

Investigating the support of reflective activities by collaborative technologies: an activity theory based research model

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Abstract

This paper describes an extension of Stahl's (2000) model of collaborative knowledge building. Three cycles of reflective thinking activities are added to the original model in order to support the investigation of the role of reflection in collaborative knowledge building. The model is combined with activity theory to make reflective thinking activities the unit of analysis. This fosters the investigation of participants articulating and making explicit their own knowledge (cycle 1), the analysis of participants engaging in collaborative reflective discourse to develop shared understanding (cycle 2), and studying the participant's use of reflective conceptual artefacts (cycle 3) to formalize and objectify knowledge. The extended model also supports the study of how collaborative technology may support reflective activities. The paper concludes with comments on how this model may be applied.

Keywords

collaborative knowledge building, reflective thinking, activity theory

1 INTRODUCTION

This paper presents a research model designed to guide an investigation into the Collaborative Knowledge Building (CKB) process (Stahl 2000). The research model borrows perspectives from the pedagogy of reflective thinking (Rodgers 2002), the pedagogical model (Scardamalia and Bereiter 1994; Morch et al. 2004) and process of CKB (Stahl 2000). Cultural historical activity theory (CHAT) (Engestrom 2001) will be utilized as a descriptive and analytical research tool to investigate the CKB process.

Though there are studies documenting CKB (Scardamalia and Bereiter 1994; Campos 2004), exploring the distributed nature of knowledge building in the collaborative context (Aalst et al. 2005) and identifying knowledge building indicators (Lipponen 2000), disagreement exists regarding the nature and the process of CKB. CKB is conceptualized as a social process in which participants co-construct knowledge through interactions (Stahl 2000; Lipponen 2002). It is not yet clear as to what processes are involved that help the participants engage in higher level thinking and how conceptual change is brought about. Aalst and Hill (2006) propose self monitoring of knowledge as a means by which participants gain an insight into their own learning processes. We propose, that in order to study participants conceptual change and the process of CKB, a cultural-historical analysis is needed that traces the development of conceptual artefacts within the activity (Vygotsky 1978). Conceptual artefacts are "understood as the products or objects of thinking and reasoning that can be collectively argued about and distributed" (Tillema and van der Westhuizen 2006, p52).

The constructs of cultural historical activity theory (CHAT) (Engestrom 2001) provide a useful framework for explaining the individual and collective aspects of the CKB process. The construct of mediation of artefacts is used to explain how participants construct meaning when they interact with artefacts and social others in the community (Yamagata-Lynch 2003). The dynamic interaction between artefacts, individuals, and other members of the community helps in the development of shared understanding and contributes to knowledge

building. It is argued that participants use reflective thinking activities as a tool for the articulation of knowledge, self monitoring of knowledge (Aalst and Hill 2006), and developing reflective conceptual artefacts for knowledge building and sharing. In other words, reflective thinking and reflective conceptual artefacts act as tools in conceptual change (Tillema and van der Westhuizen 2006) and mediate the process of CKB.

Stahl (2000) in his study of the CKB process breaks down the process of CKB into a number of useful phases, including cycles of personal understanding and social knowledge building. The modified model of the CKB process introduces three cycles of reflective thinking activities and assists in researching and developing a greater understanding of the reflective thinking activities and their role in the CKB process. This leads to an improved understanding of how technology can be designed to assist the CKB process and reflective thinking activities.

The paper is organized as follows. The next section introduces CKB and discusses the origins of the concept in the studies by Scardamalia and Bereiter (1994). The second section discusses the Stahl's (2000) model of the CKB process and, the relevant research conducted within CKB leading to the development of principles for assessing and scaffolding knowledge building (Aalst and Hill 2006). This leads to the next section which presents the modified model of the CKB process by combining Stahl's model (Stahl 2000), principles of knowledge building (Aalst and Hill 2006) and incorporating cycles of reflective thinking activities (Figure 1). The pedagogy of reflective thinking (Rodgers 2002) and its usefulness in knowledge building is discussed under the section reflective thinking and knowledge building. The section on the CKB activity system discusses the usefulness of CHAT as a descriptive and as an analytical tool in researching the CKB process. It provides an overview of the reasons for using CHAT as a research tool. The last section discusses the role of mediating artefacts (reflective thinking activities) in the CKB process. This aids the formulation of the research questions and conceptualizing the CKB process as a number of knowledge building sub-activities.

