Artefacts Mediating Practices across Time and Space: Sociocultural Studies of Material Conditions for Learning and Remembering

Kai Hakkarainen, University of Helsinki, kai.hakkarainen@utu.fi
Beatrice Ligorio, University of Bari, bealigorio@hotmail.com
Giuseppe Ritella, University of Helsinki, gritella@gmail.com

Hans Christian Arnseth, University of Oslo, h.c.arnseth@iped.uio.no
Alfredo Jornet Gil, University of Oslo, a.j.gil@intermedia.uio.no
Ingeborg Krange, University of Oslo, i.h.krange@iped.uio.no

Géraldine Fauville, University of Gothenburg, geraldine.fauville@loven.gu.se
Annika Lantz-Andersson, University of Gothenburg, annika.lantz-andersson@ped.gu.se
Roger Säljö, University of Gothenburg, roger.saljo@ped.gu.se

Mona Lundin, University of Gothenburg, mona.lundin@ped.gu.se
Åsa Mäkitalo, University of Gothenburg, asa.makitalo@ped.gu.se

Erno Lehtinen (discussant), University of Turku, erno.lehtinen@utu.fi

Abstract: The theme of this symposium is to explore the material conditions of learning and remembering from a sociocultural perspective. We do this in four different empirical contexts. Learning and remembering are understood as meaning-making processes that are dependent on and co-constituted by mediating tools that enable practices to extend across time and space. Our interests are precisely in what ways the "tools" people employ in these studies mediate activities of learning and remembering, and how they contribute to the organization of collective forms of knowing. We also address how we analyze the specific material features of tools that co-determine the unfolding of the activities.

Overall focus and issues addressed

The overall focus of this symposium is to explore the material conditions of learning and remembering from a sociocultural perspective. It is nowadays not uncommon to think of learning and remembering in terms of socio-materially entangled and distributed practices, but this idea, in fact, has been around for quite some time. The basic notion in sociocultural studies of the material basis of learning and remembering is mediation, initially introduced by Vygotsky (1997). Vygotsky argued for situated studies of how humans interact with artefacts – technical as well as "psychological" – as they engage in activities and practices. To make his idea of mediation salient, he used an analogy and argued that psychological tools restructure the capacities of the human mind (i.e. learning, remembering, coordination of actions and perceptions) in ways that are similar to how "technical tools" transform physical activities. This is the essence of the idea of tool-mediated action.

The inclusion of a tool in the behavioral process, thus, reorganizes what Vygotsky (1997, p. 87) refers to as the "instrumental act". First, it "sets to work a number of new functions connected with the use and control of the given tool; second, abolishes and makes unnecessary a number of natural processes, whose work is [now] done by the tool; third, it modifies the course and the various aspects (intensity, duration, order, etc.) of all mental processes included in the instrumental act, replacing some functions with others, i.e., it recreates, reconstructs the whole structure of behavior just like a technical tool recreates the entire system of labor operations." (Vygotsky, 1997, p. 87)

As many scholars have pointed out, the distinction between psychological and technical tools must be understood as an analogy, since in a sociocultural tradition the distinction between the material and the ideal/conceptual is not accepted. Cultural tools "are simultaneously ideal (conceptual) and material" as Cole argues (1996, p. 117).

Based on these ideas as a shared premise, this symposium will first present four empirical studies conducted in diverse settings. Then the contributors will discuss the situated processes of meaning-making that are salient in the activities studied, and they will explore how these are contingent on material and conceptual features of tools:

1. Precisely in what ways are the "tools" people employ in these studies mediating activities of learning, remembering, and how do they contribute to the organization of collective forms of knowing?
2. What are the specific material features inherent to those activities?

Collective contribution to the discussion of these issues

As a collective enterprise we will explore and discuss the different ways that the notion of mediation is relevant in our studies in order to make salient what could be referred to as the materiality of learning and remembering in situated activities. It should also be noted that mediating tools may extend or restrict people's participation, they may serve to support or challenge people's co-ordination and interaction, they may black-box certain processes people engage in, they may function as prosthetic devices that extend people's agency or as vehicles for entering into domains and practices that are entirely new.

