

## **Conceptualising work activity for CAL systems design**

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**Abstract** As computing technology has increasingly become relevant to people's everyday lives, emphasis is being placed on ensuring Computer Assisted Learning (CAL) tools support users in ways that are meaningful to them. This requirement has highlighted the need to understand the complex and often dynamic social and cultural organisation of collaborating individuals in context. Here, the aim is to conceptualise the natural flow and evolution of work practices so as to inform the design of these systems. This paper reports on empirical findings of an investigation into the design requirements for a CAL system for supporting knowledge sharing activities in an organisation.

**Keywords:** Information systems, collaboration, mediated, professional, case study.

### **Introduction**

More and more organisations are developing and using CAL systems to support knowledge sharing within the context of work processes. Nevertheless, developing computer-based tools that are functionally useful to the user has become increasingly complex due to the need to accommodate local social and cultural habits of the end-user within the system's support mechanism. The use of a CAL system to support knowledge sharing activities in an organisation impinges on many local social and cultural factors. Local approaches to knowledge sharing in organisations can both be formal and informal. Knowledge sharing procedures in this context can also be dynamic and continuously evolving, an aspect that makes supporting this kind of learning through the use of a computer system difficult and complex. These complications are worsened by most organisations' need to speedily implement new systems and work patterns in order to remain competitive. Achieving sufficient usefulness of a computer system requires investment in understanding the user. This requirement entails conceptualising the multiple aspects of human activity by reflecting on the social-cultural and developmental perspectives that influence the performance of human activity in context. Conceptualising these human perspectives can help to establish the mechanisms by which computer tool users introduce and use tools to mediate their work activity. Understanding the incorporation of technological tools in human activity has arguably become the most topical and technically interesting subject area in the field of systems design (Fields & Wright,

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2000). As a result of this, a growing body of literature and research methodologies has emerged. These include but are not limited to activity theory (Nardi, 1996), and also contextual design (Beyer & Holtzblatt, 1998).

The structure of this paper is presented as follows. The introduction section articulates some of the current design challenges facing developers of CAL systems used to support knowledge sharing in the context of an organisation. These discussions highlight the importance of understanding the intended user of the CAL system, and, also the environment in which the user operates. Thereafter, the paper considers the use of activity theory to help understand the user by studying work practices in context as a starting point for CAL systems design. A brief introduction to activity theory is given. This is followed by an outline of the activity theory based methodology applied to investigate work practices in two organisations. Within this section, discussions show how information about work practices in the two organisations was gathered, analysed and interpreted in terms of activity theory. Finally, the paper presents findings of the study, which emphasise the fact that the kind of tools used to mediate work activity can have an impact on knowledge sharing attitudes within an organisation. These views are reiterated in the discussions and conclusion section, which identify certain common themes that reinforce the importance of considering social-cultural and contextual issues when designing and introducing a CAL system to support knowledge sharing in an organisation.

### **Activity theory – a brief introduction**

‘Activity theory is a philosophical and cross-disciplinary framework for studying different forms of human practices as developmental processes, with both individual and social levels interlinked at the same time’ (Kuutti, 1996).

Activity theory is not necessarily a theory, but a framework from which various methods and theories for analysing human activity could be developed. The framework presents a collection of basic theoretical concepts to help understand the relationship between human mind (consciousness) and activity (what people do) (Bannon & Bødker, 1991; Nardi, 1996). Human activity is taken as the basic unit of analysis when using this framework. According to activity theory, human beings (*subjects*) engage in purposeful (*object-ive*) activity so as to satisfy established needs. Human activity is therefore driven by the need to satisfy an objective. The object or objective motivates human beings to carry out activity.