2 COLLABORATIVE KNOWLEDGE BUILDING

The concept of CKB was introduced by Scardamalia and Bereiter (1994) in their study of learning at school, in which they proposed that schools should function as knowledge building communities. Knowledge building refers to collective work for the advancement and elaboration of conceptual artefacts. This knowledge building approach and knowledge building process aims at facilitating collaborative work for sharing and advancing knowledge and artefacts (Scardamalia and Bereiter 1994). CKB puts the emphasis on collaborative work for the advancement and production of knowledge.

The genesis of new knowledge constructed jointly by participants in a collaborative environment can be explained by the knowledge creation metaphor of learning (a pedagogical approach) (Paavola et al. 2002) and the collaborative knowledge building model (pedagogical model) (Scardamalia and Bereiter 1994; Stahl 2000). The knowledge creation metaphor provides for a theoretical base by which the CKB model can be understood, applied and explained. Knowledge building involves production and continual improvement of ideas which are of value to a community (Scardamalia and Bereiter 1994). Within a community the ideas can be viewed as conceptual artefacts that can be examined and improved by means of public discourse. The focus is on developing collective knowledge through interactions. The knowledge creation metaphor of learning conceptualises learning and knowledge advancement as a collaborative process for developing shared objects of activity which can only be accomplished by participating in cultural practices and by becoming members of knowledge communities (Paavola et al. 2002). Therefore CKB is conceptualised as a social process in which participant's co-construct knowledge through interactions. This helps in explaining the innovative, expansive, and progressive aspects of the knowledge advancement process. It also suggests the examination of the process as an activity system discussed later in this paper.

3 PROCESS OF COLLABORATIVE KNOWLEDGE BUILDING

Stahl's (2000) model for the CKB process stresses the need to focus on group activities and notes the importance of conceptual artefacts. According to Stahl (2001) CKB is a process of communication where groups of people construct new knowledge through interaction of their ideas and perspectives and is preserved in artefacts (conceptual or written documents). The CKB process, or the way knowledge is built and shared is described as a "synergistic moment" by which the group reaches a shared understanding by participating in the socio-cultural process (Stahl 2001). Each member of the group brings their personal perspective and interpretations of experiences. The process by which the group reaches shared understanding and intersubjectivity through constant interactions is broken down into smaller knowledge building activities.

Aalst and Hill (2006) in their study of the characteristics of the social aspects of knowledge building analyzed the four principles of CKB:

1. Working at the cutting edge - based on the idea that a scholarly community works to advance its collective knowledge.
2. Progressive problem solving- based on the idea that when experts understand a problem at one level, they reinvest learning resources into new learning.
3. Collaborative effort- based on a focus on the importance of working on shared goals and values in developing community knowledge.
4. Self-monitoring of knowledge- based on the idea that a meta-cognitive understanding is needed for knowledge building work. Individuals require an insight into their own learning processes, as this documents the history of ideas or problems, as well as the growth of personal knowledge.

Other researchers used the principles of CKB for documenting and identifying knowledge building interactions (Scardamalia and Bereiter 1994), analyzing participation in knowledge building community (Hill et al. 2003), and exploring the role of collaboration in knowledge building (Aalst and Hill 2006). The principles also serve as guidelines for practitioners practicing knowledge building. Each of the principles highlights a skill that the participants need in order to develop support for their learning and the knowledge building process. The principles serve as scaffolds during the knowledge building discourse (Aalst and Hill 2006). These four principles involve both the social and individual aspects of knowledge building. This paper focuses on the self monitoring of knowledge (principle 4) which can be developed and fostered by reflective thinking activities.

