediated thought (Vygotsky, 1934/1987). However, these two approaches show us two sides of the same coin.

It is worth noting the way in which Vygotsky conceives concepts. As Larraín (2017) points out, in the Vygotskian theory of concept development concepts are word meanings: operations in which we treat particular and unique event as a class of events. As word meanings, concepts are properties of verbal communication or discourse "[…] they are always relational and social processes insofar as they occur in specific uses of language" (p. 523). In that way, the meaning of a concept does not rest on some kind of inner computational processing. On the contrary, it rests on the specific situated uses in which that concept fulfills some function for real social life (Larraín, 2017; Vygotsky, 1934/1987). That processual conception of concepts (see Larraín & Haye, 2014), also shows how these conventional meanings, although having the stability of language, are actual processes that change both micro- and ontogenetically: every time we use a concept, we generalize in a certain way that

depends on the specific use of language (e.g., the particular problem, objects, and context). These are microgenetic changes. On the other hand, the meaning mobilized behind the concepts we also used changes as our participation in a community or our mastery grow over the life course. These ontogenetic changes explain how children and adults—just as newcomers and old-timers—using the same word and displaying an apparently identic action, are not actually performing the same act of thinking (Larraín, 2017).

In the sixth chapter of *Thinking and Speech*[3], Vygotsky (1934/1987) describes the lines of development that everyday concepts (object-oriented and unsystematic) and scientific concepts (oriented to other concepts, although insufficiently loaded with reality) follow in childhood. Everyday concepts would be formed in everyday experience from the use that others—adults—make to name things and phenomena, but in direct relation to objects, outside any explicitly organized system. Scientific concepts, on the other hand, would arise from the singular form of cooperation that occurs in instruction, in which primary verbal definition prevails, that is, concept orientation to other concepts is stronger than towards objects. In instruction, everyday concepts are transformed by the system offered by scientific concepts; while the latter are developed based on the former, already saturated with experience.

No distinction should be made, however, among these concepts as psychological entities, since they do not inform two different essences (i.e., they are not made of a different thing), but two lines of development that converge at a certain level (Vygotsky, 1934/1987). What could and should be done is to recognize how, thanks to the singular *systematic cooperation* between the pedagogue and the child in instruction (a specific use of language), concepts develop in a new direction, which reorganizes the entire system: generalizations of higher structure (i.e., scientific *concepts*) will inevitably produce structural changes in previous generalizations (i.e., everyday concepts) (Vygotsky, 1934/1987). Such revolution of the system is, indeed, characteristic of the development of higher psychological functions, among which the development of concepts is a particular case (Vygotsky, 1930/1999, 1930/2007, 1931/1997).

According to the general genetic law of cultural development (Vygotsky, 1931/1997), every higher psychological function would appear on stage twice: first as an interpsychological category (i.e., a sociomaterial interaction) and afterwards as an intrapsychological category (i.e., an individual psychological function). These *categories* would have the character of a phenomenon emotionally experienced as a collision, a dramatic event (Fleer & Veresov, 2018; Veresov, 2004, 2010a, 2010b, 2014). If the individual does not have the means to solve directly or with ordinary means the dramatic event, they may find, in an interaction shaped by a specific use of language, the means through which reorganize their action and solve the collision. Such interpsychological category, susceptible of being solved through a specific use of signs, will initiate a process of transition that will culminate—after a certain course of development—with the internalization of the social relationship that was experienced as a contradiction, now as intrapsychological category. Concepts, as higher psychological functions, would follow such a course of development, beginning in social relations, experienced as conflicting and resolved with specific uses of language, and culminating with the reorganization of the entire system.

In the development of higher psychological functions, the reorganization of the system that results from the process of internalization does not constitute a final state, but a transitory one, which is likely to be followed by subsequent revolutions. Vygotsky (1934/1987) exemplifies it with the development of arithmetic thinking thanks to algebra, and the development of the mother tongue through learning a second language. This is particularly clear for concepts, as acts of generalization whose development, already with the appearance of scientific concepts, constitutes a generalization of previous concepts, that is, generalizations of previous generalizations (Larraín & Haye, 2014; Vygotsky, 1934/1987).