In addition, human activity is mediated through the use of *tools*. Therefore, the concept of tool mediation is central to the whole theory. In the meanwhile, activity is realised through various *actions* that are targeted towards the achievement of conscious *goals*. At the same time, actions are accomplished through a series of unconscious *operations* whose successful execution is dependent on the *conditions* that exist in the context in which activity is carried out. For example, in an organisation, conditions can be reflected in the formal or informal *rules and division of labour* specifying the procedures for carrying out work activity. Conditions therefore, form the social and cultural structure of work activity in an organisation. The social and cultural structure of an organisation (*community*) can constrain or influence the extent to which work activity is successfully carried out. As a result of these constraints and influences, human activity is not static, but instead it continuously evolves. This evolution triggers changes in human activity and also in

the design of tools used to mediate that activity. Tools are created and transformed as a result of developments and changes in human activity. Therefore, tools accumulate and transmit social knowledge about the cultural context in which they were developed and used. Given this stance, knowledge about carrying out a particular work activity is incorporated within the design of the tools in use. Therefore tools shape the way human beings interact with reality.

Activity theory was developed out of the Russian social-cultural historical psychology introduced by Vygotsky (1978) and his followers, namely Leont'ev (1978). The theoretical concepts presented in activity theory are unified in the collective model of human activity — the Activity System developed by Engeström (1987) (see Fig. 1).

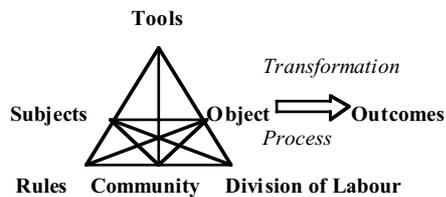


Fig. 1. Activity System (Engeström, 1987)

The theoretical concepts presented in activity theory continue to influence thinking in many areas of research and practice including systems design (Mwanza, 2001; Nardi, 1996) and work analysis (Blackler *et al.*, 2000).

### Research methodology

A study was carried out to investigate the design requirements for a computer system for supporting knowledge sharing activities in an organisational setting. The study used activity theory to analyse work practices in two organisations from a social and cultural perspective so as to establish the means by which those practices occurred and also how they were supported. The objective was to obtain insight to guide the design of a computer system for supporting those work practices. The two organisations used in the study were part of a consortium of a European funded project — Enrich (<http://kmi.open.ac.uk/projects/enrich/>). The Activity System (see Fig. 1) was used to heuristically operationalise concepts from activity theory that were considered relevant to work analysis and tool design. The study began by interpreting the various components of the Activity System in terms of work practices in the two organisations under investigation. This interpretation was necessary to obtain basic understanding about work practices in these organisations so as to produce each organisation's activity system. The interpretation process involved the use of the *Eight-Step-Model* (Mwanza, 2001) introduced as a means of operationalising Engeström's Activity System (Fig. 1). The *Eight-Step-Model* incorporates open-ended questions based on the various components of the Activity System as shown in Table 1.

**Table 1.** Eight-Step-Model (Mwanza, 2001)

Activity System component	Question to ask
Activity	What sort of activity am I interested in?
Object-ive	Why is this activity taking place?
Subjects	Who is involved in carrying out this activity?
Tools	By what means are the subjects carrying out this activity?
Rules and regulations	Are there any cultural norms, rules and regulations governing the performance of this activity?
Division of labour how	Who is responsible for what, when carrying out this activity and are the roles organised?
Community	What is the environment in which activity is carried out?
Outcome	What is the desired outcome from this activity?

Table 1 shows the various components of the Activity System whilst indicating the relevant questions to ask when translating the Activity System in relation to work practices being examined. Using the *Eight-Step-Model* whilst answering questions in relation to work practices can help the researcher to pinpoint areas to focus on during the investigations.

The data gathering process involved a combination of observational studies of work practices and also the interviewing of workers whilst they carried out their duties. The open-ended questions associated with the *Eight-Step-Model* were used as pointers to what to look for during observational studies, and also to trigger questions to ask in questionnaires and interviews. Both the interview and observational studies were conducted ethnographically (continuously in context) for over a period of two years. In addition to this, data was also gathered through formal and informal gatherings, for example team meetings and coffee breaks. A review of company documentation for example, paper-based and system-based work manuals was also carried out. Qualitative data about work practices in the two organisations was gathered in the form of interview and observational notes made on paper. The information gathered about work practices in the two organisations studied is presented as follows.

