Concept Formation in Activity

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Abstract: This symposium introduces the study of formation of concepts in collective activities (concept formation "in the wild") as a new research field in learning sciences. Using meditational and activity-oriented theoretical frameworks, the contributors analyze concept formation in diverse activities, asking: What are the key characteristics and mechanisms of emergence of functional concepts embedded in activities and what analytical dimensions might be fruitful for the investigation and facilitation of the formation of such concepts? What are the pontentials and limitations of different mediational means and multimodal instrumentalities in the formation and development of functional concepts? How are volition and future-oriented agency intertwined with the formation of functional concepts?

Overview of Symposium

Concept formation and conceptual change are central topics in studies of human learning. However, these topics are studied predominantly in laboratory and classroom contexts in which the focus is on individual learners and the concepts to be acquired are neutral, well known and defined by the researchers or instructors ahead of time. The formation of functional concepts (Greeno, 2012) in work and other collaborative activities "in the wild" has only recently been identified as a field of research (see the special issue of *Mind, Culture, and Activity;* 3/2012). Embedded in activities, concepts need to be understood as complex, emergent, contested and volitionally charged collective constructs that have serious practical consequences for communities (Engeström & Sannino, 2012). This is a new challenge to the learning sciences.

The objectives of the symposium are to take a step forward in the development of the newly formulated research field characterized as concept formation in the wild, to open up analyses of future-oriented volition as an important aspect of concept formation, and to bring together for comparison and exchange empirical analyses of different cultural contexts of concept formation and volition embedded in human activities.

Cultural-historical and activity-oriented theories (Vygotsky, 1997; Davydov, 1990; Hutchins, 2005; Nersessian, 2012) regard concept formation as crucially dependent on the construction and use of mediating means, specified as material anchors, models, or signs. Traditionally language has been seen as the dominant mediator and modality of concepts. However, there is increasing evidence that functional concepts take shape and function by means of multiple interacting modalities, ranging from the body to physical artifacts, pictures and graphic representations, symbols and various sign systems. The mediational means and multimodal instrumentalities involved in the formation and development of functional concepts are a central issue addressed by the contributors to this symposium.

Vygotsky (1997) built an explicit connection between concept formation and volition with his principle of double stimulation. In collaborative activities the formation of future-oriented concepts and volitional action to construct the future in practice go hand in hand. We may speak of future-oriented perspectival concepts or possibility concepts (Engeström & al., 2005). These qualities point toward an important, yet practically unexplored connection between concept formation and volition. Volition may be understood as the capacity to form and implement intentions that go beyond and transform the accepted routines and given conditions of the activity in which the subjects are involved. In the symposium, concept formation is discussed as a volitional and agentic process. This is a novel perspective on concept formation that requires ambitious theoretical, methodological and empirical work.

The papers opf the symposium will address the following major questions:

- What are the key characteristics and mechanisms of emergence of functional concepts embedded in activities and what analytical dimensions might be fruitful for the investigation and facilitation of the formation of such concepts?
- What are the pontentials and limitations of different mediational means and multimodal instrumentalities in the formation and development of functional concepts?

- How are volition and future-oriented agency intertwined with the formation of functional concepts?

The four papers focus on concept formation and learning in different activities and cultural settings, ranging from home care for the elderly in Finland (Engeström) to an internship of future elementary school teachers in Italy (Sannino), public schools in Moscow, Russia (Lapshin, Safronova and Virkkunen), and greenhouse vegetable farms in Finland (Vänninen and Pereira Querol). The discussant will be Professor Rogers Hall (Vanderbilt University).

What are Functional Concepts?

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Functional concepts embedded in collective activities are typically polyvalent, contested and contradictory. They carry ethical and ideological challenges and visions. They are often "loose" (Löwy, 1992) and generate surprising manifestations. They cannot be easily defined and put to rest as categories in a dictionary. Yet we need functional concepts as tools, which makes it necessary that we try to fix and stabilize them, at least temporarily. Formal-logical notions of a concept are not sufficient for the understanding of functional concepts (Greeno, 2012).