Coming back to the touchstone, we have proposed above, the Vygotskian understanding of concepts and their development, seems to be better suited as a theory of concepts. The changes that

3 Vygotsky's *Thinking and Speech* (1934/1987), chapters 5 and 6 treat concepts in two different ways. In chapter 5, Vygotsky describes three different structures of generalization in the development of concepts (i.e., syncretic, complexes, and concepts). While in the mentioned chapter, a concept only corresponds to the more developed and systematic structure of generalization, in chapter 6, he uses again the term concept but to refer also to early generalizations. In the same six[th] chapter, Vygotsky introduces the distinction between everyday and scientific concepts. For the purposes of this manuscript, we will use this last distinction.

Vygotsky's concepts undergo in every use, address and restore the ever-creative process of conceiving, rather than the mechanical use of blocks in classifying. Its development over the life course and, particularly, its roots in specific uses of language, account for the socio-material practice in which concepts arise, are used, and change. Lastly, their social nature, their genesis as an interpsychological category, frames the psychological phenomena that interest us and their explanation in a dialectical epistemology, that does not split nor collapse the social and the individual dimensions in psychological development.

Methodological implications: the need for experimental-genetic method

While accounting for the criticisms mentioned above, the Vygotskian perspective brings to the foreground theoretical considerations that, in turn, raise important methodological implications. Foremost, concepts are not object-like realities accessed by some computer. Instead, they are processes that rest in specific, concrete uses of language. Therefore, an apt method should go beyond their external appearance and treat them as *processes*. Additionally, as every time we use a concept, we generalize in a certain way that depends on the specific use of language (e.g., the particular problem, objects, and context), a method for study them should be sensitive to the subtle changes derived from specific uses of language in concrete situations. Additionally, since concepts also change as practices and our participation in them evolve—which explains why children and adults, as well as newcomers and experts can communicate and exchange successfully even performing very different acts of thinking—, the study of concepts must be able to track and distinguish the different meanings held by individuals at different moments in their participation trajectories. In sum we could state, with other socio-cultural approaches, that the study of concepts cannot be dissociated from the study of their development.

Vygotsky also highlights where and how concepts are formed and transformed: they initiate their development as a different category (i.e., a social one) that is not recognizable in developed concepts. As every higher psychological function, a concept initiates its development as a socio-material interaction, to become afterwards a psychological process. Its very structure (in our case, the concept now internalized) is not only different from the one it had at the beginning of its development, but also its original shape (i.e., the interpsychological category) is indiscernible in its developed form (Veresov, 2010a; 2010b). The study of the development of concepts, then, must seek the origin of concepts in social relationships since these are the beginning of their development, the very concepts that will be finally internalized.

Although these remarks inform how the study of concepts and their development should be and the challenges it should overcome, they provide little insight on how to access these ever-changing processes as well as their initial, social manifestations. These methodological implications are, however, part of Vygotsky's general concerns about the psychologies of his time.

In the frame of the cultural-historical theory, Vygotsky proposed what he called the genetic-experimental method. This method aims at the restoration of the dynamism of the process under development, which by the end of its development may have the appearance of a static product (Veresov, 2010b; Vygotsky, 1931/1997). As described by Veresov (2014), the method is characterized by two main traits: first, and as mentioned above, it should address not to the results, but the process of development; second, it opposes the descriptive and the explanatory task in the analysis of the process under study. While the first feature has been commented multiple time through this section, the opposition of descriptive and explanatory may require a few additional words.

