Enriching learning activities with epistemic practices – enhancing students' agency and epistemic authority

Inger Eriksson & Viveca Lindberg

In this chapter, we explore how the characteristics of epistemic practices, a concept introduced by Karin Knorr Cetina (1999, 2001, 2005, 2007), as used in educational settings could be challenging and/or enriching learning activity, a concept developed within the cultural historical activity theoretical (CHAT) tradition (Davydov, 2008; Repkin, 2003). We firstly outline the core aspects of Knorr Cetina's concept in brief, as a point of departure. Secondly, we review how the concept epistemic practice has been used in educational contexts, (predominantly science education), and thirdly we present basic principles of as well as criticism against learning activity. In the final part of the chapter, we suggest some complements to learning activity, based on the review of epistemic practices in educational settings, in order to address the criticism directed toward learning activity.

Epistemic practices are considered to be included in epistemic cultures, "the cultures of knowledge settings" (Knorr Cetina, 2005, p. 65), which are linked to and form the basis of a broader contemporary concept, the knowledge society. Epistemic practices as a concept are primarily related to knowledge as the frame of meaning within which people "enact their lives" (Knorr Cetina, 2007:364). Knowledge is thereby present in what people do, how they do it, what they do, what tools they use and how they communicate in and about their doing, that is, knowledge is built into activities. Knowledge is thus constituted in people's actions. Secondly, Knorr Cetina distinguishes between epistemic and habitual practices. Epistemic practices are mainly characterized by knowledge production and learning, whereas habitual practices are characterized by routine (doing and tradition).[1] In epistemic practices, the object(s) that the researchers work with are not only static objects in the world (facts, concepts, models, things), epistemic objects are treated as incomplete – they are "open, question-generating and complex" (Knorr Cetina 2001:190). Another way of expressing this is to distin-

[1] This dichotomy may give the impression of a hierarchy. However, the concept *habitual* refers to aspects that makes it possible to distinguish a practice as a practice, that is, recurring patterns of actions etc., in Knorr Cetina's words: "Current conceptions of practice emphasize the habitual and rule-governed features of practice" (2001:175).

guish between types of relationships to objects: in everyday notions of objects, we tend to take them for granted and their meaning as self-evident. When an object becomes an epistemic object, the relationship to the object is what changes. A conclusion from Knorr Cetina's concepts is that a change in the relation to an object results in a change in actions, and, as a consequence, these changes in actions make all the difference between habitual and epistemic practices.

As Knorr Cetina's empirical work is related to research and our interest in this chapter relates to teaching/learning, we have reviewed internationally published research in order to explore how the concept epistemic practice has been used in educational settings in relation to teaching in compulsory school. A common understanding of school is that it is a place where knowledge is reproduced, that the production of knowledge takes place somewhere else but not in school. With such an understanding of education, activities in school would, according to Knorr Cetina's categories, be labelled as habitual practices. However, Eva Forsberg (2010: 205 *our translation*) remarks that

> With the knowledge society, educational issues and phenomena have come to the fore. Society is permeated by expectations imposed on its citizens, professionals, experts and researchers to actively participate in the development, appropriation and use of knowledge in all sectors and all activities.

This calls for approaches to education that challenge traditional ways of understanding teaching. Ingrid Carlgren (2015) is one of the representatives for such approaches, relating – among others – to Knorr Cetina's work. She suggests teachers' work to be regarded as an epistemic work: "Knowledge is the teacher's raw material (that is to be transformed to content of teaching) as well as the result of this work (students' knowing)" (p. 16 *our translation).*

According to Kelly, Crawford and Green (2001:137), "epistemic activities as such are central to education". In the following, we begin by mapping the work related to epistemic practices/activities by educational researchers in order to explore how epistemic practices have been characterized in the educational context. In the following section of the chapter, we turn to the cultural historical research that developed the concept of learning activity (Davydov, 2008; Repkin, 2003), a concept we found to be close to that of epistemic practices. After describing the characteristics of learning activity, we compare the two concepts focusing on possible similarities, complementarities and contradictions.

Epistemic practices in teaching

Epistemic practice as a concept is less common in relation to research related to school students, however those who do use it relate it to the school subject of science. Through a series of searches in the database ProQuest Social Sciences[2], we identified four researchers who fulfilled the criterion for inclusion that we had defined, i.e. that the concept epistemic practice was addressed in the article and not only mentioned. All four researchers, whether writing alone or with colleagues, addressed epistemic practices in relation to science education. The researchers we identified were (in alphabetical order) Mark Enfield, Gregory Kelly, William A. Sandoval, and David Stroupe. We searched further in the databases using their names as authors. Of these, Kelly and Stroupe specifically relate to Karen Knorr Cetina's work and the concept of epistemic practice where the object is constitutive for the practice.

