Researching Concept Mapping Using Cultural Historical Activity Theory: Collaboration and Activity in the Zone of Proximal Development

John Cripps Clark

Deakin University

johncc@deakin.edu.au

This paper locates concept mapping within the theoretical framework of cultural historical activity theory. Cultural historical activity theory provides an analytic tool for understanding how concept maps can act as 'stimuli-means': a cultural artefact that can mediate the performance of subjects (Vygotsky, 1978). Concept maps possess Vygotsky's double nature: they not only enable students to enact academic practice but also they allow reflection on that practice. They allow students to build an "internal cognitive schematisation of that practice" (Guile, 2005, p. 127). Further cultural historical activity theory gives the tools analyse the social context of our use of concept maps and thus consider the mediating rules (tacit and explicit) and division of labour that mediate our use of concept maps. Concept maps can be viewed as acting within Brandom's (2000) space of reasons which allows learners to use reasons to develop and exchange judgements based on shareable, theoretically articulated concepts and collectively develop the ability to restructure their knowledge and enact these judgements (Guile, 2011). In particular multimodal collaborative concept maps can act as Vygotsky's (1978) zone of proximal development, where teacher and peer-to-peer interaction allow students to solve problems and learn concepts and skills that they would be otherwise unable to tackle.

Introduction

Apart from a frequent reference to Ausabel and Vygotsky (Novak & Cañas, 2006), concept mapping has generally concentrated on the empirical. Yet within cultural historical activity theory there are powerful ideas which could be used to interrogate concept mapping and, reciprocally, the analysis of concept mapping can provide insights into theory. This paper outlines a number of ideas from cultural historical activity theory and associated theoretical lenses which can inform the analysis and use of concept maps.

Cultural historical activity theory is a framework for systematically analysing human activities in context: "a powerful analytic tool that helps to reveal the fundamental aspects of social practice, and support structured, meaningful interpretations of empirical data"

(Kaptelinin & Miettinen, 2005, p. 1)1. It was developed within the Moscow school of cultural-historical psychology in Soviet Russia, notably by Vygotsky and Leont'ev, between the 1920s and 70s before moving to the west and being further developed by social researchers. Within the theory, activity is framed as intentional, object orientated and directed towards creation of outcomes (physical or mental). Mental activity does not prefigure physical activity but the physical and mental are inextricably bound to each other (Leont'ev, 1978). Thus knowing can only be understood in the context of doing; "you are what you do" (Vygotsky, 1978) and vice-versa. The great utility of cultural historical activity theory is that it is a realist theory that enables systematic analysis of social activity in context: it highlights the most important factors that affect the activity and provides a language with which to analyse these. It is a mid-level theoretical tool which unites different communities of scholars and links disparate discourses. Below I explicate some of the ideas from within the cultural historical activity theory tradition which provide lenses through which to analyse multi-modal collaborative concept maps: mediation, activity theory, double stimulation, zone of proximal development, collaboration in the space of reasons, and ascent from abstract to concrete.

Mediation

> The idea of mediation … runs as the unifying and connecting lifeline throughout the works of Vygotsky, Leont'ev, Luria and the other representatives of the Soviet cultural-historical school. (Engeström, 1999, p. 21)

The idea of mediation was used by Hegel in terms of ideas and by Marx in terms of objects: "Man uses the mechanical, physical, and chemical properties of objects so as to make them act as forces that affect other objects in order to fulfil his personal goals" (cited in Vygotsky, 1978, p. 54). Vygotsky combined these two aspects of mediation: "Mediators are understood to be twin entities that have both material and ideal properties simultaneously" (Zinchenko, 2001, p. 283).

> A fundamental assumption of Activity Theory is that tools mediate or alter the nature of human activity and, when internalised, influence humans' mental development. (Jonassan & Rohrer-Murphey, 1999, pp. 66–67)

Vygotsky proposed that the action of the subject on the object could be mediated by tools (or artefacts or instruments) as shown in Figure 1. These tools can be physical, cultural or mental. For example, a tool could be a calculator, pedagogy, language genre, or concept map.

[11] Kaptelinin & Miettinen are referring to the object of activity rather than cultural historic activity theory but the description is apt to both.

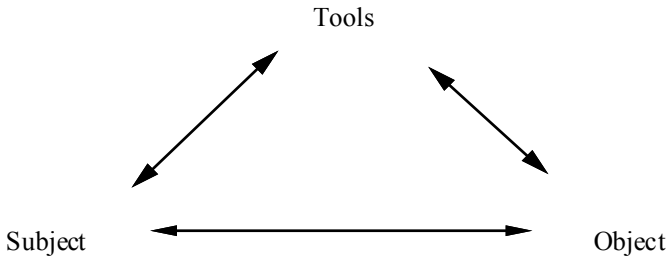

Figure.1. Tools mediate between subject and object (Vygotsky, 1978).