4 THE MODIFIED MODEL OF CKB PROCESS

Stahl's (2000) original model of the CKB process is extended by including cycles of reflective thinking activities. Self monitoring of knowledge (Aalst and Hill 2006) requires participants to become aware of their own learning processes. It requires higher level meta-cognitive skills that force the participants to critically think about the relevancy of their learning. This ability to sit back and critically analyse the learning for solving a problematic situation (implementation of learning) requires participants to engage in reflective thinking activities. Critical analysis is fostered with the help of cycles of reflective thinking activity that are incorporated into the original model. The modified model discussed here includes the participant's use of reflective thinking activities as a tool in the CKB process helping in the articulation of knowledge and critically analysing their own learning.

The research model allows for research to focus on reflective thinking activities as a unit of analysis within the CKB process. This will lead to a greater understanding of reflective thinking activities, their role in the CKB process, and as a consequence an improved understanding of how technology can assist the CKB process. The modified model of the CKB process including the cycles of reflective thinking activity (shown as shaded circles in Figure 1) enables:

1. The study of participants articulating and making explicit their own knowledge (cycle 1).
2. The analysis of participants engaging in collaborative reflective discourse (Lin et al. 1999) to develop shared understanding (cycle 2).
3. The study of the participant's use of reflective conceptual artefacts (cycle 3) to formalize and objectify knowledge.

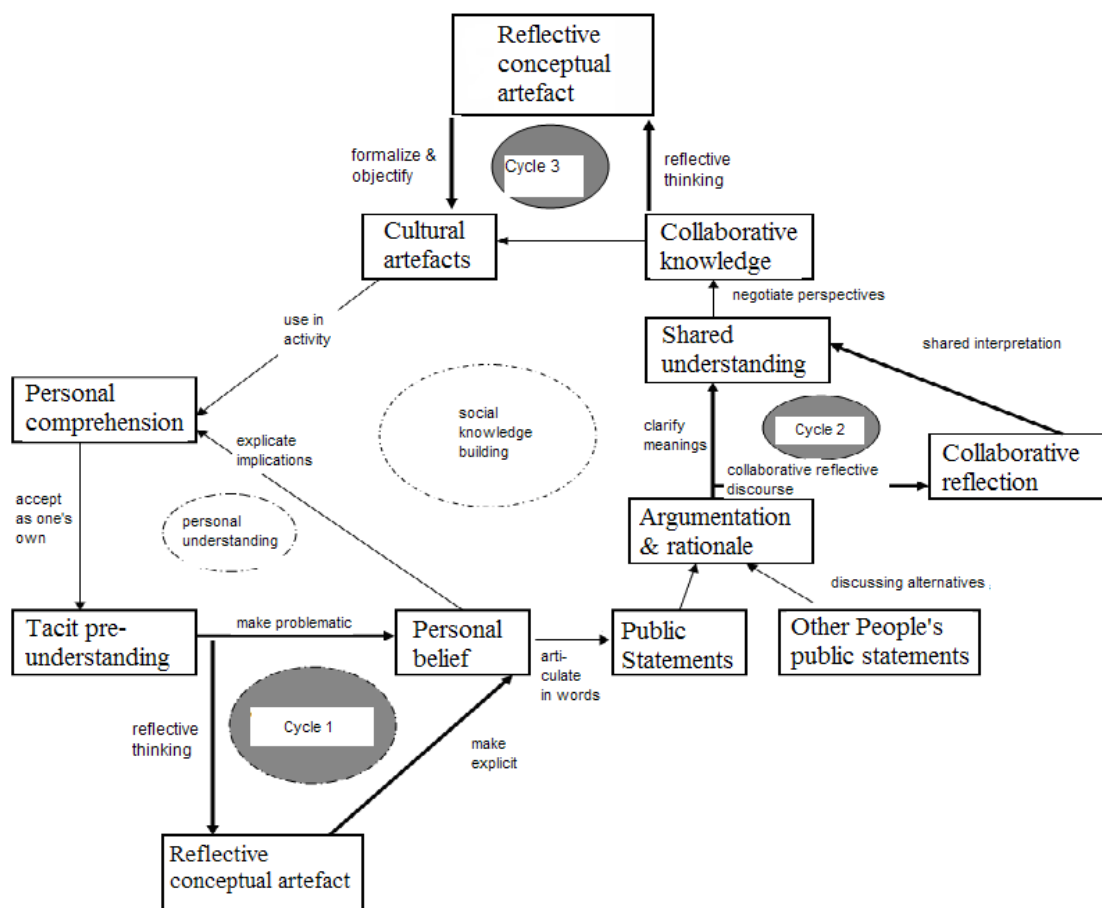


Figure 1: The modified CKB model – adapted from (Stahl 2000).