### **Organisation One: An industrial computing organisation**

Organisation One develops and maintains industrial computing systems for its customers all over the world. Part of this maintenance involves rendering continuous customer support on products sold. The organisation was trying to provide better customer support by encouraging workers to share their knowledge and experiences about resolving customer problems. The organisation already had in place several mediators to support the activity of sharing knowledge about work. These mediators included the use of a computerised Call Tracking System (CTS). The CTS was used to trace and monitor the progress of a call from the first time a customer reports a problem, right up to the time the problem gets resolved. A case was usually created to reflect details of the problem and solutions applied. The CTS was linked to a database of customers' cases information. The use of the CTS therefore facilitated knowledge sharing at various levels of customer support by enabling workers to access and update customers' cases information on the database. Online and paper based manuals were also used as information resources for staff to refer to when solving cases. The organisation employed two different product support systems for resolving cases. These included a fast track system for dealing

with prepaid cases charged at a high rate, and a basic rate system charged at a low rate. A '3 hour rule' was introduced for dealing with fast track cases, as these had priority over basic rate cases. There was no fixed duration for resolving basic rate cases. The two product support systems did not contribute directly to the knowledge sharing effort. They were instead introduced to enhance flexibility and efficiency in the customer support process. A database of frequently asked questions (FAQ) together with answers was being developed as a way of encouraging workers to share their experiences from solving cases. Workers were therefore required to identify and gather suitable questions and answers from their workloads whilst carrying out normal duties so that these could be included in the FAQ database.

In the meantime, the organisation had also introduced the use of a performance rating system so as to monitor both individual and team performances against targets. This performance rating system used bar charts as performance measures. The bar charts showed the total number of problem cases received, the number of cases resolved, the number of cases pending, the number of cases targeted, and also the category of cases showing whether they were priority or basic rate cases. These bar charts were published on a weekly basis and used by management to determine the productivity of an individual for the purpose of promotion. Management in this organisation also used bar chart performance indicators to determine the productivity of a team for the purposes of allocating responsibilities when deciding which team should support which product. Each team normally specialised in supporting a single product. This meant that no two teams worked on the same product at the same time. Therefore, there was a need to familiarise workers with supporting various product types. A job rotation system was introduced to allow workers to familiarise themselves with duties of other teams supporting different products from theirs.

Workers in this organisation had a very informal method of sharing knowledge. It involved a work cultural norm of consulting a local unofficial expert within the team when faced with a difficult case. This unofficial local expert would be someone recognised by fellow workers as someone willing to assist once consulted with a problem case.

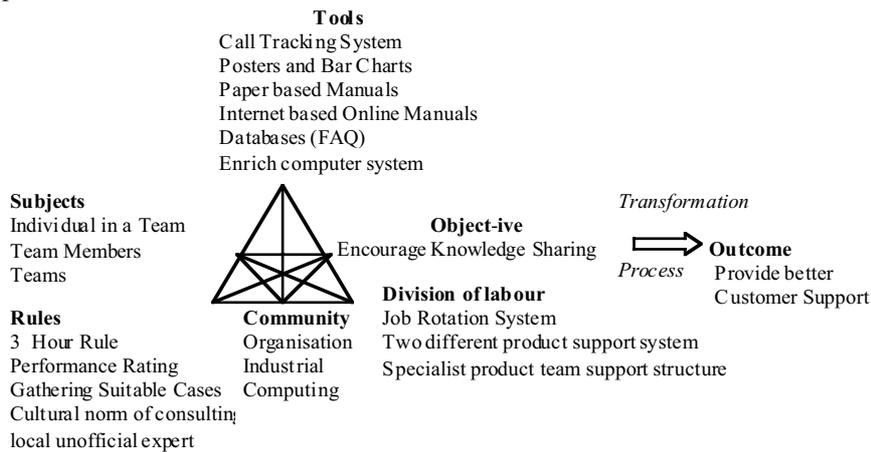


Fig. 2. Organisation One's Activity System

The information gathered about work practices in Organisation One was translated in

terms of activity theory to produce Organisation One's Activity System as shown in Fig. 2.

