Activity Theory as a Framework for Accommodating Cultural Factors in HCI Studies

Edith Maier

University of Applied Sciences St.Gallen, Switzerland

Abstract

This article is based on research conducted in the framework of an EU project aimed at enhancing knowledge management and setting up an eLearning platform. It focuses on one particular aspect, i.e. accommodating cultural factors in human-computer interaction (HCI) studies, of a wider ranging study which has been published as a doctoral thesis under the title "The Quest for a Theoretical Framework for eLearning and Knowledge Management Activities". For the purposes of this article, the eLearning dimension with associated models and concepts has been largely excluded from the discussion. Similarly, the complex issue of defining culture and context and the different approaches to identifying cultural differences cannot be dealt with within the scope of this article.

1   Background and Context of Research

The aim of the EU project concerned the creation of customised Web-based training (WBT) courses for a major manufacturer of helicopters in France with a culturally highly diverse range of customers. At an early stage in the project the partners realised that cultural factors would have to be taken into account at all levels (analysis of user requirements, development and design, implementation and evaluation) for the application to succeed. If on-site training was to be supplemented by eLearning components, cultural adaptation and adaptability, respectively, would have to be integrated into the design of the modules. The crucial question addressed by the research was whether it was possible to design Web-based training modules for a culturally heterogeneous, but professionally homogeneous user group in such a way that they could be understood and were acceptable without further customisation or localisation. A corollary to this question was the extent to which particular requirements were truly culture-specific or genre-specific, i.e., for example, whether in the case of pilots - as opposed to technicians - professional background including a relatively special process of selection would override cultural influences. The quest for a theoretical framework which could accom-

modate the role of cultural factors and the importance of context, community and inter-action in HCI studies, soon came to assume a central role. The study required a theoretical framework that could supply concepts and models both for human-computer-interaction as well as for learning and teaching in a virtual environment. At the same time, the framework had to accommodate human, social and cultural factors, cope with computer-mediated collaboration processes and take into account the environment or context in which activities such as learning and teaching occur.

In the following paragraphs I give a very brief outline of some of the major approaches in HCI research and the role which they assign to cultural factors. I discuss their main characteristics and point to their shortcomings, which leads me to activity theory as an alternative. I present a brief survey of its history and discuss its most important principles and tenets. These are then illustrated by discussing a series of studies which have applied activity theory in HCI studies. Finally, I describe how I used activity theory for analysing the empirical data gathered mostly by means of ethnographic research and usability tests. They were analysed with the help of Grounded Theory (Strauss 1994), evaluated using the activity checklists developed by Kaptelinin and Nardi (1997) and then structured, organised and eventually integrated into a wider activity theory framework that accommodates cultural factors.

2   Theoretical Models in HCI

Publications in the field of HCI rarely deal with cultural differences beyond interface design. Authors, on the whole, make little effort to define the concept of culture or to establish links between existing concepts in cultural psychology with HCI theories. When cultural factors are taken into account in HCI studies, they tend to be restricted to their impact on interface design. Similarly, few authors in the HCI field have tried to define the concept of culture or establish links between existing concepts in cultural psychology with HCI theories. Hoft (1995) was one of the first to direct attention to existing cultural models and encourage her readers to use them as tools for optimising internationalisation.

An author who has not only applied cultural models to usability engineering, but also conducted an in-depth scientific investigation into the relevant theoretical issues is Honold (2000). In her doctoral thesis on the impact of cultural factors on the design and use of technical products, she compares concepts and models for gathering cultural information during requirements analysis, attempts to define the notion of culture and examines the role of cultural factors in usability engineering.

In my own study, four approaches were selected and discussed in more detail, namely:

1. cognitive ergonomics, the most influential and predominant approach at the moment,

2. situated action, which emphasises the situational context surrounding the use of a product,

3. distributed cognition, which moves the unit of analysis to the system, whereas in traditional views of cognition the boundaries are those of individuals, and, finally,

4. activity theory as a meta-approach.

Cognitive ergonomics serves as the theoretical underpinning for many models and methods prevalent in the HCI field. It rarely addresses the concept of culture and, by and large, studies based on this approach tend to ignore the context in which HCI occurs.