The tools node is not just an alternative pathway for the activity; it fundamentally changes the activity. The subject is able to achieve different outcomes using a tool and in turn the subject is changed. "[Mediating tools] possess the specific function of reverse action, it transfers the psychological operation to higher and qualitatively new forms and permits the humans, by aid of extrinsic stimuli, to control their behaviour from outside" (Vygotsky, 1978, p. 40, emphasis in the original). Mediating tools can be internalised: "Mediation is how culture enters psychological processes and shapes behaviour" (Guile, 2005, p. 126).

> The person, using the power of things or stimuli, controls his own behaviour through them, grouping them, putting them together, sorting them. ... He changes the environment with the external activity and in this way affects his own behaviour, subjecting it to his own authority. (Vygotsky, 1987b, p. 212)

To emphasise that activity is socially located and the community around the activity profoundly affects and is affected by the activity (Leont'ev, 1978) proposed that we consider the community as a mediator, as shown in Figure 2.

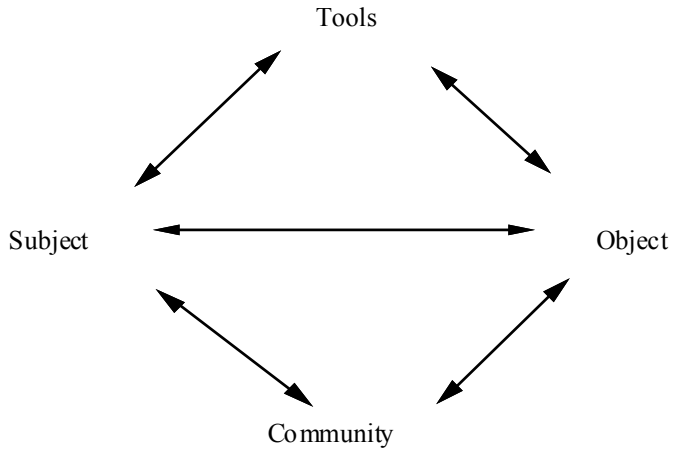

Figure 2. Community as mediator between subject and object.

Activity theory

Yrjö Engeström (1992) has introduced two other mediators: rules and division of labour, to create a network (Figure 3) which can act as an analytic tool which is particularly useful in analysing the contradictions in the activity system which can either derail the activity or drive change to new forms of activity.

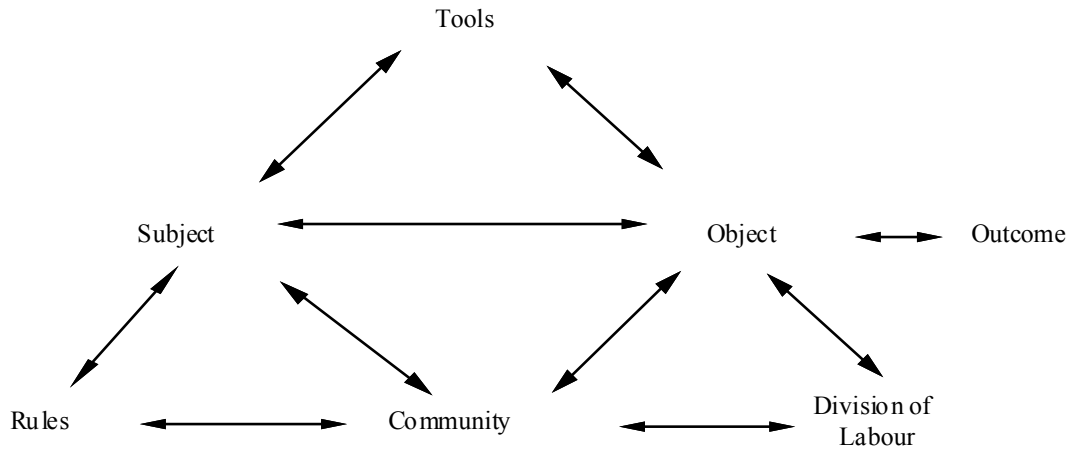

Figure 3. Activity system, triangle representation (Engeström, 1999).

The words used in activity theory clearly have a meaning that is historically contingent. Thus Vygotsky and Leont'ev used the word "deyatelnost", a word with no equivalent in English, but for which the word "activity" is generally used (Wertsch, 1985). Activity Theory has developed within several small groups in specific historical and cultural contexts.

Activity: this is the basic unit of analysis. Activity is both directed and conscious. It can be described as the process of a subject producing an outcome by acting on an object. Thus, in this case, the teacher is aiming to produce learning in students by acting upon their concept of science.

Subject: The subject can be an individual or a group. It is their agency in the activity that provides the focus of the analysis. In this study the teacher is the subject but it could equally be an individual student or a group of students working together on the practical activity. In any social context there may be multiple activity systems with different subjects but overlapping objects.

Object: can either be viewed as the objective of the activity or the object on which the activity acts: "the 'raw material' or 'problem space' at which the activity is directed and which is moulded and transformed into outcomes" (Roth & Tobin, 2002, p.113) or "what you have to shift to get to the outcome" (Daniels, 2005, p.1). The object is both material and ideal (Foot, 2002); it exists in the physical, mental and cultural world.