### **Organisation Two: An aerospace manufacturing company**

Organisation Two operates in the aerospace industry. They manufacture aeroplanes and body parts for both commercial and military purposes. The company employs thousands of people at its manufacturing sites or what is usually referred to as 'plants' all over the UK. Manufacturing operations at these plants are organised in a team structure. Team operations tend to be product oriented with team members working in various areas including engineering and assembling plane body parts. Each team consists of a minimum of 15 workers. In terms of division of labour, a team usually has a leader who is responsible for directing work operations within a team. The team leader reports to the line leader who in turn reports to the production manager and the hierarchy goes on. In addition to carrying out their normal duties workers were required to continuously reflect on their work practices by holding team planning meetings in order to assess or rate their performances against targets set by management. The key idea behind these team-planning meetings was to encourage workers to evaluate their work practices during the team planning process so as to learn from each other's experiences. The management later introduced the use of a paper-based company workbook as a tool to guide the team planning process and provide a means for recording team-planning activities.

The company workbook includes the team planning sheets and team scoring matrices. The team planning sheets were used for setting new objectives to be satisfied. They were also used to record decisions made with regards to the kind of actions to be taken so as to achieve targeted objectives. The team scoring matrices on the other hand were used to assess whether or not the objectives set had been met. This was established by rating and recording scores for each target. During the team planning exercise, a team would normally hold a meeting to measure its performance against any of the targets by indicating the current level of performance, thereafter, to set future targets to be met.

Management's decision to introduce the use of a company workbook to guide the team planning process was an attempt to standardise the performance assessment procedure across all teams in the whole organisation. This standardisation initiated the process of formalising work procedures in this organisation. Management had hoped that formalising work procedures in this way would encourage knowledge sharing about work, across all teams throughout the organisation. Knowledge sharing about work took the form of an accumulation of 'lessons learnt' or what was referred to as 'best practices'. These 'best practices' mainly consisted of work experiences of other teams at different plants within the organisation. Within the framework of the Enrich project, management in this organisation suggested the idea of developing a computer system as an enriched and enhanced version of the paper-based company workbook. The initial design requirements for the Enrich system were therefore focused on supporting knowledge sharing activities, such as data capture and storage, and also on providing interactive access to information stored.

The information gathered about work practices in Organisation Two was translated and used to produce the organisation's Activity System as shown in

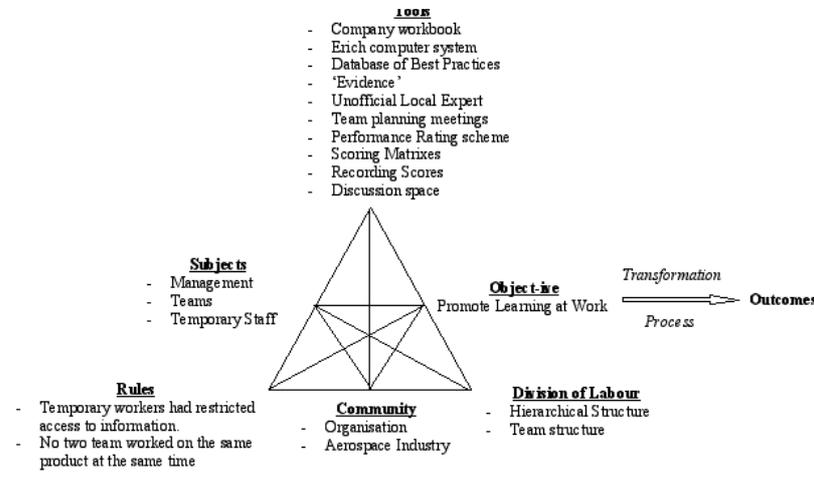


Fig. 3. Organisation Two's Activity System

Fig. 3.