From the work of Gregory Kelly and his colleagues, we have chosen two articles, which emphasize important aspects of science education in relation to epistemic practice. The first article discusses aspects of interaction that must be fulfilled in order for teaching to qualify as epistemic practice (Kelly, Crawford & Green, 2001):

- the significance of interaction in scientific practice, that is, the actors display "what members of a particular community interactionally acknowledge as experiments, texts, objects, valid interpretations, and theoretical frameworks, among other cultural elements" (p. 137), which in turn contributes to a more nuanced picture of epistemic activities.
- the need for interaction in science teaching and its significance for students' learning particular ways of talking science. Teachers can also contribute to mediating different ways (more or less valid for the science community) of talking science, depending on whether the students see themselves as future scientists or school students.
- the necessity of students' agency, that is, their interaction in classrooms, and "the ways that students interpret and discriminate the multiple voices of science heard in science settings" (p. 138).

In all three kinds of interaction, "facts are constructed; membership is inscribed; social relationships are established and challenged; a way of talking is established; and discourse practices are developed and displayed" (ibid, p. 138). Based on Kelly et al., a conclusion is that whether the focus in interaction is related to science research or science classrooms, they both con-

[2] The first search was made in 2013 and the final one in June 2015. The keywords used were: (epistemic practice) in combination with school. Most of the hits were related to epistemic without connection to practice. The keyword school also resulted in articles related to higher education such as School of Medicine.

tribute to establishing cultural practices. Further, whether or not the interaction is part of an epistemic practice or not is not necessarily a question of research or school, but rather the type of activity, where interaction is constitutive, that is established.

In a later article, Kelly (2008) discusses four research directions related to research on the discursive practices of science teaching. These are: access and equity to science, the practical epistemologies of everyday school science, activity theory and learning and multiple literacies. He emphasizes that studies within each of these perspectives have contributed to the understanding of the aspects of what constitutes social practices, e.g. how these support or limit (groups of) students' participation, that "[t]he instantiation of epistemic practices in schools relies on interpretation of scientific knowledge and practices by social and symbolic mediators whose views may vary from those of both their students as well as scientist" (ibid. p. 334). Further, activity theory is regarded a future research approach in (science) learning as such approaches "consider social epistemology, language, and participation as prominent theoretical constructs for the interpretation of potential learning events" (Kelly, 2008:335). These two – the dialogic perspective on meaning making and the teacher's contribution as a mediator of meaning through introduction, framing, shaping and evaluating dialogue – are regarded as central if students are to become increasingly more competent participators.

In his article, Stroupe (2014) frames "classrooms as a science practice community" (p. 489) in focusing power and epistemic agency in relation "to learning science-as-practice" (p. 489). However, he finds that conservative forms of teaching do not qualify as such classrooms, whereas what he calls ambitious teaching provides opportunities for students to learn science-as-practice. In these classrooms, teaching is characterized by four dimensions that newcomers learn in context: a conceptual, a social, an epistemic and a material dimension. According to Stroupe, teachers that enact ambitious teaching "in which students learn science-as-practice, help reframe students' roles from knowledge recipients to epistemic agents—individuals or groups who take, or are granted, responsibility for shaping the disciplinary knowledge and practice of a community" (p. 492 italics in original text). One aspect of the dimensions that Stroupe finds crucial for ambitious teaching is the negotiation between participators about what knowledge counts or, in other words that what he calls cognitive authority, is a question of negotiation where individuals' experiences can influence practice over time. The main focus in Stroupe's study is the agency made available to students in classrooms characterized by ambitious teaching. For this, Stroupe analysed classroom communication in relation to two aspects: firstly, who knows, that is whether the discussions were private or collective; and secondly, who in the classrooms had cognitive authority, that is whose arguments qualified as knowledge. Stroupe also found that in classrooms characterized by ambitious teaching, teachers involved students in negotiations where their argu-

ments were given cognitive authority. In conservative classrooms, cognitive authority was related to teachers only. He also found that in classrooms, where teachers created what he calls a public practice with their students, "teachers and students together engaged in the conceptual, epistemic, social, and material aspects of science work. Over time, the classroom community advanced their collective understanding of science" (p. 507). In classrooms characterized by what Stroupe calls private discussions, the communication between teacher and student is conceived of as individual and thereby nothing that other students needed to engage in.