This shortcoming has been largely remedied by the more empirically grounded situated action approach which differs from the rationalistic accounts of human behaviour found in traditional cognitive theories. It states that every course of action depends in essential ways upon its material and social circumstances (e.g. Suchman 1987). The embeddedness of the user in a specific (cultural) context and a framework of reference is therefore recognised. situated action approach with its focus on real activities in real situations. Although for many situated action represents a welcome corrective to the dominant cognitive credo, it has been criticised for its lack of reference to overall motives and objectives and the fact that the approach does not provide tools or models with which to describe them, especially if they go beyond the immediate situation. It has also been criticised for being too global to provide guidance to applied studies and, on the other hand, too concerned with microscopic and detailed analysis (Nardi 1996).

Distributed cognition also favours ethnographic methods for capturing the interactions between people and artefacts and supplements them with experiments. But, unlike the situated action approach, it attempts to free research from the particulars of specific cases and to discern the important constituents of interactions among people and between people and material artefacts. It therefore allows generalisations and has actually begun to generate a body of comparative data on patterns of work practices in various domains such as aviation or navigation. Distributed cognition also recognises the need to look at real activity – to study cognition 'in the wild' as its advocates like to call it – in order to understand interactions between people and technologies. Unlike cognitive ergonomics, it extends its reach beyond the individual to focus on whole environments and moves the boundary of the unit of analysis beyond the individual and thus situates the individual as an element in a complex cultural environment. Cognition is therefore no longer isolated or separate from culture.

More recently, activity theory has emerged as a sort of meta-approach that can help overcome the shortcomings of the information processing models of cognitive science and the lack of abstraction and modeling capacities of the situated action approach.

Actually, distributed cognition also claims to provide an overarching research framework. Hollan, Hutchins and Kirsh (2000), for example, propose this approach as a new foundation for HCI which integrates the merging dynamic of interaction. Indeed, distributed cognition not only has a great deal in common with activity theory, it also shares many of its tenets, as is confirmed in Nardi's (1996) comparison of three approaches to HCI – situated action, distributed cognition and activity theory. Nardi sees

activity theory and distributed cognition as very close in spirit and believes that the two approaches will "mutually inform, and even merge, over time" (1996:89). The problem with the distributed cognition approach is that although an outline exists as an integrated research framework, it has not yet been implemented. Hollan, Hutchins and Kirsh (2000) admit that the integrated research program they have sketched out is ambitious in scope and in the skills demanded and describe the efforts they have embarked on in this respect. But they concede that they will need to await the results of their various ventures to better understand the consequences of putting into practice what they propose.

3   Activity Theory as a Theoretical Framework

Activity theory is a set of basic principles that constitute a general conceptual system rather than a highly predictive theory and, since it is a dynamic and systemic approach, it can cope with a rapidly changing environment. People are seen as embedded in a sociocultural context with which they actively interact. The complex interaction of individuals with their environment is called activity and is regarded theoretically as the fundamental unit of analysis. Activity theory traces its roots back to psychological perspectives in the Soviet Union in the 1920s. Its basic foundations were laid by psychologists such as Vygotsy, Luria and Leontiev. It was only with the collapse of the Soviet Union at the end of the 1980s that activity theory became known to HCI researchers in the West. It was above all Bødker's works (1989, 1991) that stimulated interest in activity theory and its potential benefits to the HCI community. Her ideas have been taken up and developed further by researchers such as Kuutti (1992), Bannon and Bødker (1991), Engeström (1996) and, above all, in the compilation of articles edited by Nardi (1996). Although activity theory now supports studies in other fields, especially in developmental psychology and educational technology (which will be discussed in the following chapter), it also provides a broad framework for describing the structure, development and context of computer-supported activities and a foundation on which HCI researchers might base common discourse and from which they can derive tools for design and evaluation (see e.g. Kaptelinin and Nardi 1999).

Tool mediation is one of the most important concepts of activity theory. Tools or artefacts refer to culturally produced means for changing the environment and achieving goals. Humans are seen as continually changing tools or artefacts or creating new ones. From an activity theory perspective, computer technologies and the Internet, for example, are considered tools. At the same time, activity theory shifts the focus from interaction between users and computers or computer-based systems to the wider context of interaction between human beings and their environment. According to Kaptelinin (1996), understanding the use of computers in a particular case requires an analysis of the computer's history and its potential developmental transformations. Furthermore, the author states that the term 'user' encompasses not only individuals, but also groups and organisations. The HCI field, therefore, needs to be recognised as an open system consisting of the meaningful context of the user's goals, environment, available tools and

interactions with other people. The inclusion of both communicative and collaborative aspects makes activity theory also an appropriate basis for addressing important aspects of HCI, including computer-supported cooperative work and cross-cultural aspects of computer use.