Significance of each contribution

The contributions to this symposium accordingly share specific interests but they also differ with regard to empirical contexts and the kind of artefacts included in the activity. This will be fruitful for the discussion we wish to promote. In the first paper, by Ritella, Ligorio and Hakkarainen, design students' collaborative activity (as they engage in creating artefacts in their design project), and their meaning-making process are analyzed through the Bakhtinian concept of chronotope. A similar, and yet different, case is presented in the paper by Arnseth, Jornet and Krange. The study reported concerns student work on sustainable energy use in the context of science education. As the authors follow how students engage in meaning-making with discursive and non-discursive artefacts in multi-modal learning environments, they use the analytical notion of a functional system (John-Steiner, Meehan, & Mahn, 1998). The third contribution, by Fauville, Lantz-Andersson and Säljö, explores students' meaning-making as they engage with a mediating tool, a so-called carbon footprint calculator. This tool has been designed for people to conceptualize and understand the complexities of climate change, and, more specifically, the environmental consequences of their daily activities (travel, shopping, food intake etc.). Here the notion of psychological tool is drawn on to elaborate on the reflexive nature of engaging with personal behaviors through the lens of a powerful artifact. The final contribution, by Lundin and Mäkitalo, shares important elements of the third contribution with respect to how the self-generated data from people's everyday life are visualized to facilitate learning to manage one's own life situation. The tool in this case is used in hypertension care (a common but invisible condition). The study explores the tensions that this mediating tool creates in the clinical encounter as patients draw on their own documentation and experience to frame and understand their health status.

Building space-time frames and shared understanding in a media design task

Giuseppe Ritella, Beatrice Ligorio and Kai Hakkarainen

This study is aimed at investigating if and how the building of space-time frames is intertwined with the construction of a shared understanding of the task to be accomplished during a media design project course. The literature suggests that building a shared understanding of the task is crucial for CSCL (Dillenbourg *et al.*, 2010; Rochelle & Teasley, 1995). Moreover, design tasks are considered as ill-structured or wicked, which require additional interpretative efforts for the building of a shared understanding. Nevertheless, we argue that a comprehensive understanding of the relationship between two crucial processes is missing: (a) building a shared understanding of the task and (b) framing the context of learning in space and time. In particular, we analyze students' interaction when the link between negotiation of space-time relations (chronotope) and shared interpretation of the collaborative task is explicitly articulated in students' activity. By looking at such moments, we shed light on the collective interpretation of the task as a holistic sense-making process regarding what the task is about (including subtasks), and the space-time organization (chronotope) of the activity, as it is mediated by multiple artifacts created and updated by students throughout the course. We conducted participant observation at a media design course where students worked in groups of 4-5 to develop a project, held at Metropolia University of Applied Sciences in Helsinki. Students worked in teams of 4-5 participants to develop a project. Students had to build a product or a service based on a problem presented by a representative of a company, who acted as their customer. The course lasted 16 weeks and the students worked together for ten hours per week. Many technological tools such as smart-boards, tablets, and notebooks, were available for them. Groups were free to negotiate and select the tools they considered appropriate at the different stages of the course, which gave them a relatively high degree of autonomy in the management of the collaboration. In this

paper we will present the analysis of one group, composed by five students coming from different master programs. The principal method of data collection of this study was participant observation, involving also collection of audio and video records, which allowed documenting multi-level activity processes taking place while participants are engaged in technology-mediated learning (Goodwin, 2000). Six weeks were selected for participant observation: two weeks at the beginning of the course, two weeks in the middle and two weeks at end of the course. The rationale of this sampling was to follow the development of space-time management in the different phases of the course. Moreover, the collection of video records was complemented with screen records of computer-mediated activity whenever students used a smart board. Furthermore, we had access to most of the artifacts that students shared during the course. Artifacts and field notes were used as secondary data. The qualitative methods employed allowed triangulating various aspects of the emergent chronotopes and their development. The data analysis was organized in three steps:1) exploration of the data and preliminary interpretation; 2) selection and transcription of the data for in-depth qualitative analysis: we selected the clips in which (a) students were explicitly discussing their interpretation of the task; (2) the students were referring to space-time coordinates in their speech; (3) the students were taking decisions implicitly framing the task or the chronotope;3) qualitative video analysis of the 52 selected clips.