Sandoval and his colleagues seem to have their basis in the tradition of conceptual change and elaborate their studies based on design experiments. They distinguish between epistemic understanding and epistemic practice. Epistemic understanding refers to a set of ideas that students should "understand and be able to appropriate as they engage in or think about science" (Sandoval, Bell, Coleman, Enyedy & Suthers, 2000:3), whereas epistemic practices are defined as the cognitive and discursive activities students are expected to "engage in to develop their epistemic understanding" (ibid., p. 2). An epistemic practice in the view of Sandoval et al. is characterized by: explicit articulation and evaluation of the individual's knowledge; coordination of theory and evidence; making sense of patterns of data; developing representational fluency and holding claims accountable to evidence and criteria. The character of epistemic understanding is described as a set of goals for students' learning:

- seeing knowledge as an object of inquiry;
- understanding various forms of scientific knowledge;
- understanding the reciprocal nature of theory and data and understanding representations within interpretive frameworks; and
- understanding criteria for evaluation of knowledge claims.

Such goals challenge contemporary teaching practices. Sandoval et al. suggest the following design principles for teachers, as guidance for enhancing this type of (scientific) learning:

- provide epistemic forms[3] for students' expression of their thinking;
- give distinct forms of knowledge distinct representations;
- design representations that can be coordinated and linked;
- representations should prompt and support epistemic (not just conceptual) practices and communicate evaluation criteria and connect them to representations.

[3] Examples of what Sandoval means by forms of knowledge can be found in an article from 2005 "Besides theories, laws, and hypotheses, models are an important form of scientific knowledge. There are also rhetorical forms, such as explanations, predictions, and arguments that rely on these other epistemological forms to advance specific claims" (p. 641).

Obvious in these suggested design principles, is that the only one one-to-one connection to goals for students' learning relates to evaluation criteria. Typical for the other suggestions is that *form* seems to relate to *practice*. Furthermore, Sandoval and his colleagues (Kawasaki, DeLiema & Sandoval, 2014) emphasize the necessity of acknowledging that the social contexts students engage in may be both epistemic in terms of school science, and non-epistemic (e.g. media and home). This movement is regarded a constraint as resources such as tools and material are influenced by demands and rules, as well as social relations from a variety of epistemic as well as non-epistemic settings between context. Still, Sandoval and his colleagues in their work (Ryu & Sandoval, 2012; Sandoval, Sodian, Koerber & Wong, 2014) appear to make clear distinctions between science as epistemic practice and the kind of practices made available for students in schools:

> assertions that children are little scientists or that science is the refinement of everyday thinking notwithstanding, thinking as a scientist and thinking scientifically are not the same thing. /…/ The metaphor of the child as scientist acknowledges that the seeds of scientific reasoning lie in what appear to be fundamental human capacities for cognition but obscures two very different aspects of the social nature of scientific thinking. First, scientists do their thinking within highly developed communities designed for the purpose, including well-developed social infrastructures, technological machinery, and expertise. To call this sociotechnical infrastructure a refinement of everyday thinking grossly underestimates its role and value in the production of scientific knowledge and could hardly explain the success of science as a cultural institution (Sandoval, et al. 2014:140).

Enfield, Smith and Grueber (2008) use the concept of epistemic practices for referring to the kind of thinking and reasoning about phenomena that reflect the socially shared practices of science. Further, scientific or investigative (epistemic) work is characterized by its motives concerned with "finding connections among experiences, patterns, and models or theories" (ibid, p. 612 – italics in original). One point of departure in their work is that traditional science teaching seems to provide students with experiences of "science as separate facts, definitions, sequences, and diagrams", whereas "scientists make sense of the world by finding connections among experiences, patterns, and models or theories" (p. 612). Experiences are defined as "individuals' interactions with the systems and phenomena of the world that scientists call observations or data" (p. 612). Their article focuses on elementary science curricular material developed for enhancing science teaching and learning that is having an impact on teachers' enactment as well as students' experiences. It is worth noting that the understanding of epistemic practice that Enfield, Smith and Grueber (2008) present is related to specific actions. Thus, the concept is used in plural "a set of epistemic practices", where "Asking questions represents an epistemic practice consistent with the

formal epistemology of science" (p. 612). In Knorr Cetina's work, asking questions would rather be actions related to a practice, but not a practice in itself. Like Sandoval, the basic assumptions in Enfield et al. are related to conceptual change, however here specified as socially constructed conceptual change.

Summarizing, one important aspect of the characteristics for (science) education in school that has been related to the concept of epistemic practice is the emphasis on students' agency and authority over what counts as knowledge in the (science) classroom. In other words, when students become involved in scientific work, be it experimental or argumentative, their agency is part of the classroom practice, as it would be in a professional context. So even though school science has a reproductive responsibility, this responsibility is not limited to content in its narrow meaning. Instead, the forms of scientific knowledge production are also a significant part of the curriculum when epistemic practices are aspired to. In a way, part of the research related to epistemic practices in school settings has mapped the characteristics of the habitual practice that serves as a model, but also the differences as compared to traditional habitual (science) teaching practices (Knorr Cetina, 2001). As compared to how Knorr Cetina has used the concept, we can see that while her main emphasis is on the object and its characteristics (incomplete, relational, and negotiable), this is an issue that has received less attention in articles relating to epistemic practices in science education. On the other hand, in Knorr Cetina's work there is less emphasis on agency – perhaps as research settings assume equal agency for all participants.