3.1   The Role of Culture in Activity Theory

Culture and its historical roots enjoy a prominent place in activity theory. People are seen as embedded in a sociocultural context with which they actively interact. Whereas for Vygotsky (1978) the unit of analysis was still the mediated action of an individual, Leontiev (1978) extended it to include the collective activity, something done by a community with a motive. Kaptelinin (1996) is also very explicit about the role of cultural factors in activity theory and considers it to provide a wider theoretical basis for HCI studies than cognitive psychology. He also argues that although cognitive psychology can be successfully applied to a number of HCI problems, such as the user's perceptions, mental models, control of the system and user interface versus functionality of the system, one of its serious limitations is what he terms 'ecological validity' (1996:106). Since the information processing loop is closed, it is difficult to take into consideration the phenomena that exist outside it, i.e. the social, organisational and cultural context in relation to the goals, plans and values of the user.

From an activity theory perspective, the computer, or an eLearning system, is considered as a mediating tool that needs to be seen in the context of the entire environment within which it will be used (e.g. the classroom setting, the presence or lack of presence of an instructor and his/her role, the role of other students etc.). Tools are regarded as carriers of cultural knowledge and social experience.

3.2   Critique

Despite the many benefits of activity theory for HCI studies, its advocates do not promote it as the panacea for HCI studies, but instead argue in favour of an eclectic approach that combines models and concepts from distributed cognition, situated work theories and activity theory. Kaptelinin (1996), in particular, in his outline of the potential impact of activity theory on the study and design of computer use in real-life settings also mentions some of the limitations and shortcomings of activity theory. These include:

- Activity theory's original focus on understanding individual activity, not that of a group or organisation

- Activity theory's narrow view of culture

- Its perspective on tool mediation has not anticipated the representation problems of virtual reality.

- Its lack of operationalisation.

The last point has also been taken up by Honold (2000), who deplores the comparative lack of concrete applications of activity theory. She notes that its very comprehensiveness implies great freedom for researchers when it comes to applying its basic principles, but at the same time harbours the danger of arbitrariness and theoretical aloofness. However, the shortcomings enumerated by Kaptelinin are currently in the process of being remedied. The following chapter discusses recent studies that have applied concepts and models from activity theory including to topics such as collaboration in groups and to virtual reality.

4   Application of Activity Theory to HCI Studies

Context and Consciousness (1996), a collection of articles edited by Nardi, provides an excellent introduction to activity theory as a theoretical alternative to the cognitive science approach that still dominates much of HCI research but also examines some practical applications of activity theory by giving research examples as well as providing clear suggestions for research methodology. In her own contribution, Nardi reflects on how the use of activity theory would have been a better choice in analysing her data from a field study of slide makers. The aim of the study was to ascertain whether end-users prefer task-specific or generic application software. By comparing the analysis of data before and after the application of activity theory, the reader gains a good insight into the 'added value' of activity theory as an analytical tool.

Bødker introduces the concepts of 'breakdown' and 'focus shift'. As can be seen from the discussion of the article written by Spagnolli, Gamberini and Gasperini (2002) below, the concept of breakdown provides a link to Thomas' cultural standards approach in which critical incidents are used for capturing cultural differences in the use of technology. Studying breakdowns or critical incidents when designing or evaluating the use of applications enables us to identify usability problems. As already mentioned, Spagnolli, Gamberini and Gasperini (2002), who share a background in psychology, have applied the concepts of activity theory to the analysis of breakdowns. In their study, they combine activity theory with the situated action approach to analyse breakdowns in a virtual library. They place action at the centre of the analysis of users' interaction with the technology to examine it from a structural and organisational level. The authors argue that combining the two approaches allows us to concentrate on the breakdowns occurring during users' interaction with the virtual environment and study these episodes from a situated point of view. They proceed in two steps: identifying and collecting breakdown episodes, recording them on videotapes and then analysing their structure, circumstances and development including any possible actions taken to remedy the problem.

Gould, Verenikina and Hasan (2000) have applied activity theory to the design of interactive Web-based information systems. They base themselves largely on the principles outlined by Leontiev (1978), but adapt certain concepts to make them more suitable for usability. Instead of referring to internalisation/externalisation, they use the term "struc-

ture and dynamics of interaction", while "mediation and development" is referred to simply as "development" and object orientedness is replaced by "environment". Gould and his co-authors attribute the appeal of activity theory to its broad view of the human psyche and behaviour and its well-structured categories for analysis. Another HCI researcher who recommends activity theory because of its adaptiveness to a wide range of domains is Honold (2000) in her work on intercultural usability engineering. She argues that activity theory can serve as the underlying approach for tackling the complex interdisciplinary issues that arise in the design of products for different cultures.