Finally, two stimulated recall group interviews were conducted in order to gather students´ perspective on the investigated phenomena. The interviews were used as secondary data set and analyzed using discourse analysis (Gee, 2000). The analysis shows that students´ interpretation of the task is a developmental process, interdependent with students' perception of the space-time relations of the ongoing activity. At the beginning of the course, when the task is defined in abstract terms, space-time frames were marginal in students´ discourse. However, already at the third week of the course the time-space frames, become relevant for building a shared interpretation of the task. Often students discussed – and changed – their interpretation of the collaborative task in association with the discussion of the space-time organization of the activity. For example, while discussing the task and defining subtasks, students referred to time constraints, to the organization of the workspaces, to the tools and resources available in the context. Therefore, both the task and the chronotope appeared to be emergent (and interdependent) features of the learning process. When collaboratively building a shared understanding of the task the chronotope was negotiated as well. Multiple artifacts and tools were used by students in this process: a concept map tool was relevant especially in the beginning of the course to create a preliminary shared understanding of the task; a shared dropbox folder was used to collect artifacts that were created and updated every week by students and contributed to create shared understanding and coordinate efforts; the slides for the final presentation, which became relevant for creating a shared understanding of the task in the end of the course. These results show that interpreting the task and organizing the activity in space and time are integrated layers of activity strongly "grounded" in the artefacts created and updated by students throughout the course. During the presentation some excerpts of students' discourse will be illustrated to exemplify how these processes are interrelated.

Learning in a material world: Reflection in science education as embodied practice

Hans Christian Arnseth, Alfredo Jornet Gil and Ingeborg Krange

Learning about sustainable energy use is a very important topic in science education. There exists a range of educational resources that support such learning in both formal and informal settings, but these resources are seldom systematically connected to other resources or embedded into curricular trajectories designed for knowledge integration and reflection. As part of a research program concerned with understanding how to better connect learning experiences across formal and informal settings, we implemented a technology-rich curriculum that was designed to facilitate the emergence of coherent conceptual trajectories across activities. In this paper, we analyze video recordings of classroom interaction in an upper-secondary school, and examine how a teacher and a group of 1st year students engage with material objects and digital resources to learn about energy transformation. We are concerned with how interactions between students and their teacher and their perceptually available world are organized through their exchange of semiotic means (Streeck, Goodwin & LeBaron, 2011). Our analyses focus on how participants orientations to the different material objects and digital resources, become occasions to reflect on prior experiences and to connect those experiences with the overall topic of energy. Attending to the embodied nature of these reflection practices, we examine how students and teachers together structure and perceive the world in certain contextually relevant ways.

The use of curricular resources such as still pictures or interactive, dynamic visualizations, have always been part of education in general, and of science education in particular. Educators can use these kinds of resources to make abstract concepts and relations between these more coherent and accessible (Edelson, Gordin,

& Pea, 1999; Lee, Linn, Varma, & Liu, 2010). Despite being carefully designed, resources are ambiguous and inference rich. This ambiguity, rather than problematic, can constitute a basis for the emergence and development of conceptual discussions in collaborative activities (Roschelle, 1992). In the learning sciences focus has shifted towards investigating the ways in which resources enable joint activities. For instance, Schwartz (1995) reported that dyads working with graphical representations of scientific issues outperformed individuals in conceptual performance, and theorized this advantage to be based on the need to build a common ground for mutual understanding. More recently, literature on computer-supported collaborative learning has taken interest in understanding how interaction is organized so as to lead to *uptake* sequences*, that is, sequences in which participants take aspects of prior events as having relevance for ongoing activity (Suthers *et al*., 2010). Such uptakes often involve the enactment of teacher-led reflective practices by means of which conceptual links across events are an outcome (Scott, Mortimer, & Ametller, 2011). Although achieving such conceptual links is often regarded as relying on the participants' intellectual competences, and on how the latter are mediated by dialogue, recent research taking a semiotic and cultural-historical approach has shown that bodily and perceptual aspects of the organization of interaction also plays an important role (Jornet & Roth, in press). However, research has not yet fully scrutinized the embodied nature of joint reflective practices. In the paper we address the following research question:

How do students perceive and translate between discursive and non-discursive artefacts in multi-representational learning environments?

We extend the unit of analysis beyond the individual and see learning and sense making as emerging features of social interaction. This extended unit is captured in the notion of a functional system (John-Steiner, Meehan, & Mahn, 1998). According to Luria there are two distinguishing features of functional systems. The first is the presence of a task that is performed by variable mechanisms. The second is the complex composition of the system itself (Luria, 1932). The teacher provides the directionality for the development of the system, but there is a mutually constitutive relationship between the changing participation of the students and the changing system as a whole. The data were collected as part of a larger project where 24 first year upper secondary students worked on concepts of energy transformation using both physical and digital resources. We designed a curricular trajectory distributed over 7 days and spread across a four-week period. Emerging findings suggest that the teacher is crucial in contextualizing material objects and digital resources that students make use of while solving curricular tasks. The students have problems to see the resource in relevant ways. In this way, the teacher plays a decisive role to help them make significant interpretations of the curricular topic of energy transfer.

"I was shocked and embarrassed by the results": Carbon footprint calculators as mediators of tangible information and as resources for knowing and reasoning about emissions

Géraldine Fauville, Annika Lantz-Andersson and Roger Säljö

Human activities over the past century have resulted in a rapid accumulation of carbon dioxide (CO_2) in the atmosphere, resulting in changes in the global climate. To deal with the issue of climate change, citizens need to gain understanding of their own CO_2 emission, also referred to as their carbon footprint (CF) – linked to their lifestyle activities. However, one of the major difficulties to grasp the abstract concept of CF is that such emissions are invisible to the human eye. Recently, the emergence of digital technologies has extended the range of concepts we can visualize and manipulate. Representational devices such as carbon footprint calculators (CFCs) present questions concerning the user's lifestyle, and by answering the questions, the users receive their total CO_2 output in kilograms. This raises interesting questions about how CFC mediates understanding and enables altered ways of reasoning about CF.

The few studies that have investigated the impact of learning about the personal emission through CFCs and then analyzed environmental behaviors, display divergent results. On the one hand, for example Mallett and colleagues (2013) suggest that adult self-confrontation via a CFC promotes guilt, which partially mediates willingness to support actions for existing pro-environmental groups. On the other hand, Brook (2011) describes how some adults might be less likely to engage in pro-environmental action after receiving negative feedback from the CFC. Even if the implications of the use of the CFC in instructional settings have not been thoroughly studied, the results so far cautiously point to the positive impact that use of CFC has in how the students are able to link their lifestyle to climate change (e.g. Cordero, Todd & Abellera, 2008). The present study aims at contributing to this field of research by scrutinizing how the visualization of the CFC relates to the students' understanding of their CF and their reasoning about ways to decrease it.

By grounding the study in a sociocultural perspective on learning (Vygotsky, 1978; Wertsch, 1998; Säljö, 2005), we regard the CFC as a material and psychological tool, which mediates the idea of CF and its determinants in manners that offer possibilities to understand and learn about climate change and about how one's personal behaviors contribute to carbon emissions. Our empirical study focuses on learning activities implemented to scaffold high school students around the world to understand their CF and to envision local and global solutions. Students first calculate their CF by using a specific CFC (http://footprint.stanford.edu/footprint.html), and then they discuss different aspects of the climate change issue using a social media platform (muut.com). Data were collected from the September 2014 session, involving 45 classes from 15 countries. In the analysis, we scanned the discussions for comments where students clearly addressed potential CF decrease.