Learning activity – a CHAT approach

The texts analysed above show an explicit interest in epistemic practices in (science) teaching. We will now proceed to learning activity that has its historical roots in the tradition of cultural historical activity theory (CHAT) – based on, among others, Vygotsky (1934/1986) and Leont′ev (1975/1978).

The concept learning activity can be regarded as a didactical concept within the CHAT tradition.[4] The concept was primarly developed by the Russian researchers Daniil Elkonin and Vasily Davydov at the Psychological Institute of Russian Academy of Education. The researchers collaborated with teachers in School No 91 in Moscow. Elkonin and Davydov conceptualized and expanded Vygotsky's theoretical work into a mathematical programme – often called the Davydov Programme (or Curriculum) that is framed by the tradition of developmental teaching that conceptualizes both

[4] We use the concept *didactic* as a theoretical approach to issues related to teaching/learning practices and curriculum theories related to epistemic practices.

the curriculum and the didactical principles of teaching/learning activity (*Obuchenie* in Russian) (Schmittau, 2004, 2005). A key feature of learning activity is to make it possible for students to, in collaboration with other students and teachers, participate with agency in a content-rich learning environment where historically-developed knowledge can be reconstructed (Chaiklin, 2002; Davydov, 2008; Repkin, 2003; Rubtsov, 2013).

Learning activity is thus regarded as a special form of activity. However, learning activity cannot, in any simple manner, be compared to the different types of activities that are commonly the focus of activity theory, e.g. work activity (Repkin, 2003). In an activity theoretical perspective, an activity is motive-driven, object-related and tool-mediated. The object relatedness demands and activates goal-directed actions that are operatively sign and tool conditioned (Leont′ev, 1975/1978). In order to separate one activity from another, Leont′ev argued that the dominating motive and the related object need to be discerned. It is by the motive-infused object (object/motive) that one activity can be separated from another, even if the actions and tools used are seemingly similar. If the object/motive changes or is replaced, the activity also changes or is replaced by a new one. Being part of an activity ideally requires that the individual appropriates the dominating object/motive. In contemporary activities there is seldom only one object/motive – most activities are multi motive-driven and thus are also realized through combinations of objects/motives that may create tensions and contradictions in the on going activity. When a learning activity is in focus, the issue of object/motive is even more complicated. In a culturally and historically developed work activity, the object/motive is always connected with production in some way (Engeström, 1987). In an educational setting however, students are seldom invited into a full, on going, productive work activity where artefacts, services or knowledge are produced. Students are not expected to appropriate (or develop) the motive of the productive work activity represented in education but rather to develop a motive for learning, where the object/motive is always subject-specific knowledge developed in other settings. What distinguishes a productive work activity from a learning activity is thus the object/motive. In a learning activity there may be a product as a result (an essay from language lessons, a wooden bowl from sloyd, a solution or a formula from mathematics etc.), as there would be in a work activity. But even if the product could be the same, the objects are different: in a learning activity the object/motive has to be learning something still unknown from the students' perspective and the students are to be viewed as agents in the process of knowledge (re)production. From a learning activity perspective, it is only by developing their object/motive for learning that the students can put their efforts into, what from a production perspective could be seemingly unimportant, details or aspects (cf Davydov, 2008/1986).

Thus, students need to develop an object/motive for learning where the result can be described as a transformation of their actual knowing to a

knowing that is more complex and specified but also broader and theoretically more advanced. However, from an activity theoretical perspective it is not possible to develop an object/motive if it is disconnected from a personally experienced need or a want. Even if students come to school with an idea of learning, such a general motive will not give their actions any direction. Consequently creating an educational setting, a specially designed learning task, in which students can experience or develop a need (often by using problems that provoke or intrigue them) for new and specific knowledge is therefore an extremely qualified task for teachers. A learning activity can be planned for, but there are no guarantees it will occur – it occurs only if the students experience or develop a need and a motive to establish and participate in an activity.

Mathematics teaching – an example of learning activity

In many Swedish schools, mathematics teachers are concerned with students' lack of motivation and put much effort into choosing math tasks that relate to students' everyday experiences and interests. The mathematical content is, so to say, contextualized in topics that students are assumed to find interesting, fun or familiar. Thereby the same mathematical exercises can be contextualized differently: into motors or nutrition (Murphy, 2008, 1995).[5] Motivation is often believed to be enhanced through the framing of the task in relation to students' everyday interests. Taking a learning activity perspective, this type of motive is not regarded as a true motive and will not enable students to establish a learning activity.