Also worth mentioning is yet another example of the wide applicability of activity theory, namely a study in which it is used for drawing up requirements for work situations. Turner, Turner and Horton (1999) show how activity theory concepts can be used to structure and organise ethnographically acquired data on work processes in a software house, or more specifically, a video record of a series of meetings held between a group of software designers. This work by Turner, Turner and Horton expands on the design checklist drawn up by Kaptelinin and Nardi (1999) and adapts it to their specific context and goal, i.e. requirements definition. Although the number of studies that apply activity theory to investigate and/or analyse the sort of complex interdisciplinary issues that were associated with the Project is still very small, the chances are very great that this will improve considerably in the years to come. In the following chapter I describe how I used activity theory as a tool for analysing the empirical data gathered in the course of the project.

5   An Activity Theoretical Analysis

Although the general principles of activity theory can help orient thought and research, they are nonetheless somewhat abstract when it comes to the actual evaluation of the data. This is why so-called activity checklists have been developed (e.g. by Kaptelinin and Nardi 1999) that can be adapted to the research context under study and used to structure and organise the empirical data usually gathered through ethnographic methods. With the help of these checklists, a contextual space is laid out which is represented by the most relevant areas. For the purposes of this study, the key areas consisted of strategies and goals, organisational context, learning, cognition and interaction as well as transformation and development. The checklists help make concrete the activity theory conceptual system for specific tasks and elucidate the most important contextual factors in the (computer-mediated) activities under study.

The diagram above illustrates how the key areas/factors identified in the course of this investigation can be integrated into an activity theory framework. At the centre of the structured description of the training activity is the activity 'triangle'. This goes back to Engeström (1987), who extended the graphical representation of an activity to recognise that it occurs in the context of a community, praxis (formal and informal rules) and division of labour. The Subject denotes the target users (mainly instructors and clients); the Tool refers to the knowledge management system and the eLearning platform (to be)

developed in the course of the Project. The model is complemented with the Environment, i.e. the organisational context that influences the training activity, as well as the Infrastructure, which in this case refers less to the hardware and more to the information architecture that lies at the heart of any knowledge transfer and exchange. Another key area is represented by Mental Models, i.e. the expectations, traditions and behaviour patterns of users. These are acquired through interaction with the environment and are thus rooted primarily in experience and the tacit knowledge resident in the environment and the way it is distributed and accessed. They do not determine the behaviour of individuals but point to probable modes of perception, thought and action. ental models also include the human, social and cultural factors that are integrative to any activity. In order to coordinate individual and group activities, this context-specific knowledge has to be externalised, i.e. formalised and communicated.
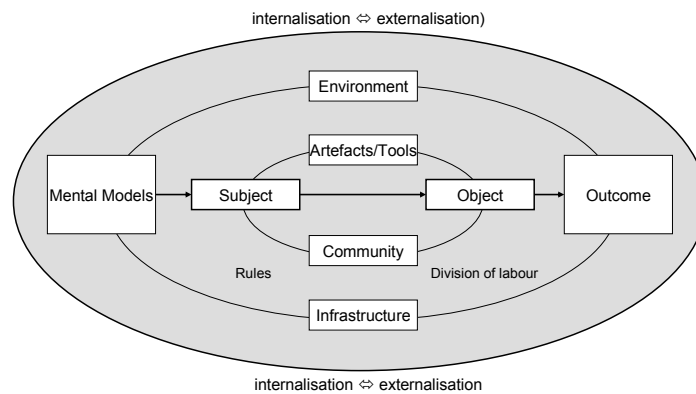

Figure 1: Training Activity System

The interaction between the two types of knowledge – as indicated by the bidirectional arrows - brings about what is referred to as the spiral of knowledge creation and, thus, is closely associated with learning. Learning, cognition and interaction represents *the* key area in this study and encompasses the entire shaded area in the diagram. The arrows indicate that the internalisation – externalisation dialectic drives the development process whilst, at the same time, influencing the mental models. It thus mirrors the fact that computer systems should support both internalisation of new ways of action and articulation of mental processes, when necessary, to facilitate problem solving and social coordination. The figure brings together the essential elements of the training activity, i.e. the role of cultural factors, the embeddedness of the activity in its organisational context and the importance of community and collaboration in both HCI and eLearning.