Preliminary results show that the CFC as an artefact makes discussions possible and the metric system used offers concrete reference points for understanding emissions both at the personal level and more generally. Thus, this digital tool supports meaning-making by creating new access points to tangible reasoning practices that concern CF and environmental impact. These results imply that the use of CFC's gives the students opportunities to enhance their understanding of, and involvement in, the climate change issue.

Documentary practices in transformation: Follow-up consultations with patients and health care staff in hypertension care

Mona Lundin and Åsa Mäkitalo

In current health care reforms, for instance those building on person centred care, new relations between health care institutions and their patients have been articulated. It has been argued that patients need to be more actively involved in managing their own health and take on more responsibilities for their own well-being and treatment. In recent policy discourse, 'patients' are accordingly being reinvented as 'partners' in the delivery of health care services (Candlin, 2000; Dunston *et al*, 2009). This implies that responsibility and agency need to be both renegotiated and shared between the parties, and trust needs to be established in the new relation. Technologies are suggested as potential solutions to several problems identified when it comes to establishing new relations and supporting individuals in self-management and treatment. Digital tools are seen as useful and handy devices for entering and sharing information on a daily basis (on blood pressure, pulse, medical treatment, symptoms, physical activity etcetera). The information that is entered may also be stored in databases that can be made available for the parties. This implies a new basis for medical consultations and allows for new patterns of following up treatment. In addition, the information may be aggregated over time and displayed in web-based graphs (bar, line, pie, area charts etcetera), allowing for visual *re*-presentation of the individual's health status. As such, technologies in person-centred care provide the person with a *technologically mediated version* of him- or herself. Such representations of one's own health status, allow individuals to distance themselves and provide a reflexive element in daily life. From a sociocultural and dialogical perspective we study the reflexive element that mediational means (Wertsch, 2007) like technologies of this kind may provide in practices of self-documentation and *re*-presentation. Engaging with such mediational means on an everyday basis may have profound implications for identity formation and learning (Vygotsky, 1997) as well as for moral accountability and responsivity to 'the other' (Linell, 2009). At the same time technologies of this kind may create tensions for both parties – as clinical practices are extended into peoples' homes (Winthereik & Langstrup, 2010), responsibilities and obligations will be re-negotiated.

Our empirical material consists of 20 follow-up consultations (10 videorecorded, 10 audiorecorded) with hypertension patients and health care staff. Our preliminary analysis of the material features of this system, shows that the way the patients' data are visualized and displayed graphically on the computer screen during the consultation provides support for remembering and discussing their everyday life and related health issues. It is also evident that the consultations were embedded in multiple documentary practices that created tensions in the organisation of the face-to-face encounter. We will thus highlight how a material-semiotic tool in the form of a mobile phone-based system anticipates new relations between patients and health care staff.

References

Brook, A. (2011). Ecological footprint feedback: Motivating or discouraging? *Social Influence*, *6*(2), 113–128.
Candlin, C. N. (2000). The Cardiff Lecture 2000 - Reinventing the patient/client: New challenges to health care communication. Downloaded 2014-11-04 from: http://www.cf.ac.uk/encap/resources/HCRC-candlinlecture.pdf.
Cole, M. (1996). *Cultural psychology: A once and future discipline*. Cambridge, MA: The Belknap Press.

Cordero, E. C., Todd, A.M., & Abellera, D. (2008). Climate change education and the ecological footprint. *Bulletin of the American Meteorological Society*, *89*(6), 865–872.

Dillenbourg, P., & Jermann, P. (2010). Technology for classroom orchestration. In M. S. Khine & I. M. Saleh (Eds.) *New science of learning* (pp. 525-552). New York, NY: Springer.

Dunston R, Lee, A, Boud, D, Brodie, P & Chiarella, M. (2009). Co-production and health system reform – from re-imagining to re-making. *The Australian Journal of Public Administration*, *68*(1), 39-52.

Edelson, D., Gordin, D. N., & Pea, R. (1999). Addressing the challenges of inquiry-based learning through technology and curriculum design. *The Journal of the Learning Sciences, 8*(3&4), 391-450.