Thus, central to a learning activity is choosing a problem that is complex (with embedded contradictions and tensions) as well as culturally and historically relevant. Problems that contain the knowledge the students need to develop. One of the examples Davydov (2008/1986) has used in constructing the programme concerns the historically developed societal need for measuring and the corresponding tools for measurement. In a learning activity the teacher usually proposes the problem in a direct or indirect manner: "How can we compare two volumes in different containers if they are in different cities?" The teacher cannot merely present the problem and tell the students to try to solve it. In order for the students to establish a learning activity, they need to develop an object/motive, a want as a source for identifying a goal that in a first step will require them to transform the problem into a learning task and thereafter to search for tools and strategies that can help them to

[5] Differences in task performance in mathematical tests were taken as a point of departure for an interview study where children where asked to comment on tasks where gender differences were statistically significant. The study showed, among other things, that differences in performance were either related to different experiences, in which case the *context* of a mathematic problem created gender differences in performance, not the *mathematical content*.

solve the problem in joint actions (Davydov, 1986/2008; Rubtsov, 1989, 2013; Zuckerman, 2004). The problem must therefore appeal to the students as meaningful. Further, each problem needs to be shaped so that the students discern that the tools and solutions they are familiar with are restricted. When working with the learning task, the students need to analyse the problem from different perspectives in order to identify what they already know – often by testing previously developed methods and tools. Thus, if the students collectively find the problem relevant or intriguing, they will try to seek alternative tools and procedures, or as Repkin (2003:27) puts it "a problem in the sense that the available modes of actions are unsuitable and there are no others. In other words, new modes of actions are needed." In this way, problems can create a situation that Vygotsky (1934/1963) refers to as giving students the opportunity to work in a zone of proximal development. When the problem is defined, they can start finding new ways to solve the problem. The final step in a learning activity is related to reflection and evaluation. In the process of reflection the students have to simultaneously identify their own and others goals and means and acknowledge other students' perspectives. Here the teacher is expected to encourage the students to argue for their solutions, initially without assessing them. Zuckerman (2004) elaborates the process of reflection by pointing out three aspects that highlight that reflection is not an individual endeavour. The students' need:

> (a) to consider the goals, motives, methods, and means of one's own and other people's actions and thoughts; the mental facet of this ability is sometimes called metacognition; (b) to take other people's point of view; view things from perspectives other than one's own; and (c) to understand oneself; study one's own strong points and limitations in order to find the ways to excel or to accept one's shortcomings. Introspection is one part of this remarkable human faculty; the power for self-changing and transcending one's limitations is another component of the human ability for reflection. (Ibid. 2004:10)

The discussion will not end until the students have reached a conclusion they find correct or functional (Zuckerman, 2004). The result of this type of work is the students' development of theoretical generalizations based on their actions (Davydov, 1986/2008; Kinnard & Kozulin, 2008; Schmittau, 2004, 2005; Sophian, 2007; Zuckerman, 2005, 2011).

The tradition developed by Davydov and those building on his work strongly emphasize the development of a curriculum that secures that students (re-)develop the theoretical tool, or the sign-mediated thinking that is characteristic for a specific subject. Therefore, clearly identified, and historically developed subject domains for these specific programmes have been analysed, designed, tested, and revised over time.

Learning activity is thus developed to enhance students' theoretical thinking. Theoretical thinking is to be understood in relation to empirical think-

ing, where empirical thinking is a result of everyday experiences and concrete operations while theoretical thinking in a Vygotskian perspective requires that 'core principles' or 'conceptual relations' constituting a specific knowing or phenomenon are discerned and understood through learning actions in a content-rich practice (Chaiklin 2002; Davydov 1986/2008; Schmittau 2004). If the students can find a specific core principle of a concept and its conceptual relations – a symbol, a model or a tool – then they can exemplify and find concrete instances of the theoretical knowledge embedded in culturally diverse, tool-mediated activities. This process is described as ascending from the abstract to the concrete (Davydov 1986/2008).

Learning activity and its criticism

However, the Davydov tradition has also been criticized within the CHAT tradition. Eugene Matusov (2001) criticizes the authoritative aspects of Davydov's programme related to *who* it is that defines, and *what* is defined as, knowledge.[6] Referring to perspectives of situated cognition, multicultural and feminist theories, Matusov (2001:235) argues that Davydov's programme is to be regarded as "modernist, scientist (i.e. privileging scientific knowledge over all over types of knowledge)". Another aspect that Matusov criticizes is the dialectics, which is an important cornerstone of Davydov's theory. He says, "It is a very sophisticated but still monological approach. It tries to reduce messy networks of hybrids of artefacts, practices and communities (Latour 1987) to one essential contradiction" (ibid. 2001:235). Matusov argues that the way Davydov's theory is developed means it will result in a democracy deficit, as the knowing which students are expected to develop is predetermined. Student agency has thereby not, according to Matusov, been considered in Davydov's theory.