This paper will examine five key dimensions of functional concepts, namely (1) the dimension of empirical vs. theoretical contents of concepts, (2) the dimension of verbal vs. multi-modal mediation of concepts, (3) the dimension vertical vs. horizontal movement and interplay of concepts, (4) the dimension of stabilized vs. fluid or loose concepts, and (5) the dimension of adaptive vs. transformative agency. Two examples of functional concepts with which we are currently working in our research group will be analyzed through the lenses of the five dimensions. These are the concept of *integrated pest management* or *IPM* (Kogan, 1998) as it is shaped and implemented among greenhouse vegetable growers in western Finland, and the concept of *sustainable mobility* as it is constructed and implemented among the workers and clients of home care for the elderly in Helsinki, Finland (Engeström, Nummijoki & Sannino, 2012).

For Vygotsky (1987), the key difference between what he called everyday and scientific concepts was that the former are learned in personal casual experience whereas the latter are acquired by means of instruction in school. Davydov (1990) points out that this distinction tells nothing about the *contents* of the two types of concepts. The second key difference between everyday and scientific concepts according to Vygotsky is that the latter form hierarchical systems while the former are without a system. Davydov points out that also empirical concepts commonly appear is systems, such as genus-type relationships, elaborate classifications and pyramid-like hierarchies. In other words, the existence of a system or hierarchy of concepts in no way guarantees that it is a theoretical or scientific concept. For Davydov the essential point is that with empirical concepts you perform actions of comparison, identification, naming, and classification. Empirical concepts are definitions and categorizations that aim at fixing and freezing the reality, creating closed compartments which can be filled or matched with appropriate examples. Theoretical or dialectical concepts are procedures of ascending from the abstract to the concrete in a given domain, requiring actions of historicizing, transforming and experimenting, modeling (constructing a germ cell abstraction), examining or testing the model, and deriving new expanded implications and applications from the germ cell (rising to the concrete). Theoretical concepts are open-ended, they generate constantly new possibilities and applications. Both the concept of *integrated pest management* and the concept of *sustainable mobility* can be used either as an empirical categorization device or as a theoretical device for ascending from the abstract to the concrete. The paper will demonstrate how these alternatives, and their mixtures, are displayed in the history and current life of these two concepts.

Vygotsky emphasized the verbal, language-bound character of concepts. On the other hand, researchers such as Poddyakov (1977; 2011) have shown that already preschool children are capable of key actions of theoretical thinking, namely experimentation and modeling, using material artifacts and visual images. Our own work (Engeström, Nummijoki & Sannino, 2012) points toward the great potential of physical movement and bodily sensation in the formation of theoretical functional concepts. The paper will analyze how each of the two concepts discussed here appears in different guises, as verbal definitions and instructions, as graphic models and pictorial representations, and as bodily actions and sensations, and how the movement and blending between the modalities may be obstructed or facilitated in various ways.

The vertical movement of concepts was powerfully disucssed by Vygotsky and Davydov. The horizontal movement may be understood as comparison, confrontation and blending between different perspectives and definitions of a concept (Engeström & al., 2005). This polyvalence is present not only in newly emerging concepts such as *sustainable mobility* but also in a concept with a long history and official authority such as *integrated pest management.*

Stabilization of functional concepts typically happens by means of political, economic and legal authorization and investment. Functional concepts serve as future-oriented visions that engender transformative

agency. But they also serve as mechanisms of adaptation, calling for adherence to received wisdom and gradually becoming self-evident components of hegemonic consciousness. Thus, as Löwy (1992) shows, certain looseness in key concepts may be may necessary for the development of our understanding of complex phenomena. Along with stabilization, we may observe, perhaps also facilitate, processes of destabilization of functional concepts.

Anchoring Backward and Anchoring Forward: Conceptualization and the Emergence of Agentive Action

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In situations of uncertainty or cognitive incongruity human beings usually turn to conceptual and material anchors to support sense making and engage in meaningful actions. Available literature on anchoring primarily focuses on what may be characterized as backward anchoring, that is, well-stabilized representational components in the conceptualization processes involved in these situations. On the other hand, literature on sense- and meaning making does not systematically identify actions involved in this conceptualization processes. With the help of empirical analysis in laboratory setting, the analysis presented here aims at opening up a way toward a notion of forward anchoring which involves both conceptualization and agentive action.