Gee, J. P. (2014). *An introduction to discourse analysis: Theory and method*. Ort: Routledge.

Goodwin, C. (2000). Practices of seeing visual analysis: An ethnomethodological approach. In T Van Leeuwen & C. Jewett (Eds.) *Handbook of visual analysis*, 157-182.

John-Steiner, V., Meehan, T. M., & Mahn, H. (1998). A functional systems approach to concept development. *Mind, Culture, and Activity, 5*(2), 00-00.

Jornet, A., & Roth, W-M. (in press). The joint work of connecting multiple (re)presentations in science classrooms. *Science Education*.

Lee, H.-S., Linn, M. C., Varma, K., & Liu, O. L. (2010). How do technology-enhanced inquiry science units impact classroom learning? *Journal of Research in Science Teaching, 47*(1), 71-90.

Linell, P. (2009). Rethinking language, mind and world *interactional and contextual theories of human sense making*. Charlotte, NC: Information Age Publishing

Säljö, R. (2010). Learning in a sociocultural perspective. In P. Baker & B. McGaw (Eds.), *International encyclopaedia of education* (3rd ed.) (pp. 498-502). Amsterdam: Elsevier.

Luria, A. R. (1932). *The nature of human conflicts: Or emotion, conflict and will.* New York, NY: Liveright.

Mallett, R. K., Melchiori, K. J., & Strickroth, T. (2013). Self-confrontation via a carbon footprint calculator increases guilt and support for a proenvironmental group. *Ecopsychology*, *5*(1), 9–16.

Mercer, N., Littleton, K., & Wegerif, R. (2004) Methods for studying the processes of interaction and collaborative activity in computer-based educational activities. *Technology, Pedagogy and Education, 13*(2), 193-209.

Roschelle, J., & Teasley, S. D. (1995). The construction of shared knowledge in collaborative problem solving., *Computer supported collaborative learning*, 128, 69-97.

Roschelle, J. (1992). Learning by collaborating: Convergent conceptual change. *Journal of the Learning Sciences, 2*(3), 235-276.

Schwartz, D. L. (1995). The emergence of abstract representations in dyad problem solving. *Journal of the Learning Sciences*(4), 321-354.

Scott, P., Mortimer, E., & Ametller, J. (2011). Pedagogical link-making: A fundamental aspect of teaching and learning scientific conceptual knowledge. *Studies in Science Education, 47*, 3–36.

Streeck, J., Goodwin, C. & LeBaron, C. (2011). Embodied interaction in the material world: An introduction. In J. Streeck, C. Goodwin & C. Lebaron (Eds.), *Embodied interaction. Language and body in the material world*. Cambridge, MA: Cambridge University Press.

Suthers, D. D., Dwyer, N., Medina, R., & Vatrapu, R. (2010). A framework for conceptualizing, representing, and analyzing distributed interaction. *Computer-Supported Collaborative Learning, 5*, 5–42.

Säljö, R. (2005). *Lärande och kulturella redskap. Om lärprocesser och det kollektiva minnet* [Learning and cultural tools. On learning processes and the collective memory]. Stockholm: Norstedts.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Vygotsky, L. S. (1997). The instrumental method in psychology. In R. W. Rieber & J. Wollock (Eds.), The collected works of L. S. Vygotsky (Vol. 3). Problems of the theory and history of psychology (pp. 85-89). Ort: Springer.

Wertsch, J. V. (1998). *Mind as action.* New York, NY: Oxford University Press.

Wertsch, J. V. (2007). Mediation. In H. Daniels, M. Cole & J. V. Wertsch (Eds.), The Cambridge companion to Vygotsky (pp. 178-192). Cambridge, UK: Cambridge University Press.

Winthereik, B. & Langstrup, H. (2010). When patients care (too much) for information. In A. Mol, I. Moser & J. Pols (Eds.), *Care in practice. On tinkering in clinics, homes and farms*. Bielefeld: Transcript Verlag.