In order to better understand Matusov's criticism we need to look at the work Matusov and his colleagues (Matusov, von Dyuke & Han, 2012) have been doing in relation to the concept of ontological *communities of learners* (CoL). In the perspective of ontological CoL, a learning activity has to be developed as situated, problem-related and collective. In an educational situation the teacher cannot (as is the case in traditional education and in non-ontological CoL) take the position as the only knowledgeable person and

[6] When developing the theory and methodology of expansive learning, Engeström (1991) to a large extent used Davydov's learning activity. According to Engeström and Sannino (2010:5), Davydov's concept of learning activity is developed further In the theory of expansive learning in order "to deal with the challenges of learning outside the school and the classroom". Engeström's and Sannino's (2010:7) interpretation of Davydov's theory is to a high degree in line with Matusov's when saying it is "oriented at learning activity within the confines of a classroom where the curricular contents are determined ahead of time by more knowledgeable adults". Expansive learning is oriented towards a new and expanded activity where what to learn is not possible to decide upon in advance.

thus position students as learners. With references to Bakhtin, Matusov advocates for an ontological CoL where learning activity is polyphonic and "in which all participants are actively involved in developing emergent endpoints as a result of dialogic learning" (Matusov, et al. 2012). There has to be a possible mutual space for surprise and curiosity. The goal for ontological CoL teaching

> is not to "produce knowledge" (McAuley, 2001), to "achieve a collective consensus" (Coleman, Rivkin, & Brown, 1997), or to build up "a shared understanding" (Varelas et al., 1999), but rather to help the students to develop their own voices. (Matusov, et al. 2012:58)

Learning activity as epistemic practice

Following Knorr Cetina's definition of epistemic practices as practices where knowledge production is the main object, Matusov's criticism of the Davydov programme is worth considering. Ontological CoL, as described by Matusov, von Dyuke, and Han (2012), are perhaps more in line with Knorr Cetina's concept of epistemic practices since neither the teacher nor the students can, in advance, decide what learning, in a narrow sense, should be accomplished. The object is thus both shaped and worked on by both students and the teacher in a collaboration characterised by equity and mutual agency. Designing a learning activity that realizes a polyphonic ontological CoL may address many of today's educational issues related to how to prepare students for a diverse and complex knowledge society (Apple, 2012). However, this may also result in a practice where the cultural heritage (epistemic cultures) represented by different school subjects will not become available to all students. Students that are not fully enculturated into different societal subject-specific practices (as science or mathematics) can be deprived of the ability to participate in practices that are of societal value. From our point of view this may also result in a democracy deficit but of a different kind to the one Matusov acknowledged. Further, Matusov's argument that student agency has not been considered by Davydov can also be discussed. Their agency to decide the overarching goals are restricted but their agency in relation to the constitution of the learning activity is, to a greater extent, required.

The Davydov Programme – student agency – epistemic practice

In a programme such as that of Davydov the teacher knows what to accomplish – what type of knowledge the students have to develop, whereas this knowing is new to the students. In this way the classroom practice can be interpreted as epistemic for the students. That is, from the students' perspective the knowledge (re)production they are involved in can be understood as knowledge production. This practice provokes genuine problems for the students and if an object/motive is developed in the group, the students may have the opportunity to act with agency to establish a learning activity in order to solve the problem. For the teachers, however, the teaching practice, in relation to the content or topic covered in some aspects can be described as neither uncertain nor provoking. But this does not necessarily mean that teachers following Davydov's Programme act within a habitual practice. Since a learning activity never can be planned in detail, the teacher is dependent on the students' responses for decisions on how to proceed. Such decisions are based on the situated analysis of students' various responses – an analysis that has to take into account both individual learning trajectories and the learning trajectory of the entire class. Students' responses cannot be fully anticipated so the object for teachers is to establish and further enable students' learning activity. That is, both students and the teacher must work together in order to realize a sustainable learning activity – or, in Carlgrens (2015:16, *our translation*) words: "In collaboration with each group of students the teacher (re)discovers and (re)creates the epistemic achievements of humanity". Thus we argue that learning activity can be regarded or developed as a school-based epistemic practice that enables students to become knowledgeable agents in culturally developed epistemic cultures.

Concluding remarks

While learning activity has a tradition that goes back to the 1950s but still not widely spread outside Russia, research related to epistemic practice is an emerging field of interest in teaching, and so far only used in science education. We found that both seem to address similar kinds of issues regarding teaching/learning.

Both address the situated nature of knowledge and knowing and thereby also what qualifies as knowing, and a teaching that strives to establish epistemic practices that can become meaningful for students. Both are dependent on descriptions of the habitual – the recurring characteristic patterns of situated knowledge production – in order to establish a classroom practice with the potential of expanding student learning from working with facts and procedures to producing knowledge.