The opposition of these tasks is rooted in the exercise that Vygotsky was proposing in the frame of his project of concrete psychology. In such project, he tried to develop a Marxist psychological science, which for him means no other thing that "true" science—in opposition to a bourgeois one that contributes to the production of a biased or limited representation of reality (Castorina & Baquero, 2005). Such effort, Vygotsky's concrete psychology, intended to be a general psychological theory. In contrast to empirical psychologies, this general psychology should be able to offer explanatory principles to the diverse and often-incompatible facts produced by the different empirical psychologies. For our author, the Marxist character of this psychological science lies in two related aspects: its practical nature and the way it is constructed. The practical nature of a Marxist psychology was

associated, first, with the inherently transformative character of epistemic activity (i.e., producing objective knowledge requires a transformative activity), and second, with the fields of application, which for Vygotsky were "territories of confrontation and validation that strongly collaborated with the orientation and definition of theoretical hypotheses" (Castorina & Baquero, 2005, p. 160).

The way in which a Marxist science is constructed, on the other hand, is more strongly articulated with the opposition of descriptive and explanatory analysis. Following Castorina and Baquero (2005), the right scientific method for Vygotsky involved not only the abstraction of the phenomena, which is common to every science. Instead, it should take the initial *represented concrete*, as a starting point to revisit the multiple determinations it has in reality, and to come back afterwards as a new *represented concrete,* now rich in determinations and relations. Since even the apparently initial contact implies an abstraction of the phenomena, which is already oriented for a conceptual system, such contact will not shed light over the multiple determinations. Then, this dialectical movement would be the path to develop a scientific comprehension of concrete phenomena as they actually are. The opposition of the descriptive and the explanatory tasks in the analysis of psychological processes, precisely materialize that character of Marxian science. Since different actions may express themselves as seemingly identical, but actually have deep differences among them, Vygotsky distinguishes a phenomenological, descriptive analysis from a conditional-genetic one (Veresov, 2014). While the first type of analysis assumes the coincidence between the external manifestation and the actual process underlying it, the second seeks to disclose the real connections behind the external appearance. This opposition of the two tasks, which implies the subordination (in no case the rejection) of the phenomenological aspects to the genetic aspects, remind us precisely the dialectical movement needed to unveil the concrete in its multiple determinations, for what matter to us, the laws governing psychological development.

It is important to make an observation at this point. Vygotsky's endeavor focused on early childhood, where he believed it was the more appropriate age to reveal the general laws of mental development lying behind their phenomenological manifestations (Fleer & Veresov, 2018). Nevertheless, since the development in the cultural-historical theory is rooted in the interactions of an individual with their environment, those interactions will certainly continue beyond the school age, and so will development. Undoubtedly, these interactions that may produce development will vary throughout life, and work-related activities will likely become the more generative sources of development. The experimental-genetic method and the experimental paradigms built by Vygotsky and his colleagues probably will not be suited for the study of concept development in work activities. However, over the last section we have been distilling the methodological challenges that a research approach in such a setting must address.

In what follows, we will present the approach of Activity Clinics, an interventionist, developmental, and transformative research perspective developed in the field of work psychology. While developed for a different purpose, we will argue for its potential for the study of concept development in work activities.

On the borders of Activity Clinics: studying concept development through cross self-confrontations

Activity Clinics and development of work

Activity Clinics is a French school in work psychology created by Yves Clot and his team at Cnam in Paris (Clot, 1995, 1999; 2008; 2014; 2015; 2020). It explores development at work in an interventionist way strongly anchored in a Vygotskian perspective, claiming the need to provoke development in order to study development: development is seen both as the object and as the method of the research (Vygotsky, 1927/1999). Development is defined as functional migration, i.e., a functioning becoming the means for another functioning (Vygotsky, 2017). In its research practice, Activity Clinics more precisely aims at developing the power of acting of the professionals (a term borrowed from Spinoza and pursuing Canguilhem's ambitious understanding of health as the possibility for a human being to produce their own norms for living). The power of acting "measures the effective radius of action of the subject or subjects in their usual professional environment, what we call the radiation of the activity, its power of re-creation" (Clot, 2008, p. 13—our translation and emphasis). Researchers in