Note – arrows represent transformative process & rectangles represent products (forms of knowledge)

5 REFLECTIVE THINKING & KNOWLEDGE BUILDING

The development of reflective thinking (re-visiting the experience) and higher level thinking skills (applying knowledge to different situations) are essential in developing learning experiences. Many researchers (Mayer 1991, Tishman, Jay, & Perkins 1993 as cited in Baker and Lund 1997; Kim and Lee 2002) have identified that reflective thinking (meta-cognition) is an important capability that needs to be cultivated in learning situations. Kim and Lee (2002, p 1) in their definition of reflection state that “Reflection refers to active, intellectual thinking for monitoring one’s own learning activity and process, and a continuous internal activity of exploring oneself for new learning”. Wong et al (1995) define reflective thinking as effectual means of learning. Reflective thinking involves actively monitoring, evaluating, and modifying one’s thinking and comparing it to expert models and peers (Lin et al. 1999). For the purpose of this paper, reflective thinking is described as an active thinking process for monitoring one’s own learning process to bring about effective conceptual change.

Reflective thinking encourages learners to develop higher level thinking skills and deep understanding of a domain by articulating and monitoring what has been learnt.

1. Firstly, reflective thinking allows for better use of cognitive process skills by allowing evaluation whether cognitive process skills that one has used work or not (Kim 2005).
2. Secondly, reflecting on what has been learned can help in transformation of a negative experience into a positive learning experience. Negative experience is associated with the learner’s feelings or motivation (discomfort, anxiety, difficulty) experienced (Kim 2005).
3. Thirdly, reflective activities can lead to changes in the way of dealing with learning in future by extracting inferences or meaning from current learning experience (Lin et al. 1999).
4. Finally, reflective thinking can provide information regarding learning processes, feelings, belief systems, and understanding of the participants (Kim 2005).

The learning models proposed by Kolb's experiential learning theory (Kolb et al. 2000) and Engestrom's (2001) expansive learning theory contain reflective thinking as an important step in the learning process. The learning and knowledge building theories mentioned above place importance on reflective thinking in learning and knowledge building. It is argued that participants use reflective thinking as a tool to develop a reflective conceptual artifact which helps them in articulating and sharing knowledge. Reflective conceptual artefacts are defined as conceptual artefacts developed by participants while reflecting upon their existing knowledge and forming "reference" points.

Participants when faced with a problematic situation use prior experiences and knowledge to solve the problem. By engaging in reflective thinking, participants are able to re-call prior knowledge (reference point) that might help or is useful in solving the problem. This helps the participant to develop a reflective conceptual artefact which signifies further consolidation and narrowing down of the required knowledge to solve the problem. In order for the reflective conceptual artefact to be used by others, and further consolidated by the participant, the artefact needs to be made explicit in the form of an idea or a belief. This cognitive movement by the participant from a state of "unknown" to "known" (having extracted the required knowledge to solve the problem) is defined as a cycle of reflective thinking activity. The process for developing reflective conceptual artefacts can also be explained by participants appropriating experiences and beliefs on an internal plane as a representational activity (Internalisation) (John-Steiner and Mahn 1996). These internalised reflective conceptual artefacts are then transformed or externalised (through communicative language, symbols etc) by the participants for CKB, the entire process being mediated by reflective thinking activities. This use of prior learning for solving a problem is what Scardamalia and Bereiter (1994) refer to as knowledge building.