A primary difference identified between research related to epistemic practices in education and learning activity research is that the latter aim at challenging and developing the students' object/motive in order to enable them to establish and participate in a content-specific learning activity, while those working with epistemic practices have focused the practice of science and what it can offer as didactic principles.

We have identified tensions both within research related to epistemic practices and between research related to epistemic practices and learning activity. Firstly, among researchers that have elaborated on the concept epistemic practices in education we found two different uses of practice. Sandoval and Enfield and their respective colleagues use the concept epistemic practices as referring to that which in a CHAT-percspective rather would be seen as action. Secondly, concerning learning activity within the CHAT-tradition, the tensions concern teacher's authority in relation to what is known and the (re-)construction of knowledge versus students' voices and agency. Thirdly, the concept of epistemic practices origins from research, where knowledge production is the object of the activity, whereas learning activity relates to school – mostly related with the re-production of knowledge produced elsewhere. However, research is not an epistemic practice in every aspect, everyday scientific work also has habitual aspects. Similarly, teaching/learning does not necessarily have to be predominantly habitual. Epistemic teaching practices, as an overarching concept, has the possibility to capture some specific elements and embrace different teaching traditions that all try to break with a tradition where the teacher has the "cognitive authority" as described by Stroupe (2014). The way Kelly and Stroupe use epistemic practices, highlights aspects such as students' (epistemic) agency, negotiation, multiple voices, interaction or communication (valid for the science community) and correspond to several of the aspects that Matusov has used to describe an ontological CoL. Taking Matusov's criticism seriously it is obvious that learning activity does not have a very well developed conceptual framework concerning student epistemic agency and could definitely benefit from having one. With the help of epistemic practice, the principle of learning activity could be elaborated and more in line with todays' knowledge society, embracing multi-voiced democratic ideas.

If developing education (or schooling) into subject-specific epistemic practices is considered interesting enough to pursue, the tasks used for teaching/learning could be tooled in such a way that they open up for new types of actions and interaction. This demands that teaching/learning take into account the historically developed cultural tools for creating an epistemic learning activity as a means for knowledge production and thereby transform both teaching and learning (cf. Stetsenko & Arievitch, 2002). This challenge is well in line with what Forsberg spells out as potentials for a Utopia Pedagogicum that "carries an embryo for a possibly better future" (2010: 206, *our translation*).

References

Apple, M. W. (2012). *Knowledge, power, and education: the selected works of Michael W. Apple*. New York, NY: Routledge.

Carlgren, I. (2015). Kunskapskulturer och undervisningspraktiker. Göteborg: Daidalos.

Chaiklin, S. (2002). A developmental teaching approach to schooling. In G. Wells & G. Claxton, (Eds.). *Learning for life in the 21st century*. Oxford, UK, Blackwell Publishers

Davydov, V. V. (2008). *Problems of developmental instruction: a theoretical and experimental psychological study*. New York: Nova Science Publishers, Inc. (Original work published 1986)

Dewey, J. & Bentley, A. F. (1960). *Knowing and the known*. Boston: Beacon Press.

Enfield, M., Smith, E. L. & Grueber, D. J. (2008). "A sketch is like a sentence": Curriculum structures that support teaching epistemic practices of science. *Science Education, 92*(4), 608–630.

Engeström, Y. (1999). Innovative learning in work teams: Analyzing cycles of knowledge creation in practice. Y. Engeström, R. Miettinen., & R-L. Punamäki (Eds.). *Perspectives on Activity Theory*. Cambridge University Press.

Engeström, Y. & Sannino, A. L. (2010). Studies of expansive learning: foundations, findings and future challenges. *Educational Research Review, 5*(1), 1-24.

Forsberg, E. (2010). Kunskapssamhället och Utopia Pedagogicum. In I. Eriksson, V. Lindberg & E. Österlind (Eds.), *Uppdrag undervisning – kunskap och lärande* (195-201). Lund: Studentlitteratur.

Kawasaki, J. N., DeLiema, D. J. & Sandoval, W. A. (2014). The influence of non-epistemic features of settings on epistemic cognition. *Canadian Journal of Science, Mathematics and Technology Education, 14*(2), 207-221.

Kelly, G. J. (2008). Learning science: Discursive practices. In M. Martin-Jones, A. M. de Mejia & N. H. Hornberger (Eds.), *Encyclopedia of Language and Education, 2nd Edition. Volume 3: Discourse and Education* (329-340). Springer Science & Business Media LLC.

Kelly, G. Crawford, T. & Green. J. (2001). Common Task and Uncommon Knowledge: Dissenting Voices in the Discursive Construction of Physics Across Small Laboratory Groups. *Linguistics and Education, 12*(2), 135–174.