the Activity Clinics tradition answer and negotiate "demands" from diverse practitioners, working with diverse institutions (including schools, justice, Church, prisons, sport, and car factories). These demands may be related to health, safety or training issues at work, for example. In the last 20 years, an increasingly number has been related to the debate on the quality of work, aiming at "making, even 'in a small way', the conflict of criteria the starting point of the exchanges, in search of something new. The discussion is pushed to the limit, even into the finest practical details, until the banality of everyday life is taken seriously" (Clot et al., 2021, p. 115). All demands are discussed with the practitioners and hierarchies, so that the object of the intervention is defined by all partners, as "today, we can consider that transformations are only sustained by the action of work collectives on themselves" (Clot, 2008, p. 102). A complex intervention process coordinating the work with first line volunteer practitioners in an "associated research group" and directions, trade unions and nominated experts in a "steering committee" aim at supporting these transformations based on a co-analysis of the work activity. This co-analysis is allowed by attention for methodological development, with the creation for example of cross self-confrontations as a tool for intervention and research.

Cross self-confrontations as a developmental methodology of work co-analysis

Cross self-confrontations have been developed to carry on this complex, dialogical and developmental co-analysis of the work activity with the practitioners and organizations. They make use of video-based analyses of sequences of work activities carefully selected with practitioners taking part to the associated research group. The methodology is explicitly based on Vygotsky's psychology (through the idea that consciousness is a social contact with oneself, for instance), attempts to organize such contacts repeatedly, and includes some ideas from Bakhtin's dialogism. Cross self-confrontations have been defined as "reflective experimentation spaces" (Kloetzer, 2013), almost in Boal's understanding, as possibilities to test, rehearse, explore for oneself and together, new ideas and ways of doing.

Phases of an intervention using cross self-confrontations

1. First phase: build an associated research group to co-analyze the work activity

- Observe work situations and activities to get some understanding and focus on specific situations with the practitioners;
- Make practitioners interested in exploring work activities, for example obstacles, resources and astonishments, and gather a group of volunteers for further design of the research and analysis;
- Discuss and select together in the associated research group significant sequences of activity to be co-analyzed.

2. Second phase: exploring experience thanks to Simple and Cross Self-Confrontations

- Video-record selected sequences of activity with volunteers;
- Discuss the video-recordings of these activities with one volunteer practitioner in the presence of the researcher in "Simple Self-Confrontation interview", and record these discussions;
- Discuss the video-recordings of these activities with two volunteer practitioners in the presence of the researcher in "Cross Self-Confrontation interview", and record these discussions.

3. Third phase: expand the dialogue

- Edit the video-recordings to produce dialogical artifacts (see Kloetzer & Tau, in press);
- Discuss these video-recordings in the associated research group and steering committee;
- Identify potential transformations in the work activity;
- Make sure this process of transformation can be carried on in the organization, transform the conditions of dialogue for the different partners in the organization (employees, managers, directions, etc.).

Researching conceptual development in Activity Clinics

Although conceptual development per se is the object of a limited number of research and publications in Activity Clinics, in its interventions we can observe the development of many concepts related to the work activity. Here we will quote two extensively: Prot's research on VAE (validation des acquis de l'expérience, validation of acquired experience) (Kostulski & Prot, 2004; Prot, 2012), introducing the concept of *potential concept*; and Kloetzer's research on safety in technical diving, discussing the concept of *professional concept* (Kloetzer, 2013). Both works expand conceptual development discussed by Vygotsky for school children to adults at work (technical diving being both a professional and a leisure activity according to the circumstances for the participants), and build on the distinction between everyday and scientific concepts (Vygotsky, 1934/1997), highlighting the double source of concept formation.

The first field (VAE) is part of a long-term investigation of the Activity Clinics team (see for example Clot et al., 2000). In France, VAE offers the possibility for experienced workers to get their experience validated in the form of an official certification: [...] any person, regardless of age, nationality, status and level of training, who can prove at least one year's experience directly related to the certification in question, may apply for VAE. This certification, which may be a diploma, a title or a certificate of professional qualification, must be registered in the National Directory of Professional Certifications (RNCP) (Ministère du Travail, du Plein emploi et de l'Insertion, s.d., our translation).