Tools: One of Vygotsky's many great insights was the realisation that physical and mental tools can influence the subject acting on the object; these tools mediate the relationship between subject and object.

Community: Leont'ev's contribution was to find a way to express the social nature of humans within activity systems by describing the community which acts a mediator between subject and object, in an equivalent way to the tools (Leont'ev, 1978).

Rules: These can be explicit and implicit and mediate the way in which the subject and community interact.

Division of labour: Since the outcome producing activity occurs within a social context there is inevitably some distribution of actions within the community. Division of labour can be interpreted as social role which mediates between the community and subject (see for example (Cripps Clark, 2001, 2003; Spasser, 2002).

A proposed activity triangle for concept maps used in the activity of learning or teaching conceps is shown in Figure 4. Below a number of ideas from cultural historical activity theory which have a relevance to concept mapping are raised.

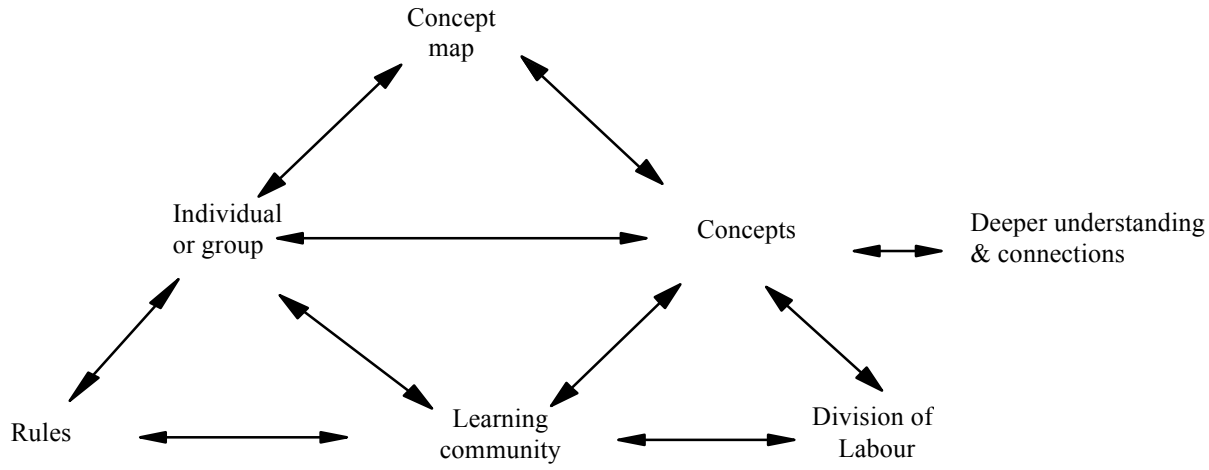

Figure 4: An activity triangle for concept mapping

Double stimulation

Within Vygotsky's project of developing a new psychology in which social mediation of the 'higher mental functions' was central, he proposed the mechanism of double stimulation. Vygotsky developed the idea of double stimulation to understand the interaction between everyday and scientific concepts in development. In double stimulation a neutral object (a concept map) becomes a tool for the development of higher mental functions (understanding the relationships between concepts and thus the concepts themselves). As Vygotsky explained it:

In such cases a neutral object is placed near the child, and frequently we are able to observe the neutral stimulus is drawn into the situation and takes on the function of a sign. Thus, the child actively incorporates these neutral objects into the task of problem solving. ... We simultaneously offer a second series of stimuli that have a special function. In this way, we are able to study the process of accomplishing a task by the aid of specific auxiliary means; thus we are able to discover the inner structure and development of higher psychological processes. The method of double stimulation elicits manifestations of the crucial processes in behaviour of people of all ages. ... We regard our method as important because it helps to objectify inner psychological processes. (Vygotsky, 1978, pp. 74-75)

In refining these ideas Vygotsky introduced the idea of the social mediation of intellectual development in that "higher psychological functions appear twice, first interpsychologically in collaborative action, and later intrapsychologically, internalised by the individual" (Engeström, 2007, p. 366). Concept mapping is an example of double stimulation since "it pushes the subject to go beyond the problem initially given, to open up and expand upon an object behind the problem" (Engeström, 2009, p. 303).

Concept mapping also act as an external memory field which externalises, crystallizes and objectifies concepts in the same way as Feynman diagrams (Ritella & Hakkarainen, 2012). Richard Feynman, awarded Nobel Prize in Physics in 1965 with Tomonaga and Schwinger "for their fundamental work in quantum electrodynamics, with deep-ploughing consequences for the physics of elementary particles"(Nobelprize.org) is famous for his Feynman diagrams which were "extremely useful in understanding and developing quantum field theory in simple and natural terms, rather than only abstract mathematical ones" (Mehra, 1996, p. 287). Like concept maps, Feynman diagrams are examples of the way "writing and visualization allow human beings to establish a theoretic culture based on gradually accumulating the external symbolic storage systems" (Ritella & Hakkarainen, 2012, p. 242). Feynman explained in an interview by the MIT historian Charles Weiner:

> Weiner once remarked casually that his new parlton notes represented "a record of the day-to-day working," and Feynman reacted sharply.
>
> "I actually did the work on the paper," he said.
>
> "Well," Weiner said, "the work was done in your head, but the record of it is still here."
>
> "No, it's not a record, not really. It's working. You have to work on paper, and this is the paper. Okay?" (Gleick, 1992, p. 409)

Zone of proximal development

> [The zone of proximal development is] a metaphor to assist in explaining the way in which social and participatory learning takes place. (Daniels, 2001, p. 56)

As with the mediation provided by tools such as concept maps, the mediation provided by the teacher and students enables students to solve problems and learn concepts and skills that they would not be able unassisted. A useful way of describing this mediation is to use Vygotsky's zone of proximal development, which describes students' developmental potential in terms of the difference between what can be achieved on their own and with assistance.

Vygotsky's most commonly quoted definition of the zone of proximal development is:

> the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p. 86)

or more succinctly: "what the child is able to do in collaboration today he will be able to do independently tomorrow" (Vygotsky, 1987a, p. 211).

Understanding the student's zone of proximal development and teaching within it is important because this where the student's maturing psychological functions, necessary for the next stage, can be developed (Chaiklin, 2003). It is assumed that a student can only make use of the expert guidance or collaboration with a more capable peer if they have the developing psychological functions that are necessary in the "proximal and subsequent periods of his stage of development" (Vygotsky, 1987c, p. 203).

Vygotsky found that zone of proximal development was a better predictor of children's intellectual development than their present IQ but did not give a systematic account of how one could assess a students' zone of proximal development in practice (Chaiklin, 2003). His most detailed account is:

> We show the child how such a problem must be solved and watch to see if he can do the problem by imitation, demonstration, or we begin to solve the problem and ask the child to finish it. Or we propose that the child solve the problem that is beyond his mental age by cooperating with another, more developed child or, finally, we explain to the child the principle of solving the problem, ask leading questions, or analyse the problem for a minute. (Vygotsky, 1987c, p. 202)

Imitation is a term Vygotsky used to describe the interaction with a more competent other around a specific task that the student would not otherwise to do (Chaiklin, 2003). Imitation depends on the context of the assistance, who is assisting, and the type of assistance. In attempts to operationalise the concept of zone of proximal development a number of types of assistance have been suggested (for example (Brophy, 1999; Coltman, Petyaeva, & Anghileri, 2002; Tharp, 1992). Some of the assistance strategies suggested include:

- encouraging and drawing attention to relevant issues in relation to the task;
- giving a framework for the problem;
- asking leading questions;
- demonstrating the actions necessary to solve the task using an equivalent context;
- comparing performance to a standard;
- directing the student towards particular strategic pathways, and away from others;
- sequencing and structuring the task;
- structuring new cognitive operations through questions and explanations;
- initiating the task and gradually withdrawing assistance; and
- direct instruction.

Vygotsky's zone of proximal development was a theoretical and practical tool to understand children's development of their integrated psychological functions from one stage to the next, it was not a tool to examine learning (Chaiklin, 2003). For this the term scaffolding is useful. Although scaffolding does not appear in Vygotsky's work (Verenikina, 2003) the metaphor has become popular among teachers as a way of encapsulating some of the ideas of the zone of proximal development: "'scaffolding' is an attractive concept for both psychology and education because it offers a neat metaphor for the active and sensitive involvement of the teacher in a students' learning" (Mercer, 2000, p. 73). In particular it captures the ideas, important to teachers, of challenge and support (Mariani, 1997). An important element of scaffolding is the modelling of effective strategies of thinking and communication by the teacher (Rasku-Puttonen, Etelaplelto, Hakkinen, & Arvaja, 2002).

The quality of the interaction between the novice and more experienced is crucial as (Radziszewska & Rogoff, 1991) have demonstrated. They found that the knowledge of children improved with adult guidance but not with the assistance of more knowledgeable

peers. This was largely because the adults used guided participation, and in particular modelling strategic thinking.

The role of play in the zone of proximal development is important because "the child moves forward essentially through play activity" (Vygotsky, 1978, p. 103). Vygotsky (1933/1966, online) argued that "play is the source of development and creates the zone of proximal development." Leont'ev (1981) explained that this activity "contributes in a decisive way to the development of the child by promoting new actions and psychological processes that anticipate a new episode of development."

The existing knowledge and skills are a function of students' past experiences both inside and outside the learning environment, their everyday knowledge and skills, and the dispositions they have developed as a result of these experiences. Vygotsky (1978) showed how, when students acquire new subject knowledge and skills, it extends the meaning of their existing knowledge and skills, and that the new knowledge and skills only become functional when they are integrated into existing knowledge and skills. The zone of proximal development reminds us that "context and capacity are inextricably entwined" (Lee & Smagorinsky, 2000, p. 2).

Using concept maps both the teacher and other students can scaffold knowledge building. Concept maps allow the creation of multiple, overlapping zones of proximal development. This provides students with a variety of challenges, at various levels of sophistication that students working individually or in groups need to solve. Thus, in suitably structured classroom environments, students can scaffold each other in the development of concept maps. Moreover greater freedom and complexity enables students to display many of the characteristics of play, which is important for children's development.