Kinard, J. T. & Kozulin, A. (2008). *Rigorous mathematical thinking: conceptual formation in the mathematics classroom*. Cambridge University Press.

Knorr Cetina, K. (2007). Culture in Global Knowledge Societies: Knowledge Cultures and Epistemic Cultures. *Interdisciplinary Science Reviews, 32*(4):361-375.

Knorr Cetina, K. (2005). Knowledge cultures. In M. Jacobs & N. Weiss Hanrahan (Eds.), *The Blackwell Companion to the sociology of culture*. Oxford: Blackwell Publ.

Knorr Cetina, K. (2001). Objectual practice. In T. R. Schatzki, K. Knorr Cetina & E. von Savigny (Eds.), *The practice turn in contemporary theory* (175-188). New York: Routledge.

Knorr Cetina, K. (1999). *Epistemic cultures: how the sciences make knowledge*. Cambridge, MA: Harvard University Press.

Leont′ev, A. N. (1978). *Activity, consciousness, and personality*. Englewood Cliffs, NJ: Prentice-Hall. (Original work published 1975)

Matusov, E. (2001). The theory of developmental learning activity in education: Dialectics of the learning content, *Culture Psychology, 7*(2) 231-240.

Matusov, E., von Dyuke, K. & Han, S. (2012). Community of Learners: Ontological and non-ontological projects. *Outlines – Critical Practice Studies, 14*(1), 41-72.

Murphy, P.F. (2008): Gender and subject cultures in practice. In K. Hall & P.F. Murphy (Eds.), *Learning and Practice: Agency and Identities* (161-172). London, Thousand Oakes, CA & New Delhi: Sage Publication & Open University Press.
Murphy, P. (1995). Sources of inequity: understanding students' responses to assessment. *Assessment in Education: Principles, Policy & Practice, 2*(3), 249-270.
Repkin, V. (2003). Developmental teaching and learning activity. *Journal of Russian and East European Psychology*, 41(5), 10-33.
Rubtsov, V. (2013). *The concept of joint activity as a unit of activity theory*. Lecture at the ISCAR summer school, Rome, Italy.
Rubtsov, V. V. (1989). Organization of joint actions as a factor of child psychological development. *International Journal of Educational Research, 13*(6) 623-636.
Ruy, S. & Sandoval, W. A. (2012). Improvements to Elementary Children's Epistemic Understanding From Sustained Argumentation. *Science Education, 96*(3), 488–526.
Sandoval, W. A. (2005). Understanding students' practical epistemologies and their influence on learning through inquiry. *Science Education, 89*(4), 634-656.
Sandoval, W. A., Sodian, B., Koerber, S. & Wong, J. (2014). Developing Children's Early Competencies to Engage With Science. *Educational Psychologist, 49*(2), 139-152.
Sandoval W. A., Bell, P., Coleman, E., Enyedy, N. & Suthers, D. (2000). *Designing knowledge representations for learning epistemic practices of science*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, April 25, 2000.
Schmittau, J. (2004). Vygotskian theory and mathematics education: Resolving the conceptual-procedural dichotomy. *European Journal of Psychology of Education, XIX*(I), 19-43.
Schmittau, J. (2005). The development of algebraic thinking. A Vygotskian perspective. *ZDM, 37*(1), 16-22.
Sophian, C. (2007). *The origins of mathematical knowledge in childhood*. Lawrence Erlbaum Associates.
Stetsenko, A. & Arievitch, I. (2002). Teaching, Learning, and Development: A Post-Vygotskian Perspective. In G. Wells & G. Claxton (Eds.). *Learning for Life in the 21st Century: Sociocultural Perspectives on the Future of Education* (84-96). Oxford, UK: Blackwell Publishers Ltd.
Stroupe, D. (2014). Examining classroom science practice communities: How teachers and students negotiate epistemic agency and learn science-as-practice. *Science Education, 98*(3), 487–516.
Vygotskij, L. S. (1986). *Thought and language*. ([Rev. ed.]). Cambridge, Mass.: MIT Press. (Original work published 1934)
Vygotskij, L. S. (1963). Learning and mental development at school age. In B & J Simon (Eds.) *Educational psychology in the U.S.S.R.* London: Rutledge & Kegan Paul. (Original work published 1934)
Zuckerman, G. (2011). Developmental education. A genetic modeling experiment. *Journal of Russian and East European Psychology, 4*(6), 45–63.
Zuckerman, G. (2005). *Learning Task as a Growth Point of the Search Activity*. (Utchebnaya zadacha kak tochka rosta poiskovoy activnosty). Moscow: Academia.
Zuckerman, G. (2004). Development of reflection through learning activity. *European Journal of Psychology of Education, XIX*(1), 9-18.