**Findings**

The qualitative data gathered from the two organisations was analysed in terms of activity theory's concept of contradictions so as to identify work practices and mediators that were in conflict with the objective of learning through knowledge sharing. As well as identifying conflicting areas, the study also tried to establish those work practices and mediators that enhanced knowledge sharing activities amongst workers. Therefore, the study tried to understand the means by which knowledge sharing was mediated in a work context whilst investigating how knowledge sharing was hindered through the use of certain mediators and also other forces in the organisation.

When analysing work practices in these two organisations in terms of activity theory, certain common themes that contradicted the objective of sharing knowledge were identified. These are discussed below.

*Knowledge sharing practices*

In Organisation One, the use of a performance-rating scheme to monitor workers' performances by using weekly bar charts seemed to have created a competitive culture amongst workers. This emerging competitive culture was in direct contradiction with the objective of sharing knowledge because workers were concentrating more on improving their own performance ratings instead of, for example, identifying and gathering suitable FAQs for the database. The idea of gathering FAQs for the database was an effort to enhance the knowledge sharing process by making work experiences of employees available in an accessible form. The contradiction arises as a result of the difficulties employees experienced in finding a suitable compromise between working efficiently to improve personal ratings and finding time to reflect on work performance in order to gather suitable FAQs for the database.

A similar contradiction was identified in Organisation Two following the management's decision to introduce the idea of requiring workers to consult a database of 'best practices' as part of the knowledge sharing process. Workers in this organisation did not find 'best practices' meaningful to their duties due to the fact that the solutions did not include the context and process by which those lessons were learnt. Workers in this organisation had already established their own method of sharing knowledge that involved using the idea of 'evidence'. The idea of 'evidence' in this context refers to an individual or a document containing facts about how to go about carrying out a particular task. This notion of 'evidence' was preferred because it incorporates the methods and explanations of how the knowledge came about. Workers in this organisation could easily identify and relate to the notion of 'evidence' because it incorporated local practical ideas that were developed from team members' experiences. The introduction of the database of 'best practices' misrepresented workers' local cultural habit of sharing knowledge using the idea of 'evidence'.

Even though the two organisations employed different strategies to try and encourage workers to share knowledge, these approaches did not succeed mainly due to social and cultural forces in the work context that impacted on knowledge sharing. Organisation One's bottom-up approach to supporting knowledge sharing by encouraging workers to identify and gather suitable questions and solutions for the database was in conflict with the performance rating system. Organisation Two's top-down approach whereby the management identified suitable 'best practices' for workers to consult and learn from introduced conflicts with the workers' already established culture of sharing knowledge using 'evidence'.

#### *Formalisation of work procedures*

Both organisations used formalisation of work procedures as a means for encouraging knowledge sharing amongst workers. In Organisation One, this was reflected in the use of both online and paper-based manuals to guide the process of resolving customer problems. Organisation Two had introduced the use of a company workbook to guide the team planning process. Whilst formalisation introduces advantages of standardising work patterns hence making it easier to manage and support work practices using a CAL tool, workers felt that they were being controlled and monitored in their working styles. The study discovered that workers in both organisations already had well established work habits that were mainly informal and unstructured. These informal work patterns could not be easily formalised or standardised without disturbing local cultural habits. For example, the idea of consulting a local unofficial expert when faced with a problem could not be easily implemented into a computer support mechanism without affecting local cultural habits in one way or another. The *Enrich* computer system tried to emulate this process by introducing a 'discussion space' environment to support similar consultations and collaborations so that these could be captured, stored and accessed by all employees in the organisation. This effort disturbed the established local cultural habits due to the formalisation of discussion and collaborations that were normally informal and conducted in confidence.