Collaboration in the space of reasons

Hanewald and Ifenthaler (2013) observe that concept mapping tools can develop collaborative capacity of students. Cultural historical activity theory provides ideas that can be deployed to analyse the social context and thus consider the rules (tacit and explicit) and division of labour that mediate our use of concept maps. Concept maps can be understood within Brandom's (2000) space of reasons. Brandom argues that we locate concepts and ideas in the space of reason via the "social practice of giving and asking for reasons" (p. 3). This allows learners to use reasons to develop and exchange judgements based on shareable, theoretically articulated concepts and collectively develop the ability to restructure their knowledge and enact these judgements (Guile, 2011): "in characterising an episode or a state as that of knowing, we are not giving a logical description of that episode or state; we are placing it in the logical space of reasons, of justifying and being able to justify what one says" (McDowell, 1996, p. iv)

There is strong evidence that peer-to-peer and group learning is vital in education (Adams, 2004; Britton & Anderson, 2010; Devenish et al., 2009; Feryok, 2009; Manouchehri, 2002; McLoughlin, Brady, Lee, & Russell, 2007). Learning is much more than the acquisition of existing knowledge and skills but rather developing the ability to interpret and respond to problems that are explicitly embedded in existing and future social practice (Edwards, 2005). This necessitates the creation and maintenance of communities of learning.

Concept maps can provide the focus for communities of learning in which we create a space of reasons. Within the changing environment and expectations of contemporary education we need to generate a zone of proximal development which, in terms of Lave and

Wenger's (1991) social interpretation, reveals the difference between current knowledge and new forms of knowledge which are collectively generated from the contradictions of present practice. Contradictions play an important role in cultural historical activity theory (CHAT) by providing the philosophical and practical impulse for change: "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." (Engeström, 2000, p. 174). There is a fertile correspondence between the concepts of zone of proximal development and space of reasons (Derry, 2008). We need to construct learning environments which distribute learning across toolsi (including but not limited to ICT), artefacts (including learning objects) and social groupings. We cannot do this merely with new forms of technology: we need to give profound attention to the way students, staff, the professions and the community interact.

There is a more substantial concern lurking behind these considerations, namely the moral dimensions of our interaction with others. As Edwards (2005) points out, working together is a moral as well as a cognitive process. Hicks (2000) argues that we need to move beyond the dialogic analysis of learning (Mercer, 2000; Mercer & Howe, 2012; Wells, 2007) to the moral dimensions of engaging in sense and value making with others. We have seen a more subtle argument about these issues from conservative philosophers (Sennett, 2012; Taylor, 1991) and it behoves us to engage with these ethical issues as we construct learning objects and environments.

Davydov and the ascent from abstract to concrete

One of the more challenging ideas to emerge from Vygotskian educational psychology in Russia is Davydov's ascent from abstract to concrete. It is of interest here because this neat reversal of Piagetian developmental stage theory gives us a deeper understanding of the power of concept mapping. Vasily Davydov (1930-1998) drawing on the ideas of the philosopher Evald Il'enkov (1924–1979) (Bakhurst, 2005) and working closely with Daniel El'konin (1904-1984) (Elkonin, 2005) developed a detailed and prescriptive theory of learning activities which sequentially reproduces the historical formation of a concept from a "germ cell", an abstract but simple explanation, through the revelation and resolution contradictions (Davydov, 2008). The initially simple concept is transformed via a series of comparisons and classifications which the empirical into a more complex interconnected network of concepts.

Engeström and Sannino summarise the specific steps in Davydov's sequence as:

1. transforming the conditions of the task in order to reveal the universal relationship of the object under study;
2. modelling the identified relationship in a material, graphic or literal form;
3. transforming the model of the relationship in order to study its properties in their 'pure guise';
4. constructing a system of particular tasks that are resolved by a general mode;
5. monitoring the performance of the preceding actions; and
6. evaluating the assimilation of the general mode that results from resolving the given learning task. (2010, p. 5)

Davydov's ascent from the abstract to the concrete not only reveals the theoretical roots of the empirical success of concept mapping but also opens new routes continue to develop concept mapping.

Collaboration between concept mapping and cultural historical activity theory

There has been limited use of cultural historical activity theory ideas within concept mapping research and only rarely have the resources of theory been used to interpret the mechanisms of concept mapping. Novak and Cañas (2006) deploy the idea of zone of proximal development to advocate concept mapping in small groups selected on the basis of similar zones of proximal development. Baldón and Berionni (2006), analysing the use of concept maps by elementary science students, also use the idea of zone of proximal development but in order to construct a space of reason in which playful dialogue, and thus learning, can occur. Van Boxtel et. al. (2002) also consider coloration in a physics class to understand the role of concept maps in the "articulation, elaboration, and co-construction of meaning and sense" (p. 45). Stoyanova and Kommers (2002) use activity theory to set up a quantitative experiment in which they demonstrate the efficacy of shared group interactions during concept mapping over distributed and moderated interactions but fail to use the theory to interrogate the mechanisms. In a reversal of the usual approach, Kinchin, Hay and Adams (2000) use concept maps a way of determining students' zone of proximal development rather than zone of proximal development as way of interpretation of concept maps. In order to understand how concept maps work to develop understanding of concepts Aguilar-Tamayo and Aguilar-Garcia (2008) deploy Vygotsky's ideas about the relationship between everyday and scientific concepts. In a similar manner Moreira–Unisinos (2010) uses Bakhtin's ideas about genre (1981) to interpret the use of concept maps within schools.

