Chapter 21
Activity Theory—Lev Vygotsky, Aleksei Leont'ev, Yrjö Engeström

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Introduction

Commonly, various systems and institutions undergo a change in order to improve practices or make them more effective. However, there are few systematic theories that can be used in research to both study the changes and contribute to change and transformation of practice. Activity Theory can be used to study developmental change in systems and institutions such as hospitals and schools. It applies both a historical and a situational perspective; both an individual (micro) and a systemic (macro) perspective. In this chapter, we explain the history of Activity Theory and how it can be used in practical terms to understand change and development in general, and inquiry-based science teaching in particular.

Activity Theory has developed within the sociocultural approach to learning and development (Vygotsky, 1978; Wertsch, 1991, 1998), and pays attention to historicity, the present situation, to the individual, and the collective system. Research with human participants will to some degree involve intervention, and "the introduction of research instruments into practice, including dialogue between researcher and participants, is itself change-inducing" (Wardekker, 2000, p. 270). Activity Theory is about learning and change and is a suitable research and development approach in order to address the gap between theory and practice.

Activity Theory is based on theories developed by a group of revolutionary Russian psychologists in the 1920 and 1930s. The fundamental concept of the approach

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was proposed by Lev Vygotsky (1896–1934), the founder of the school. The relationship between the individual and the social community appears to be a classic challenge in psychology. After the Russian Revolution in 1917 Russian psychologists tried to solve this issue, and it was not an easy task since a solution had to fit the philosophy of the Marxist doctrine. Vygotsky was a central character in this context and he tried to reconcile the philosophical side of Marxism with a psychology of human development and link socialization to the social individual. In particular, he stressed three key elements that were central to his thinking: First, that human mindset is influenced by its living conditions. There are common features in the environment around humans, resulting in a united mindset and how they understand each other. Second, artifacts surrounding humans impact their living conditions. Third, humans can attain more in life by collaborating than striving alone (Vygotsky, 1978).

Activity Theory is an object-oriented theory (Engeström & Sannino, 2010). According to Engeström (2001, pp. 136–137), Activity Theory can be summed up with five characteristics.

1. Prime unit of analysis: "A collective, artifact-mediated and object-oriented activity system, seen in its network relations to other activity systems, is taken as the prime unit of analysis" (Engeström, 2001, p. 136).
2. Multi-voicedness: "An activity system is always a community of multiple points of view, traditions and interests" (Engeström, 2001, p. 136).
3. Historicity: "Activity systems take shape and get transformed over lengthy periods of time. Their problems and potentials can only be understood against their own history" (Engeström, 2001, p. 136).
4. Contradictions: Contradictions play a central role as "sources of change and development…[They] are historically accumulating structural tensions within and between activity systems" (Engeström, 2001, p. 137).
5. Possibility of expansive transformations: "An expansive transformation is accomplished when the object and motive of the activity are reconceptualized to embrace a radically wider horizon of possibilities than in the previous mode of activity" (Engeström, 2001, p. 137).

Yrjö Engeström has together with colleagues at CRADLE (Center for Research on Activity and Learning) at the University of Helsinki used the theory to analyze and intervene in many settings and situations. Activity Theory is an approach that can be used to analyze human interactions and relationships within specific social contexts. It focuses on collective social practices and considers the complexity of real-life activity. It is being increasingly used to examine issues in teacher education, as well as in other fields.

Activity Theory has developed through the following three generations or schools (Engeström, 2001): The first school was developed by Vygotsky and later his students, contributing with the cultural historical aspects of Activity Theory. The second school was mainly Leont'ev's work, a student of Vygotsky, contributing to the differences between individuals and collective activity. The third and last school was developed by Engeström, with its networks of interacting activity systems.

Vygotsky and First School of Activity Theory

Vygotsky's ideas, developed during the 1920 and 1930s, were a response to what he called "a crisis in psychology", which was most evident in the study of "consciousness"—a synonym for "mind" (Bakhurst, 2007). It was a reaction towards a reductionist understanding of psychology, where human processes were reduced to physiology or neurology by proponents like Ivan Pavlov and Vlamidir Bekhterev. Pavlov, the winner of Nobel Prize in Medicine in 1904, developed the theory of conditional reflexes through his famous experiments with dogs (Van der Veer, 2007). He found that dogs would salivate not only when they got food, but also when various conditions preceding food reminded them of food. From this, Pavlov inferred that mental activity is reflexive. Bekhterev, the founder of reflexology, claimed that all human behavior consists of complex forms of reflexes (Van der Veer, 2007). Pavlov's findings inspired the American John B. Watson, who is considered to be the founder of the school of behaviorism, and his later colleague B. F. Skinner. Signalization, or stimuli, was at the core of Pavlov's theory. It meant that organisms learn that certain stimuli signal others (Van der Veer, 2007). However, Vygotsky considered this an inadequate description of human being's higher mental functions. He introduced the concept of signification, meaning that humans are not passively reacting to their environment but actively determine their behavior through signs (Van der Veer, 2007). Bakhurst (2007) explains it in this way:

> The cornerstone of Vygotsky's "dialectical method" is the idea that everything in time must be understood in its development. Accordingly, he argues that to understand the mature human mind, we must comprehend the processes from which it emerges. The higher mental functions, he argues, are irreducible to their primitive antecedents; they do not simply grow from the elementary functions as if the latter contained them in embryo. To appreciate the qualitative transformations that engender the mature mind, we must look outside the head, for the higher mental functions are distinguished by their mediation by external means (p. 53).

Vygotsky's identification of mediated action as a unit of analysis was revolutionary. It overcame the Cartesian individual and the untouchable societal structure split. Vygotsky based his findings on reading Marx's theories on changing social and material conditions. The foundational idea of dialectical materialism is that human beings, besides acquiring knowledge and being the result of the evolution of species, also produce and transform culture. Vygotsky extended Marx's theory to psychology, emphasizing that a unit of analysis has to pay attention to the history and developmental processes (Vygotsky, 1986). He claimed that "[…] humans personally influence their relations with the environment and through that environment personally change their behavior, subjugating it to their control" (Vygotsky, 1978, p. 51). Moreover, Vygotsky was influenced by Engel's writings on the centrality of tool and sign mediation in human functioning (Wertsch, 1985). He formed what is called "the basic triangle", illustrating that the subject cannot act on the object directly but through tool mediation. "This type of organization is basic to all higher psychological processes", according to him (Vygotsky, 1978, p. 40).

Mediation also provides "a link between social and historical processes, on the one hand, and individuals' mental processes, on the other… the focus is on how

the inclusion of tools and signs leads to qualitative transformation" (Wertsch, 2007, p. 178). Thus, change is fundamental to understanding higher mental functions. From this point of view, the goal of instruction in schools is "to assist students in becoming fluent users of a sign system" (Wertsch, 2007, p. 186). Teachers try constantly to do this with their students—whether the sign system is reading literacy, ICT, classroom management or inquiry-based teaching.

Vygotsky (1986) emphasized cultural mediation and its importance for thinking: "The rational, intentional conveyance of experience and thought to others requires a mediating system" (p. 7). He argued that tools and signs mediate higher mental functioning and human action. Mediational means, particularly language, are products of cultural, historical, and institutional forces (Wertsch, 1991). In fact, Wertsch (1998) argues for mediated action as a unit of analysis in order to overcome the pitfalls of individualistic reductionism. As in the definition of "activity" in Activity Theory, he claims that the action is characterized "[…] by dynamic tension among various elements" (Wertsch, 1998, p. 27). As pointed out by Wertsch (1998), there are often resistance and tensions involved in mediated action through cultural tools. Now we turn to the second school of Activity Theory.

Leont'ev and Second School Activity Theory

Aleksei N. Leont'ev, Alexander Luria and other Soviet researchers developed Vygotsky's ideas into what is called the second generation of Activity Theory (Engeström, 2001). The focus then moved from the individual to the collective.

Leont'ev, one of Vygotsky's students, contributed with the concept of activity (Leont'ev, 1978, 1981). He criticized American psychology, which was mostly occupied with explaining what makes children what they are. Leont'ev distinguished between activity, action, and operation, and operated with collective activity as a key unit of analysis. The focus should, according to Leont'ev, be on the object and motive (Leont'ev, 1981). The *activity* of driving a car can be illustrative of these concepts. When one shifts gear while driving, the *action* is the shifting of gear from first to second gear. After one has learned to shift gears, the action becomes an *operation*. Thus, an activity is realized through actions. Activities have their own language, for example, teachers working in schools. For somebody who does not know what a school is, the activity will seem foreign. That is why one has to study an activity from the inside. Within a school, there are several activities, for example assessing student performance, which also has its own jargon. For someone unacquainted with assessment, the activity will not make so much sense. Teachers' work within an activity, for example, student assessment, becomes automatized. Their actions within the activity thus become operations. It is important to study the actions and verbalize the operations to understand the activity (cf. Vygotsky's idea of the social preceding the individual).