### *Product specialisation*

In both organisations, workers at team level usually worked on a single product whereby no two teams worked on the same product at the same time. This approach caused conflicts with the objective of knowledge sharing because it led to limited or no cross-team interactions amongst workers in both organisations. Management in Organisation One had recognised this concern and introduced measures to address it. They introduced a job-rotation system whereby individuals within a team moved to join other teams from time to time so that they could familiarise themselves with work operations of that team. In both cases it was difficult to share knowledge because employees worked on different products at all times.

### **Discussion and conclusion**

When reflecting on findings of the analysis of work practices in the two organisations in terms of activity theory, certain common themes emerge that highlight the social-cultural and contextual aspects of work practices with regards to knowledge sharing. These themes raise important issues to consider when designing a CAL system to support knowledge sharing activities in an organisation. These relate to, but are not limited to:

- The need to be sensitive to social and cultural aspects of the intended user.
- The need to understand the context of deployment for the tool being developed.
- The need to understand influences of the established local patterns of collaborating and interacting as these impact on the use and acceptability of a CAL tool.

The core issue in this paper is that developing useful CAL systems to support knowledge sharing in an organisation can be a very complex endeavour. This complexity is worsened by the often informal and unstructured knowledge sharing procedures. Informal knowledge sharing processes are not always 'self evident' since they are usually embedded in social-cultural practices. These social-cultural and contextual issues can influence the usage and usefulness of a CAL system. These issues therefore highlight the need to be sensitive to the way human beings organise themselves. By understanding this complexity, it may be possible to design and develop robust and useful tools to support work practices and learning in an organisation. The study has shown that the activity theory framework can be used to yield rich insights into the means by which users introduce and use tools to mediate their work activity. These may be useful in informing the design of a CAL system.

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### **References**

- Bannon, L. & Bødker, S. (1991) Beyond the interface: Encountering artifacts in use. In: *Designing Interaction: Psychological Theory at the Human-Computer Interface* (ed. J.M. Carroll), pp. 227–253. Cambridge University Press, Cambridge.
- Beyer, H. & Holtzblatt, K. (1998) *CONTEXTUAL DESIGN: Defining Customer-Centred Systems*. Academic Press. London.
- Blackler, F., Crump, N. & McDonald, S. (2000) Organising Processes in Complex Activity Networks. *Organisation*, 7, 2, 277–300.

- Engeström, Y. (1987) *Learning by Expanding: an Activity-Theoretical Approach to Developmental Research*, Orienta-Kosultit Oy, Helsinki.
- Fields, R. & Wright, P. (2000) Editorial: Understanding work and designing artefacts. *International Journal of Human-Computer Studies*, 1, 53, 1–4.
- Kuutti, K. (1996) Activity Theory as a Potential Framework for Human–Computer Interaction Research. In *Context and Consciousness: Activity Theory and Human–Computer Interaction* (ed. B.A. Nardi) pp. 17–44. MIT, Massachusetts.
- Leont’ev, A.N. (1978) *Activity, Consciousness, and Personality*. Prentice Hall, Englewood Cliffs, NJ.
- Mwanza, D. (2001) Where Theory meets Practice, A Case for an Activity Theory based Methodology to guide Computer System Design. In *Proceedings of INTERACT’2001: Eighth IFIP TC 13 International Conference on Human–Computer Interaction* (ed. H. Michitaka) pp. 342–349. IOS Press, Oxford.
- Nardi, B.A. (1996) *Context and Consciousness: Activity Theory and Human–Computer Interaction*. MIT, Massachusetts.
- Vygotsky, L.S. (1978) *Mind in Society – the Development of Higher Psychological Processes* (eds. M. Cole, V. John-Steiner, S. Scribner & E. Souberman). Harvard University Press. Massachusetts.