This activity, which is socially important for a lot of workers lacking proper diploma and certifications to continue their professional development, raises delicate questions on what, in the acquired experience, counts as skills and knowledge equivalent to the ones certified. From the coaches and jury perspective, this is an evaluative activity, bringing everyday concepts issued from experience with scientific concepts issued from the diploma referential. Kostulski and Prot (2004) suggested that from the candidate's perspective, the discussion with the coach and with the jury may play a role in the emergence of a *potential concept* (Vygotsky, 1934/1997), seen not as a concept, as Vygotsky writes, "but as something that can become one" (Vygotsky, 1997/1934, p. 257) (Kostulski & Prot, 2004), as the "linking of a 'concrete and functional meaning' constructed in action with a 'scientific concept'" (Kostulski & Prot, 2004, p. 425). In their analysis, the authors precise what they mean by a potential concept in the case of this analysis of this VAE interview:

> Here we verify, for the conceptual activity of adults, the validity of the definition put forward by Vygotsky for school children. The potential concept is a point of collision between a concept integrated into a system of concepts and an experienced activity. The subject, whether a child or, as in this case, an adult, is far from having developed the meaning of the scientific concept. But this first step in the use of the concept of the referential is enough to provoke a profound reworking of the elements of the everyday concept, achieving an effect similar to that observed by the Russian psychologist in schoolchildren: the potential concept is realized by the abstraction of distinctive features, [it] dislocates the concrete situation, the concrete connection between distinctive features and thereby creates the necessary premise for a new unification of these features on a new basis (Vygotsky, 1934/1997, p. 257). This abstraction is only possible if the subject distinguishes, in the superabundance of empirical connections (idem, p. 252) that characterize everyday concepts and give them their relevance, the characteristic feature that actually corresponds to the scientific concept (Kostulski & Prot, 2004, p. 439, our translation).

The second research is part of Kloetzer's long-term interest for human-machine interactions–more precisely, how human perceptions, learning and doing are transformed by technological innovations and how the humans adapt to these transformations. Building on professional didactics and the notion of pragmatical concepts (Pastré, 1999), she introduces professional concepts as a way to characterize concepts which are largely shared in a professional milieu: not reducible to everyday nor scientific concepts, "professional concepts [are] social working tools, at the crossroad of individual and collective activity" (Kloetzer, 2013, p. 320), present in the professional discourse and professional genre of the practitioners. In this paper, she studies the discursive development of the concept of "confidence in the machine" in a cross self-confrontation interview. This concept is an everyday concept serving as a professional concept, appearing in the discourse of experienced tech divers for example in this sentence:

"you have to build your confidence in the machine". In a sequence of cross self-confrontations, the researcher shows the double movement by which the tech divers are simultaneously building their confidence in the machine, thanks to routine checks based on the use of the spatial and temporal organization during their out-of-the-water preparation phase, and building parallel confidence in their own processes and control of the machine, in order to control their inner dialogue underwater. In this case, the material itself is turned into both technical and psychological tools and the professional concept of "building confidence in the machine" (which can be taught in training sessions, for example) "germinates up" from the everyday concept.

The researcher claims that conceptual development, in these examples, happens "not by creation of a new concept to grasp new professional realities but by the dialogical unpacking, unfolding and therefore, reconstruction, of a professional notion, the idea of *confidence in the machine*." (Ibidem, p. 332). However, "the stabilization of the concept emerging in this debate is related to its double anchoring: anchoring both in the emotions of the participants and in the professional genre of the milieu" (*ibidem*, p. 318).

In her second example, the researcher highlights the richness of their professional concepts related to breathing and, more specifically, to oxygen: *hypoxia, hyperoxia, hypercapnia* are medical terms translated into the divers' experience, the meanings of which are continuously negotiated at the intersection of medical science and diving practice. Similarly, the scientific concept of "partial pressures," defined in chemistry, is put to work at an operational level for the divers. Breathing is their core business in this activity; therefore, their professional concepts integrate a lot of scientific concepts related to the chemistry of gas mixes and human body (Kloetzer, 2013, p. 329).