6 THE CKB ACTIVITY SYSTEM

In the modified CKB model (Figure 1), the process by which the group builds knowledge through constant interactions is broken down into smaller knowledge building activities (Stahl 2000). The constructs of CHAT (Engestrom 2001) are used in the modified CKB model for explaining, analysing and understanding the CKB process. The constructs and terminology of CHAT help by breaking down the CKB process further into manageable activities and actions. It allows for an in-depth analysis of the CKB process and use of reflective thinking as a tool. The construct of CHAT - artefacts mediating (reflective thinking activity) the relation between subject (participant) and object (CKB) helps in formulating the research questions. The description of the artefacts (reflective thinking activity) helps in understanding the reflective thinking activity and how technology can provide scaffolds for it (how technology fits into the activity).

CHAT is a descriptive theory of human thought and behaviour within the context of a specific activity. This theory suggests that learning needs to be considered as an activity system that involves subjects and mediating artefacts (cognitive, physical) that act to transform particular objects of activity to achieve an outcome. CHAT offers a framework for describing the activity, as well as provides a set of perspectives on practice that interlink the individual and the social (Engestrom 2001). CHAT as a tool has been used by researchers in studying Human computer interaction (Kuutti 1996), develop computer supported co-operative work tools (Kuutti and Arvonen 1992), and analysing innovative learning in work teams (Engestrom 1999). CHAT is used in the research model as a descriptive tool that helps in analysing a participant's use of cycles of reflective thinking activity in the CKB process (Figure 1).

CHAT allows for analysis at the individual level, the relationship between Subject and Object mediated by tools (upper triangle, Figure 2) and the social level, the relationship between Subject and Object mediated by Community (lower triangle) (Kuutti 1996). Similarly, the modified CKB model (Figure 1) takes into account the personal understanding cycle (individual level) and social knowledge building (social or community level). It is important for the participants (subject) to have a shared understanding at the individual and community level (group in a socio-cultural context) for the fulfillment of the object (CKB). The sub activity of reaching shared understanding using collaborative reflective discourse (cycle 2) as a tool is discussed next.

The sub activity of clarifying meanings and interpretations for reaching shared understanding is supported by collaborative reflective discourse. It helps the subjects to engage in collaborative reflection which results in the transformation of that initial activity to a culturally advanced state of shared understanding (Figure 1, cycle 2). The constructs of CHAT are used to further breakdown the process for analysing that activity (Figure 2). The object of the activity is to engage in collaborative reflection and collaborative reflective discourse is used as a tool to reach shared understanding (outcome) within the subjects (participants). Lin et al (1999) define collaborative reflective discourse as a collaborative activity where each participant works collectively for knowledge building and sharing ideas.