Leont'ev claims "[…] the main feature that distinguishes one activity from another is its object. After all, it is precisely an activity's object that gives it a specific direction", which also shows that there is always a need, a motive: "There can be no activity without a motive" (Leont'ev, 1981, p. 59). Moreover, Leont'ev formally operationalized the roles of communities, the rules that structure them, and the negotiation of tasks. He was much more concerned with practical *life* and *activity* than his predecessor Vygotsky, who was more concerned with genesis and the mediation of mind by cultural tools.

The second generation of Activity Theory is inspired mostly from Leont'ev's work. In his well-known example of "primeval collective hunt", Leont'ev (1981, pp. 210–213) explained the essential difference between an individual action and a collective activity. The distinction between activity, action, and operation became the basis for Leont'ev's three-level model of activity. The highest level of collective activity is driven by an object-related motive; the middle level of individual (or group) action is driven by a conscious goal; and the bottom level of sub-conscious operations is driven by the conditions and tools of the action at hand. The idea of internal contradictions as the energetic forces of change and development in activity systems was conceptualized by Il'enkov (1982) and started to grow as a guiding principle of empirical research. Cole (1988) was one of the first to outline the deep-rooted insensitivity of the second generation Activity Theory towards cultural diversity. Nevertheless, Leont'ev never graphically extended Vygotsky's original model into a model of a collective activity system, the graphical extension was done by Engeström (1987, p. 78). With this, we turn to the third school of Activity Theory.

Engeström and Third School Activity Theory

When Activity Theory went global, questions of diversity and dialogue between different traditions or perspectives gradually became serious challenges. It is these challenges that the third generation of Activity Theory deals with. It develops conceptual tools to understand dialogue, multiple perspectives and voices, and networks of interacting activity systems. In this mode of research, the basic model is expanded to include a minimum of two interacting activity systems.

The minimum elements in the activity system are: *Subject*, *mediating artifact*, *object*, *rules*, *community*, and *division of labor*. The upper triangle with subject, object, and mediating artifact as its nodes is Vygotsky's original triangle (Vygotsky, 1978, p. 40) turned upside down. The acting *subject* could be a person or a group; it is through the subject's eyes and interpretations the activity is constructed. *Mediating artifact* is what links the subject to the object in Vygotsky's original triangle. The *object* is the goal of the activity, whereas the *outcome* is the ultimate goal or vision of the activity. *Rules* include norms and conventions in the activity system, *community* refers to all the people involved in the activity system, and *division of labor* refers to the object-oriented actions that are conducted by the people involved in the activity system. All the nodes in the triangle interact.

The principles of Activity Theory for inquiry and development are useful in conducting and studying development. Conducting developmental research which uses the activity system as a starting point can add knowledge about the situation before and after an intervention. A significant goal of using an inquiry approach is to learn from the often unexpected ways in which the intervention reveals new understandings of both theory and practice.

According to Rantavuori, Engeström, and Lipponen (2016), when whole collective activity systems, such as work processes and organizations, need to refine themselves, traditional modes of learning are not enough. Nobody knows exactly what needs to be learned. The design of the new activity and the acquisition of the knowledge and skills it requires are increasingly intertwined. In expansive learning activity, they merge (Engeström, 2015). Earlier studies of expansive learning (e.g., Engeström, 2008, pp. 118–168) have demonstrated that features of expansive learning may be found when participants face an open-ended problem-solving task, such as a need to plan something that is new for them. In an expansive learning cycle, the initial simple idea is transformed into a complex object, a new form of practice.

Relying on Activity Theory, the theory of expansive learning is fundamentally an object-oriented theory where the object is both the resistant raw material and the future-oriented purpose of an activity (Rantavuori et al., 2016). The object is the true carrier of the motive of the activity. In an expansive learning activity, motives and motivation are not tailed predominantly inside individual subjects—they are in the object to be transformed and expanded. As pointed out by Rantavuori and colleagues (2016), a powerful object of learning has an expansive potential to go beyond the exchange value, being typically an open-ended problem or challenge that has relevance for the learners and is not limited to reproducing predefined correct answers. Expansive learning is understood as a circular process in which strategic actions based on contradictions drive new strategic actions and contradictions in a cyclic process (Engeström & Sannino, 2010, p. 2). Engeström's (1999) expansive cycle of learning is related to his activity system and shows the levels of action during formative interventions. This model assumes that development does not necessarily follow a linear pattern.