These two examples show the fruitfulness and limits of the Vygotskian pair everyday concepts/scientific concepts, as well as two extensions of this reflection to adult development. They also show the interest of cross self-confrontations to study conceptual development in various social situations. Cross self-confrontations may meet some of the methodological challenges highlighted in section 5. Indeed, the method is sensitive to the movements derived from specific uses of language in concrete situations. Additionally, it may track and distinguish the different meanings held by different people at different points, and makes use of social relationships as a way to uncover the development of concepts. Finally, the methodological setting itself might support conceptual development conceived as the "dialogical unpacking, unfolding and reconstruction" of professional concepts.

Testbed: Engineering Practice and Education

The theoretical and methodological proposal of using the tools of Activity Clinics to study the development of concepts in work activity will be tested in a concrete field of Engineering (Microengineering) and Engineering Education, which is the PhD fieldwork of the first author of this paper. Engineering education not only deals with concepts, but has also stressed conceptual understanding as a central aspect of training and research (Streveler et al., 2008). As in other fields, in engineering education important differences persist in conceptions of engineering held by engineering students and professional engineers (Dunsmore et al., 2011; Stevens et al., 2014), and in the understanding they have of core engineering concepts (Brown et al., 2019). Addressing the daily laboratory and research practices of a group of engineers, the research will aim to identify and describe the concepts at stake in those contexts by means of the above discussed tools, as well as the development paths these concepts follow.

Concluding remarks

Through the first part of this article, we briefly visited some of the most influential accounts of concepts in psychology, making a longer stop in the fertile research field of conceptual change. Then, we brought to the table some important criticisms made by other authors before us, and we try to present the Vygotskian understanding of concept and concept development as better suited candidate for a comprehensive and sound theory of concepts. However, articulating the different notions of concept, underlying each psychological perspective (not to mention the diverse philosophical accounts!), may require a finer treatment. The Vygotskian perspective we have brought, reminds us that behind the same words, researchers also may actually be performing different acts of thinking. Suffice it to mention that, while some authors understand psychological processes in a cognitivist, computational way that has led them

to propose the existence of pre-verbal concepts and even innate representations (see for example, Carey, 2004, 2011), Vygotsky (1934/1987) de facto excludes such postulate, since concepts, as higher psychological functions, constitute the basic unit of analysis of verbal thought. Considering the multiplicity of theoretical approaches and, particularly, their epistemological differences, the exercise of articulation is shaping up to be a titanic task. The dialogue, however, is as difficult as it is necessary.

As we noted above, when presenting the genetic-experimental method, Vygotsky and his collaborators focused on the development of children, which was, according to them, the more appropriate age to discover the laws ruling human mental development. Obviously, regarding the development of concepts we face the same situation. Hence, it is fair to ask ourselves, as Yvon (2011) did, if the development of concepts continues throughout life, and what it looks like. However, Vygotsky's focus on early years was a methodological choice, and it does not reject the possibility of the development of higher psychological functions beyond, throughout life. As Kloetzer (2020) reminds us, for Vygotsky the source of development can be found in the interactions of an individual with their environment and, while these interactions certainly vary throughout life, they continue to occur in professional contexts, where changes in conceptual thinking are visible. While these propositions are not far-fetched theses, careful and systematic empirical research is needed to back them up.

As we have discussed, concepts develop in every use and throughout the life course. This development, then, does not occur only within the framework of a particular intervention or research. Certainly, it is not exclusive patrimony of any kind of research or practice. Nevertheless, the Activity Clinics approach provides privileged theoretical and methodological tools to analyze the movement that concepts describe, and to push them even further in the unique dialogical framework it orchestrates. While the approach, undoubtedly, is not an experimental approach—and it has never had that pretension—, we argue for its fertility. We are convinced that in the transformative tools of Activity Clinics we can also find the means to study concepts and their development properly. It is worth recalling, however, that Activity Clinics approach constitutes first and foremost an intervention methodology, and not a research methodology. While we believe in its potential to study concept development, as the reviewed research on Activity Clinics shows (Kloetzer, 2013), it might be a matter of discussion if it is possible or desirable to sustain this movement.

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Recebido em: 03 Mar. 2022
Aprovado em: 23 Fev. 2023