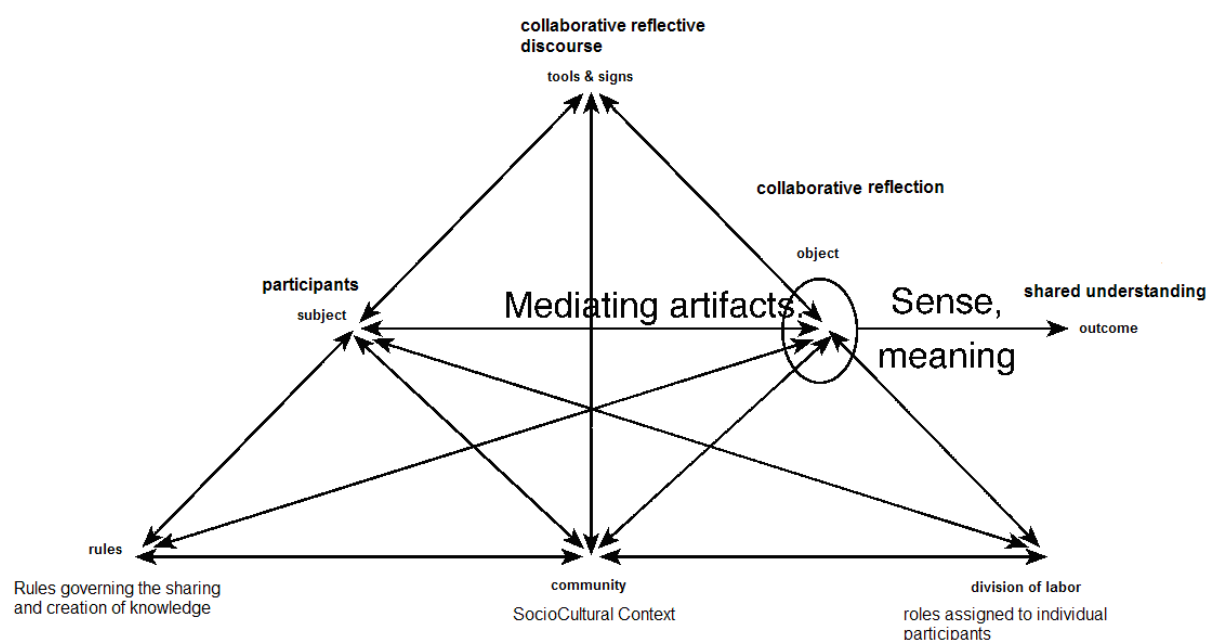


Figure 2 Collaborative reflective discourse activity, adapted from (Engstrom 2001)

Collaborative reflective social discourse serves to make visible one's viewpoint and experience to peers for the purpose of getting a different perspective. Lin et al (1999) highlight three benefits for reflective social discourse: increased interaction within participants, reflection becomes more motivating when there is a public audience, and reflection helps ideas and thoughts to become artefacts or objects for further reflection. It is these artefacts which are being referred to as reflective conceptual artefacts that help the learner apply the learning from a past experience to aid in CKB. Development of reflective conceptual artefacts also enables the subject to articulate their knowledge for knowledge building and sharing.

The activity, according to CHAT is not simply concerned with doing in terms of action for completing a task but also refers to doing in order to transform something with the focus on the contextualized activity of the system as a whole (Engestrom 2001). In a similar context, the rectangles in the CKB model (Figure 1) are products as a result of a transforming activity. The principles of CHAT allow for the study of subjects use of reflective thinking as a tool in the CKB process. The principles of CHAT that are useful for the study are discussed next.

The disturbances or transforming influences known as contradictions (Turner and Turner 2001) are very useful in this context. These contradictions help to explain the constant state of change in the activities (Hawkins and Whymark 2005). The constructs of CHAT are useful in the analysis of the CKB process because both, CKB and CHAT are dynamic processes which are in a constant state of change. Identifying and understanding these contradictions within the CKB activity system will help in the design of environments supporting CKB.

CHAT also helps in analysing the CKB activity system from various perspectives. That is, it conceptualizes the setting as an activity which can be studied on the basis of the Object and Outcomes from various viewpoints (facilitator, individual participants, and the group perspective). This “multi-levelness” allows for an analysis which is not possible with other theories or research methods (Issroff and Scanlon 2002). The discussion shows that CHAT provides for – (1) a rich description for the subjects (participants) use of reflective thinking in the CKB process, (2) the constructs and the language offered by CHAT are useful in understanding the process, (3) an analysis showing the usefulness of the constructs of CHAT to study participant’s use of reflective thinking in the CKB process, and (4) the principle of tools mediating (using artefacts) the process of subjects achieving the object (producing) is used in formulating the research questions.

6.1 ARTEFACT MEDIATED REFLECTIVE THINKING

According to Stahl (2002), knowledge building is mediated by artefacts. An artefact is defined as “a meaningful object created by people for specific uses” (Stahl 2002, p5). The proposed model of CKB has the reflective conceptual artefact developed as a result of a transforming activity. The artefact helps the subject in articulating their knowledge in the CKB process. Reflective thinking is used by the subjects as a tool for co-construction of knowledge and this process is mediated by reflective conceptual artefacts. Reflective thinking is used as a tool and a process for critically analysing the problem. As a result of this process, subjects are able to develop reflective conceptual artefacts that mediate the process of CKB. Mediation in this context “means that something happens by means of, or through the involvement of, a mediating object” (Stahl 2002, p5). It is therefore argued

that reflective thinking is used by subjects as a tool to achieve an objective (collaboratively building knowledge). This activity (Figure 3) is mediated with the help of reflective conceptual artefacts.