6   The Accommodation of Cultural Factors and Practical Implications

The study started out with the problem of defining culture and the different approaches for determining the influence of cultural factors. Finally, a pragmatic approach was chosen which implied looking for the aspects that were relevant to the issues involved in this particular investigation rather than a universally valid definition. In activity theory, social and cultural factors are considered an integral part of the context of any activity, regardless of whether the target groups are culturally homogeneous or characterised by great cultural diversity. Once we decide to study an activity in its context and try to identify the factors that influence its use, historical, social and cultural aspects automatically come into play. Depending on the target users and the usage situations, these can manifest themselves in different forms. The findings of this study challenged the conventional, anthropologically inspired bias towards equating culture with ethnic or national identity. The results of both the ethnographic research and the usability tests showed that professional background had a higher predictive and explanatory value concerning learning style, interaction patterns or preferences with regard to user interfaces than country of origin or age. It goes without saying that this finding cannot be generalised given its very specific context. However, there are other professions such as lawyers, doctors or journalists which have a strong sense of tradition or absorb certain attitudes or communication patterns as part of their training which may yield similar results (see e.g. Abramson and Mizrahi 1996). In any case, this once again confirms the importance of immersing oneself into the environment or organisational context to gain a comprehensive and in-depth understanding of an activity.

The analysis also showed that preferences and requirements with regard to usability cover a very wide spectrum. Attempts at rendering them more systematic or pressing them into a particular schema have not met with great success. As a result, the product or computer-mediated system to be developed should be as flexible and adaptable as possible. In the long run, so-called adaptive or personalised systems appear to be the only solution to tailoring user interfaces, functions and the various interactive and collaborative features to an individual or a particular group. They also represent the most promising solution to the contradiction between striving to achieve cost-savings on the one hand and high-quality training and customer satisfaction on the other. By tailoring training to the needs and requirements of clients and giving them more control over the pace and time of study, training becomes more efficient. However, although the concept of adaptive or personalised computer systems has recently been discussed at many conferences, its actual implementation still looks rather remote. For the time being, customisation and adaptation has to be achieved by other techniques such as parameterisation or systems that allow multidimensional views of the content. As already noted in the usability section, designers should aim for the most flexible design possible. In the field of eLearning, this may involve the development of certain core scenarios supplemented with some culture-specific variations of scenarios of tasks. Another aspect of culture which has to be considered when developing eLearning materials is the conven-

tions, values and communication practices that prevail in cyberspace. In the environment of an online course, significant cultural 'gaps' can result from role differences, seniority/experience, perceptions of academic ability, gender, perceptions of time, professional status, tolerance for criticism and debate. These factors were subsumed under a series of themes with possible intercultural implications, among them attitudes towards authority, group *versus* individual focus, intellectual style or discourse and task *versus* relationship focus. Their relevance for the development of eLearning materials will, however, depend on the target group(s), the context of training, the topic or any other contextual factors that can only be ascertained through examining both the environment in which they will be used and the motives and goals of the future users.

7   Final Remarks

As illustrated by the discussion of relevant publications and the use of activity theory as an analytical tool, activity theory provides models and concepts for analysing cultural, social and historical structures and processes for a whole range of computer-mediated activities: from the design of user interfaces, the drafting of system requirements to the analysis of telelearning scenarios (Guribye and Wasson 1999). Furthermore, it can accommodate both contextual and collaborative aspects and do justice to the rapid changes typical of fields characterised by dynamic development. Despite its great adaptivity and usefulness, concepts derived from other approaches must not be discarded, in particular in instances when they can cast light on specific issues or aspects involved in the research. Concepts such as that of mental models derived from cognitive psychology or the attention to contextual detail propagated by the situation action approach, are in any case not in contradiction with activity theory, but can serve as useful complements. Activity theory can influence the methodology, analysis and evaluation used and thus help in obtaining valid and reliable data relevant to real-life contexts and organising field observations. Furthermore, it can make an important contribution to the development of design support tools. The design of any new interactive system, be it for learning, training or information management, involves the design of a new activity – either at an individual or an organisational level. Activity theory can be used to develop a representational framework that will help designers to capture current practice and build predictive models of activity dynamics. The availability of such conceptual tools could assist designers to achieve appropriate design solutions, particularly in the early phases of design.

In addition, activity theory appears capable of coping with subject matters that are subject to rapid change. When current methods, styles and standards in HCI or eLearning are applied, results are inevitably obsolete soon after they have been formulated. Activity theory puts results both in the context of basic, invariant principles underlying human activity and thus provides a better chance for creating a theoretical framework with predictive potential.

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Kontaktinformation: Edith Maier, edith.maier@fhsg.ch