Anchoring backward relies on background knowledge and relatively stable representations utilized for explaining problem situations and for acting in such situations. Conceptualizations of anchoring proposed by Tversky and Kahneman (1974), Moscovici (1984) and Marková (2000) are examples of this type of anchoring: reliance on starting points yielding to biased estimates (Tversky & Kahneman, 1974) and categorization of new or unfamiliar ideas under familiar concepts and their transformation into cultural beliefs (Moscovici, 1984; Marková, 2000).

Anchoring forward is stepping into the unknown by building supporting anchors partly similar to material anchors depicted by Hutchins (2005). Forward anchoring involves representations not yet consolidated, emerging though personal sense and social interactions. These anchors are instrumental in the elaboration of new meaning, which may be stabilized to the point of supporting actions. In this paper, the notion of anchoring forward is elaborated on the basis of Vygotsky's (1987) principle of double stimulation, according to which one turns to external means for support to produce a new meaning and to be able to act.

Studies using the idea of double stimulation primarily examine concept formation without addressing how emerging concepts are related to agency. This was, however, a central concern for Vygotsky and the continuing relevance of Vygotsky's legacy largely resides in the relation between concept formation and volitional action. Vygotsky (1987; 1997; 1998) used the experiment of "meaningless situation" as a paradigmatic example of double stimulation. A subject escorted to a room is told that the experiment will start soon, but the experimenter does not return. This design allows tracing how the participants start forming a concept of the situation and how they engage (or fail to engage) in agentive actions. Videotaped, annotated and transcribed experiments with 25 individuals and 30 groups, based on Vygotsky's description, are analyzed in this paper, together with participants' stimulated-recall interviews, also recorded and transcribed.

The other set of empirical data used in the paper concerns a formative intervention to develop the internship of future elementary school teachers in Italy. 13 third-year university internship students were involved in the study. One or two first- and fourth-grade pupils were assigned to each internship student who assisted them in accomplishing learning tasks. As none of the internship students had prior teaching experience, the interactions with the pupils proved to be at times challenging situations which required conceptualization efforts and agentive actions. The data in which the students report how they dealt with these challenging situations include 108 ethnographic fieldnotes by the internship students, transcriptions of 28 interviews and 10 meetings with the internship students.

The two empirical sets of data are analyzed by focusing on both verbal and physical aspects of interaction to investigate how double stimulation is simultaneously a mechanism of conceptualization and agency. The analyses reveal both backward anchoring-based conceptualization actions and forward anchoring-based conceptualization actions. The latter are in turn further differentiated into search actions, taking-over actions, and breaking-out actions. The analyses lead to the formulation of a hypothesis of the interrelatedness of conceptualization efforts and the emergence of transformative agency.

School Change as Collective Concept Formation

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The problems typically encountered in attempts to profoundly renew school education are aptly crystallized in the conclusion of an analysis of a school reform program conducted by Hubbard, Mehan and Stein (2006): *"(...)*

a reform that began as conceptually driven was proceduralized; an approach to learning that began as student-centered became teacher-centered; a framework with many openings for the application of professional judgment became understood as scripted." In our paper we argue that a predefined concept easily turns into a rule for the practitioners rather than into an intellectual tool for creatively meeting the challenges of their joint activity. The practitioners need to be involved in the process of forming the new concept for it to become a motive and instrument of their transformation efforts. The formation of such a concept requires that practitioners take jointly epistemic actions to reveal the change-demanding inner contradictions within their activity system and to find and implement a way to re-mediate them.

The Change Laboratory is a formative intervention method that is designed for helping practitioners to accomplish this in collaboration with researcher-interventionists. The Change Laboratory aims at creating a theoretical abstraction of the new form of activity and ascending from it to the concrete new activity system (Engeström, 2007; Virkkunen & Tenhunen, 2010; Virkkunen, Newnhamn, N'leya, & Engeström, 2012). This process also builds the practitioners' transformative agency. In our paper, we will analyze such collective concept formation processes in two Russian schools.