The relationship between the subject and object is mediated by the tools which have been culturally and historically accumulated. In terms of the CKB model, the question being analysed is:

Where is reflective thinking taking place in relation to the CKB process? Is reflection being utilized as a tool to mediate the activity by the subjects whose object is to collaboratively produce knowledge?

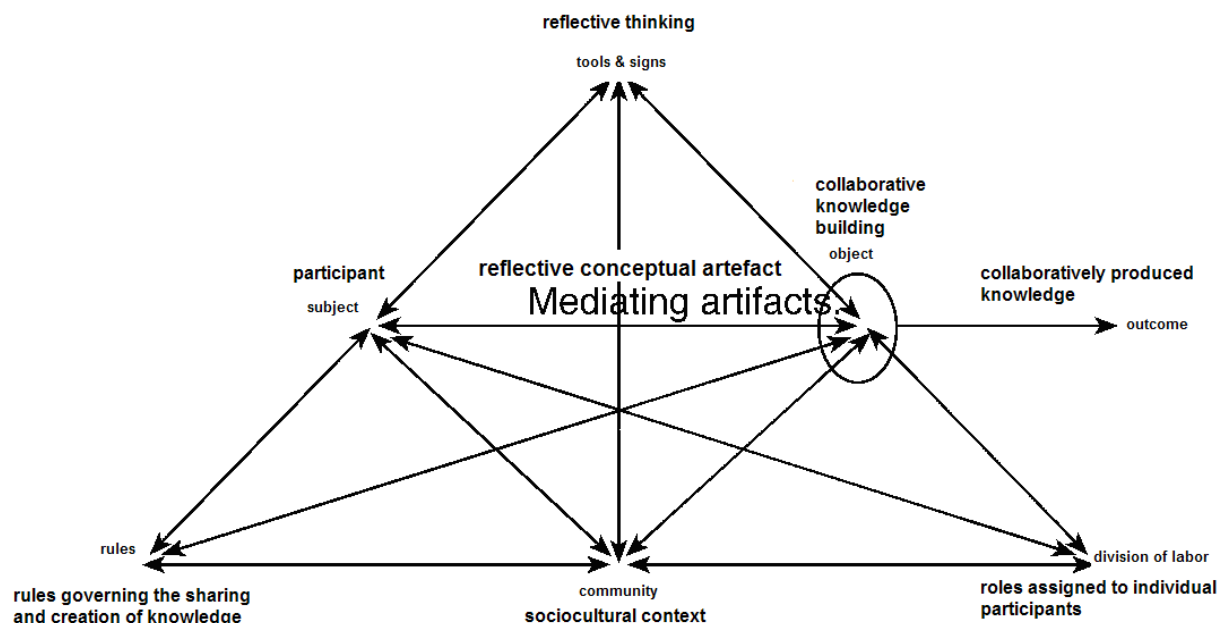


Figure 3 Role of the mediating artefact. Adapted from (Engestrom 2001)

Reflective thinking can be analysed in terms of a description of artefacts and their mediation in the activity. Engestrom (1999, p381) describes ways of using artefacts as:

1. "Primary artefacts or 'what' artefacts that are used to identify and describe objects
2. Secondary or 'how' artefacts are used to guide and describe processes and procedures, within or between Objects
3. Tertiary or 'why' artefacts are used to diagnose and explain the properties and behaviors of objects
4. Quaternary or 'where to' artefacts which mediate expansive learning and envision the future state"

The conceptual tools used and affecting knowledge production are reflective thinking and reflective conceptual artefacts. The analysis of the tools at the:

1. Primary level will help in describing, explaining, and identifying the role of reflective thinking in the CKB process.
2. Secondary level will show how reflective thinking and reflective conceptual artefacts are being used as tools by the subjects? This analysis will show how the participants use reflective thinking and reflective conceptual artefacts. A rich description at this level will make "visible" (externalize) the reflective thinking process and possible ways of providing technology support.
3. Tertiary level helps in explaining the nature of the reflective thinking process. It is useful to understand whether reflective thinking is a cognitive, behavioral or social process in order to identify possible means of technological scaffolds.
4. Quaternary level will reveal where is the mediation of tools (reflective thinking and reflective conceptual artefacts) taking place between the subjects and objects leading to an outcome (knowledge production)?