In expansive learning, learners learn something that is not yet there (Rantavuori et al., 2016). The learners construct a new object and concept for their collective activity and implement this new object and concept in practice. The theory of expansive learning is based on the dialectics of ascending from the abstract to the concrete (Engeström & Sannino, 2010). This is a method of grasping the essence of an object by tracing and theoretically reproducing the logic of its development, that is, its historical formation through the emergence and resolution of its inner contradictions. Contradictions are the driving force of transformation (Engeström & Sannino, 2010). Contradictions may create disorder and conflicts that can be perceived as a problem, but contradictions may also lead to change and new knowledge (Leont'ev, 1978). Through the process of the expansive cycle, the object and motive of the activity are reconceptualized to allow greater possibility and flexibility than the previous pattern of activity.

The idea of contradictions as a source of innovation was introduced by Il'enkov (1982) and is a guiding principle of Activity Theory, which is illustrated with Engeström's (1999) expansive circle. The contradictions between the various elements in the activity system are the starting point for development. When contradictions are identified, the development forms the formative cycle, which can be illustrated in the expansive learning cycle (Engeström & Sannino, 2010, p. 8). The expansive transformation is accomplished when the object and motive of the activity are reconceptualized to embrace a broader perspective of potentials than in the earlier means of the activity.

Vygotsky's concept of zone of proximal development (ZPD) is another central root to the theory of expansive learning. Vygotsky (1978, A full cycle of expansive transformation can be understood as a collective journey through the zone of proximal development of the activity (Engeström, 2000, p. 526; Engeström, 2001, p. 137). Meira and Lerman (2001) argue that the ZPD is not something that pre-exists; it is a symbolic space for interaction and communication where learning leads the development. They refer to Wertsch's (1985) statements about how the ZPD is not a measurable object. Nor is it only related to the interactional events which lead to cognitive change. According to Wertsch (1985), the ZPD is not just a property of the child, nor is it merely the result of inter-psychological functioning alone. As pointed out by Engeström, who has developed the individual understanding of Vygotsky's ZPD (1978, p. 174), "it is the distance between the present everyday actions of the individuals and the historically new form of the societal activity that can be collectively generated as a solution to the double bind potentially embedded in the everyday actions." The ZPD is redefined as space for expansive transition from actions to activity (Engeström & Sannino, 2010, p. 4). In the following, we turn to inquiry-based science teaching within a framework of Activity Theory.

Inquiry-Based Science Teaching and Mediating Artifacts

Inquiry-Based Science Teaching (IBST) is according to Linn, Davis, and Bell (2004) basically about teachers teaching students to obtain a better understanding of the world in which they work, communicate, learn, and live. Inquiry is the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments (Linn, Davis, & Bell, 2004).

Questioning and finding answers are extremely important in IBST as aids in effectively generating knowledge. Teaching strategies that actively engage students in the learning process through inquiries are more likely to increase conceptual understandings, and there can be variable amounts of direction from the teacher, in both open and guided inquiry. IBST is not only about asking questions but is a way of transforming data and information into valuable knowledge. As a tool for teaching inquiry, teachers can use the 5E model (Fig. 21.1). The 5E model (cf.

Fig. 21.1 The 5E model
(Svendsen, 2015)
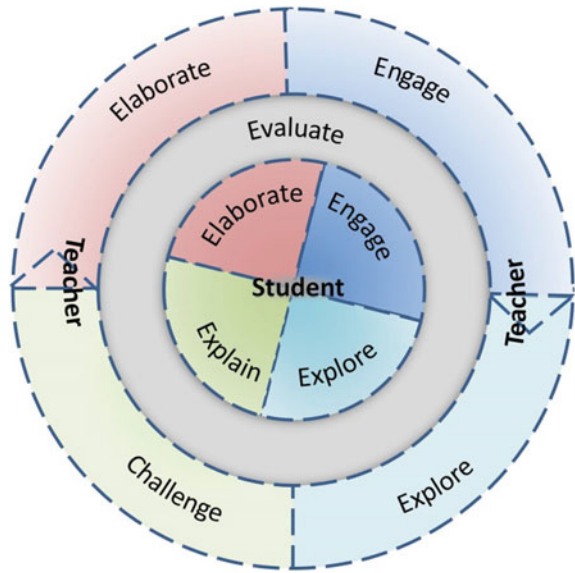
Chap. 4: Malone's intrinsic motivational theory) can be used to support teachers
in planning, implementing, and evaluating teaching. The model has its origins in
the Biological Sciences Curriculum Study (BSCS), in which American scholars
developed educational programs and research on teaching and learning in science.
The five Es are the initial letters in the words engage, explore, explain, elaborate,
and evaluate. The intention of the model is to be used for planning, implementation,
and evaluation of learning and teaching.