Although concept maps can be interpreted as a tool (in both the Vygotskian (1934/1987) and Novak and Cañas' (2006) sense), rather than seeing concept maps as merely an object cultural historical activity theory encourages the view of concept mapping as an activity: a collaborative, multi-modal tool of development. There is a rich repertoire of analytic interpretative resources out of cultural historical activity theory which can be used to analyse the tool of concept maps and the activity of concept mapping which are summarised in Figure 5. Hopefully there can continue to be a fruitful collaboration between concept mapping and cultural historical activity theory in future research.

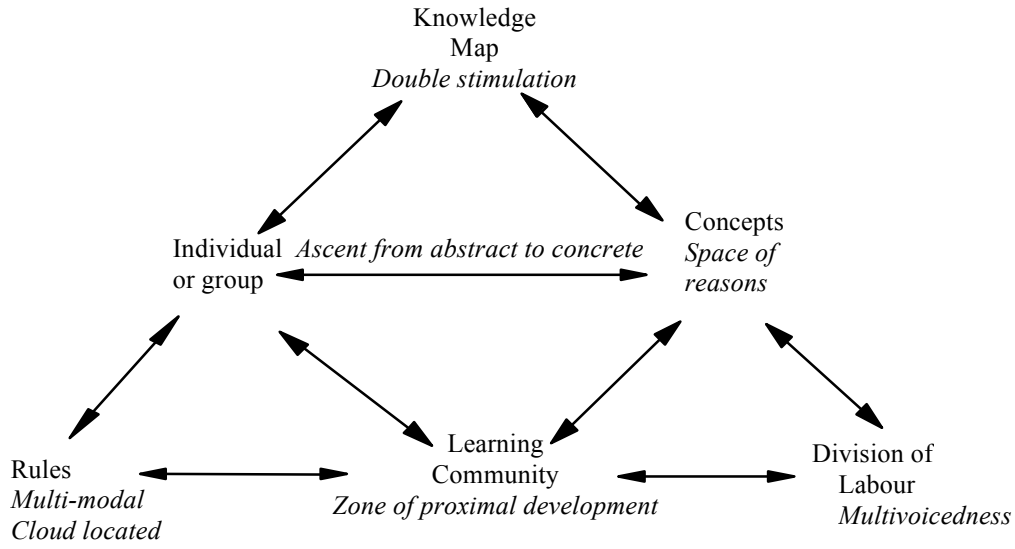

Figure 5. Cultural historical activity theoretical ideas framed within the activity triangle.

References

Adams, K. (2004). Modelling success: enhancing international postgraduate research students' self-efficacy for research seminar presentations. *Higher Education Research & Development, 23*(2), 115 - 130.

Aguilar-Tamayo, M. F., & Aguilar-Garcia, M. F. (2008). *Novak and Vygotsky and the Representation of the Scientific Concept*. Paper presented at the Concept Mapping: Connecting Educators.

Bakhtin, M. M. (1981). *The dialogic imagination: Four essays by M.M. Bakhtin* (C. Emerson & M. Holquist, Trans.). Austin, TX: University of Texas Press.

Bakhurst, D. (2005). Il'enkov on education. *Studies in East European Thought, 57*(3), 261-275.

Baldón, M. O., & Berionni, A. (2006). *Models of Social Constructivism, Laboratory Teaching and Concept Maps to Build Scientific Knowledge and Organize Concept Network Teaching Experiences in First Level Education in Italian Schools*. Paper presented at the Concept Maps: Theory, Methodology, Technology. Proceedings of the Second International Conference on Concept Mapping.

Brandom, R. (2000). Arti*culating reasons: An introduction to inferentialism*. Cambridge, MA: Harvard University Press.

Britton, L. R., & Anderson, K. A. (2010). Peer coaching and pre-service teachers: Examining an underutilised concept. *Teaching and Teacher Education*, 26(2), 306-314.

Brophy, J. (1999). Toward a model of value aspects of motivation in education: Developing appreciation for particular learning domains and activities. *Educational Psychologist*, 34(2), 75-85.

Chaiklin, S. (2003). The zone of proximal development in Vygotsky's analysis of learning and instruction. In A. Kozulin, B. Gindis, V. Ageyev & S. Miller (Eds.), *Vygotsky's Educational Theory in Cultural Context* (pp. 339-364). Cambridge: Cambridge University Press.