Primary artefacts	What	Describe and identify reflective thinking
Secondary artefacts	How	Process of reflective thinking
Tertiary artefacts	Why	Nature of reflective thinking process
Quaternary artefacts	Where to	Diagnosing the future state of reflective thinking activity

Table 1: Analysis of reflective thinking

This analysis will illustrate and explain the mediating nature of reflective thinking activities (**Figure 4**) in the CKB process and ways of providing technology support. Engestrom (1999) explains that there is nothing inherently fixed in an artifact that determines its state at different levels (Primary, Secondary, Tertiary, and Quaternary). A conceptual model may be used as a diagnostic tool, but may also become a descriptive primary artifact. Similarly, if reflective conceptual artefacts are being used by Subjects for collaboratively producing knowledge, then diagnosing the activity (reflective thinking cycles) and its future state (evolving into different level/state or to a more culturally advanced activity) will help in providing proper scaffolds for reflective thinking activities.

The unit of analysis will be reflective thinking activities based on Rogoff's (1995) notion of three planes of Sociocultural analysis – personal, interpersonal, and the institutional-community planes of analysis. For the purpose of this study, the three planes are personal understanding, mediated cognition (Vygotsky 1978) using reflective thinking as a tool, and group understanding. The process of CKB involves interactions between personal and group perspectives with reflective conceptual artefacts mediating the process (**Figure 4**) of joint meaning making and co-construction of knowledge (Lipponen 2002).



Figure 4 Three levels of analysis, adapted from (Stahl 2000a)

Stahl (2000a) describes the process of joint meaning making as a “synergistic moment” by which groups construct meaning. The synergistic moment is defined as “the critical point during collaboration in which a group constructs meaning that transcends what any participant may have in mind” (Stahl 2000a, p70). The main premise of the paper is that participants use reflective thinking activities as a tool helping in development of reflective conceptual artefacts. It is through interacting with these artefacts that participants interpret meaning (**Figure 4**). This appropriation of reflective conceptual artefacts helps participants to externalize and articulate their knowledge through communicative language or social symbol systems (John-Steiner and Mahn 1996). In other words, use of reflective thinking as a tool mediates the process of joint meaning making and externalizing knowledge in the CKB process. The meaning is embedded in the use of and interaction with the artefacts. Therefore, research needs to focus on jointly constructed artefacts. This will allow analysis to show how reflective thinking is used as a tool for forming reflective conceptual artefacts that help participants in articulating and sharing knowledge, engaging in higher level thinking, and bringing conceptual change. This in turn will highlight the nature and process of CKB and how technology can be designed to support it. The constructs of CHAT, taking into consideration personal perspective (Subject) and group perspective (Community) within the context of joint meaning making activity (CKB activity system), provide the right analytical and research tool for investigating the process of CKB.

7 CONCLUSION

The paper has presented a conceptual framework useful in researching participant's use of cycles of reflective thinking activity as a tool in the CKB process. It describes a research model that can be used to investigate the way participants construct knowledge in a collaborative context. The reflective thinking cycles incorporated in the model allows for the study of how participants implement learning and knowledge in problematic situations. The research model aims to further extend the usefulness of the Stahl (2000) model and so further our knowledge and understanding of the CKB process, and as a consequence improve our understanding of how technology can be designed to support reflective thinking activities.

The constructs of CHAT provided a useful framework for analysing the CKB process. The constructs are used in formulating the research questions and breaking down the CKB process into sub-activities. This will help in providing a rich description of the sub-activities in the CKB process. The questions posed in the paper are relevant not only for developing a sound pedagogical model, but also for investigating how knowledge workers work. Future work is now required in assessing the modified model in a knowledge building setting. It is proposed that analysis of the use of reflective thinking activity as a tool by the participants will provide guidelines and a framework that aids in the design of CKB environments.

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