The School Integration Case

Education in the Russian Federation is currently in the process of being modernized. A new system of educational objectives is implemented that highlight the development of students' general learning abilities. At the same time, separate educational institutions are merged to form Educational Incorporations in order to secure equal educational opportunity and to raise the quality of education. In the first case we analyze in our paper, a senior high school (Gymnasium), a public school and two kindergartens are being merged. Our analysis of this transformation focuses on how the ideas behind the externally given new rules can be turned into new conceptual and practical tools for the practitioners to master the new challenges. That is only possible when they construct a future-oriented concept of a shared object of the educational activity of the professionals of the new institution. In a Change Laboratory process conducted in 2013, 18 administrators and teachers from the four previously separate institutions analyzed the development of their educational activities. The analysis showed that inner contradictions had evolved within each institution's activity that the fusion aggravated while also providing new potential for resolving the contradictions, highlighting the need to find a concept of a jointly produced "product".

In the Change Laboratory discussions, the idea of *individualized instruction* emerged as a possible core of the new concept, based on the senior high school's existing practice of constructing individualized study plans as well as on the other institutions' experiences of individualizing instruction. We will examine the concept created in the Change Laboratory against the historical variations and phases of development of this concept (e.g., Gibbons, 1970; Rothrock, 1982; Hiemstra & Sisco, 1990). We will analyze the steps of ascending to a new concrete system of the joint activity of the merged institutions as stepwise resolution of manifestations of the *contradiction between the individual and the common* in the education on different levels of the new institution's activity.

The Case of Redefining the School's Educational Activity

The "School of Self-Determination" at Moscow's periphery was created to educate self-confident, cultured and active persons and over the past three decades it developed a community of kindred spirits around itself. Lately, however, its pedagogical efficiency as well its reputation in the local community have declined. The ongoing school reform in the country forced the school to begin to redefine its activity. This effort was supported by a Change Laboratory intervention from October 2012 to March 2013, in which a representative group of 24 teachers and managers took part. Interviews and videos of work situations were used as stimuli and material to discuss and analyze the current situation. Origins and systemic causes of the problems were traced in the Change Laboratory by analyzing the historical development of the activity. The analysis revealed contradictory needs and pressures within all elements of the activity that the school reform further aggravated. The reform requires the school to focus on academic results. It sharpens the contradiction between two ideas of the school, understood as "a school for all" and "a school for kindred spirits". The core of this contradiction was modeled in the Change Laboratory through two orthogonal dimensions of developmental objectives: "openness of the school" and "commonality of values" within the school community. The challenge was defined as a need to integrate these objectives. The participants seeked to realize this with a new formulation of the object and concept of their educational activity: "Each pupil is potentially able and individually gifted to be a subject of his or her own educational trajectory; to learn from his or her own strengths and weaknesses; and to choose his or her own way of development". Each element of the activity was redefined on the basis of this concept. Task force groups were formed to work on concrete tasks of implementation. The headmaster and four teacher leaders coordinated this work. Follow-up data shows that the practitioners have actually managed to concretize the abstract germ cell of the concept.

Observations

In both these Change Laboratory processes, a dialectical process evolved in which the new external demands and pressures, the practitioners' own experiences and concepts, the history of the institutions, and their future perspectives were brought into a creative dialogue. The practitioners reviewed the history of their activity from the point of view of their current challenges and at the same time approached the latter through their historical experience and the resources inherent in it. Instead of receiving the school reform as an external rule the practitioners integrated it in their analyses of their activity as an change in conditions that aggravated the inner contradictions in the activities and provided new resources for resolving them. Abstracting and modeling the central inner contradictions in the activities enabled the practitioners to make thought experiments and, through them, to cross the boundaries of current classifications and institutions. In both cases a new concept evolved as a new vision and motive of the activity and as a principle the practitioners' applied in resolving the contradictions of their activity both in thinking and in practice, thus objectifying the new concept through reconfiguration the organization and the daily practices of the schools' educational activity.