Coltman, P., Petyaeva, D., & Anghileri, J. (2002). Scaffolding learning through meaningful tasks and adult interaction. *Early Years, 22*(1), 40-49.

Cripps Clark, J. (2001, September). *Creating a community of scholarship: The CODET experience*. Paper presented at the Deakin University Students Association Postgraduate Research Conference, Deakin University, Toorak.

Cripps Clark, J. (2003, December). *A survey of the methodologies and methods of science education research*. Paper presented at the Symposium on Contemporary Approaches to Research in Mathematics, Science, Health and Environmental Education, Deakin University, Burwood.

Daniels, H. (2001). *Vygotsky and pedagogy*. London: RoutledgeFalmer.

Daniels, H. (2005, 8-9 September 2005). *Subjectivity, Identity and Workplace Divisions of Labour*. Paper presented at the Sociocultural Theory in Educational Research and Practice, University of Manchester.

Davydov, V. V. (2008). *Problems of developmental instruction: A theoretical and experimental psychological study* (P. Moxhay, Trans.). New York: Nova Science Publishers, Inc.

Derry, J. (2008). Abstract rationality in education: From Vygotsky to Brandom. *Studies in Philosophy & Education,* 27(1), 49-62.

Devenish, R., Dyer, S., Jefferson, T., Lord, L., van Leeuwen, S., & Fazakerley, V. (2009). Peer to peer support: the disappearing work in the doctoral student experience. *Higher Education Research & Development,* 28(1), 59 - 70.

Edwards, A. (2005). Relational agency: Learning to be a resourceful practitioner. *International Journal of Educational Research, 43*(3), 168-182.

Elkonin, D. B. (2005). The psychology of play, preface: The biography of this research. *Journal of Russian & East European Psychology, 43*(1), 11-21.

Engeström, Y. (1992). *Learning by expanding: An activity theoretical approach to developmental research*. Helsinki: Orienta-Konsultit.

Engeström, Y. (1999). Activity theory and individual and social transformation. In Y. Engeström, R. Meittinen & R. Punamaki (Eds.), *Perspectives on activity theory* (pp. 19-38). Cambridge: Cambridge University Press.

Engeström, Y. (2000). Activity theory as a framework for analyzing and redesigning work. *Ergonomics,* 43(7), 960-974.

Engeström, Y. (2007). Putting Vygotsky to work: The change laboratory as an application of double stimulation. In H. Daniels, M. Cole & J. V. Wertsch (Eds.), *The Cambridge companion to Vygotsky*. Cambridge: Cambridge University Press.

Engeström, Y. (2009). The future of activity theory: A rough draft. In A. Sannino, H. Daniels & K. Gutierrez (Eds.), *Learning and expanding with activity theory* (pp. 303-328). Cambridge: Cambridge University Press.

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

Feryok, A. (2009). Activity theory, imitation and their role in teacher development. Language Teaching Research, 13(3), 279-299.

Foot, K. (2002). Pursuing an evolving object: A case study in object formation and identification. *Mind, Culture and Activity, 9*(2), 132-149.

Gleick, J. (1992). *Genius: Richard Feynman and modern physics*. London: Little, Brown and Company.

Guile, D. (2005). *Knowledge, mediation and activity*. Unpublished PhD, Institute of Education, London.

Guile, D. (2011). Interprofessional Learning: Reasons, Judgement, and Action. *Mind, Culture, and Activity, 18*(4), 342-364.

Hicks, D. (2000). Self and other in Bakhtin's early philosophical essays: Prelude to prose consciousness. *Mind, Culture and Activity, 7*(3), 227-242.

Jonassan, D., & Rohrer-Murphy, L. (1999). Activity theory as a framework for designing constructivist learning environments. *Educational Technology: Research and Development, 47*(1), 61-79.

Kaptelinin, V., & Miettinen, R. (2005). Perspectives on the object of activity. *Mind, Culture and Activity, 12*(1), 1-3.

Kinchin, I. M., Hay, D. B., & Adams, A. (2000). How a qualitative approach to concept map analysis can be used to aid learning by illustrating patterns of conceptual development. *Educational Research, 42*(1), 43-57.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lee, C. D., & Smagorinsky, P. (2000). Introduction: Constructing meaning through collaborative inquiry. In C. D. Lee & P. Smagorinsky (Eds.), *Vygotskian perspectives on literacy research: Constructing meaning through collaborative inquiry* (pp. 1-15). Cambridge: Cambridge University Press.

Leont'ev, A. N. (1978). *Activity, consciousness, and personality*. Englewood Cliffs, NJ: Prenice-Hall.

Leont'ev, A. N. (1981). The problem of activity in psychology. In J. Wertsch (Ed.), *The Concept of Activity in Soviet Psychology* (pp. 37-71). Armonk, NY: Sharpe.

Manouchehri, A. (2002). Developing teaching knowledge through peer discourse. *Teaching and Teacher Education, 18*(6), 715-737.

Mariani, L. (1997). Teacher support and teacher challenge in promoting learner autonomy. *Perspectives, a Journal of TESOL, 23*(2).