Teachers teach by engaging students with a starter. A startup should be both
motivating and related to phenomena that students can relate to (like everyday phe-
nomena). The students' prior knowledge is accessed by the teacher or the syllabus
and helps students to become engaged in a concept through the use of short activ-
ities, or introduction to phenomena in order to endorse interest and provoke prior
knowledge. The activities of this phase make connections to past experiences and
expose students' misconceptions; they should serve to ease cognitive imbalance.
Activity refers to both mental and physical activity (Bybee et al., 2006). Once the
activities have engaged the students, they need time to *explore* the ideas. Inquiry-
based activities are designed so that the students have common, concrete experiences
upon which they continue formulating concepts, processes, and skills. Students work
actively with the material (read, write, investigate, observe, etc.) and add knowledge
and skills to reach new learning goals. This level is concrete and hands-on, and
the use of touchable materials and concrete experiences is essential, but not nec-
essary. The aim of inquiry-based activities is to establish experiences that teachers
and students can use later to introduce and discuss concepts, processes, or skills.
Explanation provides openings for teachers to directly introduce a concept, process,
or skill. Students explain their understanding of the concept. An explanation from

the teacher may guide them toward a deeper understanding, which is a critical part of their new understanding. By facilitating activities that build on the knowledge and skills students already possess, and allow students to reflect, discuss, read, and write to achieve the learning objectives, the teacher can introduce new concepts that challenge student's conceptual understanding (Bybee et al., 2006).

Teachers have a variety of techniques and strategies at their disposal to stimulate and develop student *explanations*. Once students have explanations and terms for their learning tasks, it is important to involve them in further experiences that extend, or *elaborate*, the concepts, processes, or skills. This level facilitates the transfer of concepts to closely related but new situations. Students' theoretical understandings and skills are challenged by their new experiences and by guidance of their teachers. They develop deeper and extensive understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting supplementary activities. Elaborative activities provide further time and experiences that contribute to learning.

Evaluation should be continuous, varied, and be a part of all levels. Assessment is self-assessment, continuous assessment, and final assessment. It can be oral and written. Teachers need to evaluate their own learning in a reflective way. Students consider their own learning and understanding, and the teacher will assess student learning in relation to learning objectives in each subject or in an activity, and in relation to the objectives of the curriculum. Students might also benefit from collaborative learning when working inquiry-based. Students engaged in collaborative learning capitalize on one another's resources and skills, asking one another for information, evaluating one another's ideas, monitoring one another's work, etc. The importance of the difference between individual actions and collective activities is to be found within the second school of Activity Theory. When students interact across activity systems, conceptual tools to understand dialogue, multiple perspectives and voices, and networks of interacting activity systems need to be developed. In this mode, the basic model from the first school of Activity Theory is expanded to include a minimum of two interacting activity systems, known as the third school of Activity Theory.

In conclusion, the 5E model can be supportive in making inquiry-based teaching explicit and targeted. By shaping clear learning aims for teaching, teachers can use the model as a reflection tool for designing, planning, implementing, and evaluating their teaching sequences and in this way expand their professional learning. Rendering the activity system, the 5E model represents a mediating artifact on which teachers and students can act and create their own understanding of the model to enhance learning and understanding of science. Mediating artifact is what links the subject to the object in Vygotsky's triangle, and it is acted upon by the subject to the object. According to Leont'ev (1981), mediation is the subject's activity. The object refers to the "problem space" at which the activity is focused and which is formed and transformed into outcomes with the help of physical and symbolic, external and internal mediating instruments, including both tools and signs. The goal of the activity is the object, and the outcome is the goal of the activity, in this case, IBST.

Summary

- Activity Theory can be used to study the developmental change in systems and institutions.
- Activity Theory has developed within the sociocultural approach to learning and development.
- Activity Theory has developed through the following three generations or schools:
    - The first school was developed by Vygotsky. The important part here is the concept of mediation.
    - The second school was developed by Leont'ev. The important part here is the difference between individual actions and collective activities.
    - The third school was developed by Engeström. The important part here is the network of activity systems.

- Expansive learning is central in Activity Theory. In expansive learning, learners learn something that is not yet there.
- Science teaching can benefit from using mediating artifacts to understand the principles behind inquiry-based teaching and trigger a learning process.
- Inquiry-Based Science Teaching is about asking questions and a way of transforming data and information into valuable knowledge.

Recommended Resources

Books

Miettinen, R. (2009). *Dialogue and creativity. Activity theory in the study of science, technology and innovations*. Berlin: Lehmanns Media.

Journal

Mind, Culture, and Activity: http://www.tandfonline.com/loi/hmca20.

Internet Source

CRADLE (Center for Research on Activity, Development and Learning): http://www.helsinki.fi/cradle/index.htm.

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