The Role of Models and Modeling in Collective Concept Formation: Transforming Pest Management in Finnish Horticulture

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Models are understood as special kinds of mediating artifacts that play a crucial role in helping us to learn about theories and the world (Morgan & Morrison, 1999). Studies of the role of models in scientific practice provide some knowledge about the relationship between theories and reality, but they do not say much about how models are used in the process of transforming activities (for important work in this direction, see Nersessian, 2012). In this paper, the case of greenhouse vegetable production in Ostrobothnia, Finland, is analyzed as case in which models are needed in the creation and implementation of a concept that guides the transformation of an activity. The learning challenge of the producers in this context is to construct an integrated management of a systemic whitefly problem. The individual producers need to overcome their competitive separation and construct a shared pest management system at the level of the whole village. The study was conducted as a Change Laboratory intervention (Virkkunen & Newnham, 2013) designed to facilitate collective pest management among the producers.

In the six Change Laboratory sessions the participants constructed and used a series of graphic models do depict, analyze and transform their problematic situation. By tracing the generation, application and modification of these models, we show how the object and concept of whitefly management was reconstructed during the collective learning process and how different forms of transformative agency emerged in the process. Using the framework of expansive learning (Engeström, 1987), we analyze in which phases of the expansive learning cycle the models were created, what specific purposes they served, what modalities of represention were involved (e.g., how the graphic models interacted with bodily gestures and verbal discourse), and which types of exprfessions of transformative agency (resisting, criticizing, explicating, envisioning, committing, and taking actions) they were connected to.

We identified three models that contributed to the expansive re-conceptualization of the activity and reconstruction of its object. The most important model served as a springboard for expanding the participants' understanding of the whitefly problem and consequently expanding the solution. The model represented the interplay of the outdoor and indoor parts of the whitefly problem and its contributing factors. It took the general form of a vicious circle, a sequence of reciprocal cause and effect in which two or more elements intensify and aggravate each other, leading inexorably to a worsening of the situation until an external factor breaks it. The model was developed in several stages during the questioning and analyzing phases of the process. The initial version was produced by growers with the help of the facilitators. Thereafter its development was continued collaboratively by growers, advisors, facilitators and the tutor of the process. It was notable that the initial versions of the model did not include the leverage component of the ensuing new model of activity: improving communication to share information between growers. The modeling process helped the participants go beyond mere bio-ecological and technical aspects of the problem, opening up the social system and its contribution to the whitefly problem and directing attention to those parts of the system that could be used as leverage point to break the vicious circle. The model helped growers to form the new object of whitefly control that is more realistic for a community of interdependent producers: not eradicating but keeping whitefly levels continuously low through collaboration. The model was referred to several times both during and between the sessions. Thus it guided thinking, triggered participants' agentic actions, and guided them in forming hypotheses on how to deal with the problem.

Based on the problem model and the associated solution components, in the solution design and testing phases the interventionists designed a second model representing a solution to the problem. The core of the model stemmed from a realization obtained when constructing the system-specific vicious circle: that a new division of labor was needed between firms for producing information that would help them improve pest

management collectively. The solution includes a standardized monitoring method of whitefly densities in the farms, a boundary object (Akkerman and Bakker, 2011) in the form of a database for storing monitoring and pest management results, and a learning club involving growers, advisors and researchers for collective analysis and discussion of the data and related pest management approaches. The solution model guided the planning of practical trials of the monitoring tool of whiteflies as well as the planning of rules for the learning club. Additionally, it proved very useful in the last session of the Change Laboratory when introducing the new concept to the growers of the neighboring village in an attempt to geographically expand the new activity.

The third model was produced and used during the testing and implementation phase to help in deciding about the format of the learning club, the two options being a webpage or face-to-face meetings. The interventionists produced a prototype webpage to exemplify how and what kind of information could be made available through the web. Prototyping enables designers and users to test new ideas through thinking-by-doing (Hartmann & al., 2006). The prototype eventually helped the growers decide in favor of face-to-face meetings that suited their learning needs best for the time being.

A preliminnary analysis shows that growers first tried to reach a solution by applying the prevailing approach to solving problems; this often involves fixed roles and individual responsibilities. During the intervention, limits of the current concept and practice were recognized. The construction and use of the system-specific model of the problem were important in triggering the agentive actions of criticizing and explicating possibilities. The second and third models were important in triggering and supporting envisioning.

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