McDowell, J. (1996). *Mind and world*. Cambridge, MA: Harvard University Pres.

McLoughlin, C., Brady, J., Lee, M. J. W., & Russell, R. (2007). *Peer-to-peer: An e-mentoring approach to developing community, mutual engagement and professional identity for pre-service teachers*. Paper presented at the Australian Association for Research in Education (AARE) Conference.

Mehra, J. (1996) *The beat of a different drum: The life and science of Richard Feynman*. Oxford: Oxford University Press.

Mercer, N. (2000). *The guided construction of knowledge: talk amongst teachers and learners*. Clevedon: Multilingual Matters.

Mercer, N., & Howe, C. (2012). Explaining the dialogic processes of teaching and learning: The value and potential of sociocultural theory. L*earning, Culture and Social Interaction, 1*(1), 12-12.

Moreira–Unisinos, S. M. (2010). *Concept map as a school genre: considerations for teaching and learning*. Paper presented at the Concept Maps: Making Learning Meaningful, The Fourth International Conference on Concept Mapping, Viña del Mar, Chile.

Nobelprize.org. The Nobel Prize in Physics 1965. Retrieved 30 Sep 2012, from http://www.nobelprize.org/nobel_prizes/physics/laureates/1965/

Novak, J. D., & Cañas, A. J. (2006). The Origins of the Concept Mapping Tool and the Continuing Evolution of the Tool. *Information Visualization, 5*(3), 175-184.

Radziszewska, B., & Rogoff, B. (1991). Children's guided participation in planning imaginary errands with skilled adult or peer partners. *Developmental Psychology, 27*(3), 381-390.

Rasku-Puttonen, H., Etelaplelto, A., Hakkinen, P., & Arvaja, M. (2002). Teachers' instructional scaffolding in an innovative information communication technology-based history learning environment. *Teacher Development, 6*(2).

Ritella, G., & Hakkarainen, K. (2012). Instrumental genesis in technology-mediated learning: From double stimulation to expansive knowledge practices. *International Journal of Computer-Supported Collaborative Learning 7*(2), 239-258.

Roth, W.-M., & Tobin, K. (2002). Redesigning an 'urban' teacher education program: An activity theory perspective. *Mind, Culture and Activity, 9*(2), 108-131.

Sennett, R. (2012). *Together: The rituals, pleasures, and politics of cooperation*. New Haven: Yale University Press.

Spasser, M. A. (2002). Realist-cally evaluating the flora of North America digital library project as an Acivity Network: a case study. *Mind, Culture and Activity, 9*(4), 270-295.

Stoyanova, N., & Kommers, P. (2002). Concept Mapping as a Medium of Shared Cognition in Computer-Supported Collaborative Problem Solving. *Journal of Interactive Learning Research, 13*(1), 111-133.

Taylor, C. (1991). *The ethics of authenticity*. Cambridge, MA: Harvard University Press.

Tharp, R. G. (1992). Instructional and social context of educational practice and reform. In E. A. Forman, N. Minch & C. A. Stone (Eds.), *Contexts for learning: Sociocultural dynamics in childrens development*. Oxford: Oxford University Press.

van Boxtel, C., van der Linden, J., Roelofs, E., & Erkens, G. (2002). Collaborative Concept Mapping: Provoking and Supporting Meaningful Discourse. *Theory Into Practice, 41*(1), 40-46.

Verenikina, I. (2003, 29 November - 3 December 2003). *Understanding scaffolding and the ZPD in educational research*. Paper presented at the Educational research, risks and dilemmas : NZARE/AARE Conference 2003, Auckland New Zealand.

Vygotsky, L. S. (1933/1966). Play and its role in the mental development of the child. *Psychology and Marxism Internet Archive* Retrieved 6/1/2006, from http://www.marxists.org/archive/vygotsky/works/1933/play.htm

Vygotsky, L. S. (1934/1962). *Thinking and Speaking* (E. Hanfmann, G. Vakar & N. Minnick, Trans.). Cambridge, MA: The M.I.T. Press.

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

Vygotsky, L. S. (1987a). *The collected works of L.S. Vygotsky: Volume 2. The fundamentals of defectology* (N. Minick, Trans.). New York: Plenum Press.

Vygotsky, L. S. (1987b). *The collected works of L.S. Vygotsky: Volume 4. The history of the development of higher mental functions* (N. Minick, Trans.). New York: Plenum Press.

Vygotsky, L. S. (1987c). *The collected works of L.S. Vygotsky: Volume 5 Child psychology* (M. J. Hall, Trans.). New York: Plenum Press.

Wells, G. (2007). Who we become depends on the company we keep and on what we do and say together. *International Journal of Educational Research, 46*, 100-103.

Wertsch, J. (1985). *Vygotsky and the social formation of the mind*. Harvard, MA: Harvard University Press.

Zinchenko, V. P. (2001). Developing Activity Theory: The Zone of Proximal Development and beyond. In B. A. Nardi (Ed.), *Context and consciousness: Activity Theory and human-computer interactions* (pp. 283-324). Cambridge, MA: The MIT Press.