Adopting a Sociocultural Perspective Towards the Research of Information and Communication Technologies (ICT) in Education

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Research studies of ICT in education have established that ICT promotes higher order cognitive skills of evaluating arguments, analysing problems and applying what is learnt. However, many of these studies focus on single learning variables and lack detailed investigation of what actually takes place in the learning environment and its sociocultural context. By adopting a sociocultural perspective of cognition, this paper provides an account of how the theoretical framework is developed to inform the design and methods of a two-phase study of uses of WinEcon in A-level Economics courses in the United Kingdom.

Phase one is a questionnaire survey, and phase two is a collective case study of three economics departments. The unit of analysis of the study is the activity system and the focus of attention is the role of the teacher. The descriptive and interpretive account of where and how an ICT package can be situated in the economics course to promote higher order thinking skills provides accumulated and useable knowledge for the integration of ICT in education. More importantly, the paper seeks to stimulate discussions and debates regarding the pertinent issues of researching the learning frameworks of ICT integration in education.

Introduction

Many studies have established the comparative advantage of ICT in academic courses (Pelgum & Plomp, 1991; Kulik, 1994; Sivin-Kachala, 1998; Taylor, 1999; Hsin-Yih, 2000). They are keen to prove that ICT 'works', and are usually concerned about showing the cognitive gains due to the use of ICT, or that the use of ICT (treatment group) has a comparative advantage over traditional classrooms (control group). Although the outcome of using ICT packages may be well documented, many of these studies lack detailed investigation and description of what actually takes place in the ICT environment.

A number of education researchers have shifted their attention towards the whole configuration of events, activities, contents, and interpersonal processes taking place in the context that ICT is used (Salomon, 1993; Laurillard and Taylor, 1994; Cole, 1995; Plowman,
For example, a particular observation of ICT use is understood and interpreted by reference to a larger background, and in turn, it provides a general account of the background that can illuminate the particular observed action. However, to keep sight of the totality while examining the particular levels of phenomena is a formidable task.

Taking up the challenge, this paper describes the construction and implementation of the theoretical framework for the study of where and how WinEcon can be situated in A-level Economics courses such that students are supported in the economics way of thinking. It draws upon the works of academics that have based their writings on the sociocultural conceptions of cognition in the learning environment (Bruner, 1990; Cole, 1985, 1995, 1996; Engeström, 1987, 1993; Lemke, 1995; Leont'ev, 1981; Pea, 1993; Perkins, 1985, 1993; Salomon, 1993; Vygotsky, 1934, 1978; Wertsch, 1985, 1991.). The common starting point of their viewpoints is the assumption that "action is mediated and that it cannot be separated from the milieu in which it is carried out" (Wertsch, 1991, p. 18).

WinEcon is a hypermedia package for teaching and learning introductory economics. It is developed over a period of three years by the Teaching and Learning Technology Programme (TLTP) Economics Consortium, consisting of economics departments from eight British universities, funded under the Higher Education Funding Council (HEFC). By linking the 'successful' and 'unsuccessful' uses of WinEcon in certain economics courses with particular teaching and learning activities, it is possible to build up a detailed account of how successful the activities are, what the participants have done to make them successful locally, and what are the problems encountered. This is particularly critical to education research where the object of inquiry is not simply knowledge, but useable knowledge. Hence, such studies will expand the repertoire of useable knowledge that is responsive to the changing needs of education practitioners.

**Towards a Sociocultural Perspective of Cognition and ICT**

The study of ICT in schools must be informed by theories of cognition. The study of cognition is to discover and describe formally "the meaning that human beings have created out of their encounters with the world, and then propose hypotheses about what meaning-making processes are implicated" (Bruner, 1990, p.2). This suggests that the data on cognition must be collected with an understanding of the sociocultural setting the participants are in.

The basic idea of the sociocultural approach to cognition is expressed in the 'general law of cultural development', where Vygotsky (1978) proposes that higher mental function appears "twice, or on two planes. First it appears on the social plane and then on the psychological plane. First it appears between people as an interpsychological category and then within the individual child (learner) as an intrapsychological category". That is, higher mental functioning is characterized by "voluntary control, conscious realization, social origins and nature, and mediation by psychological tools" (Wertsch, 1985, p.27).

There are two highly interconnected concepts in this basic idea: social origins and mediation through tools. The first concept draws special attention to the "adults' power to arrange children's environments so as to optimize their development according to existing norms" (Cole, 1996, p.111). The second concept emphasizes the consequence of tools mediating the activity. That is, "instead of applying directly its natural function to the solution of a particular task, the child puts between that function and the task a certain auxiliary means ... by the medium of which the child manages to perform the task" (Luria, 1928, p.495, cited in Cole, 1995, p.191).
From this perspective, cognition is no longer studied in light of individuals working in isolation with only their minds to guide them; instead, the emphasis is on individuals working with a variety of tools, and people that help them carry out their goal-oriented activities in a sociocultural setting. ICT is then no longer looked upon as merely extending and developing the cognitive potential of the individual; it is a mediational tool to cognitive development. Such a perspective highlights how participants encounter ICT as mediational tools incorporated within suitably rich settings of activities.

The Study of ICT as a Mediational Tool in Education

In the past, innovative education ideas were often hampered by lack of tools in education institutions that might allow them to create new learning and teaching methods in a reliable and systematic fashion. For example, Dewey's (1963) idea that children learn better if learning is truly a part of their living experience, or Vygotsky's (1978) idea that conversation plays a crucial role in learning. When these principles were applied in education, Papert (1993, p. 15-16) likened it to Leonardo trying to make an aeroplane out of oak, and power it with a mule. The lack of tools constrained the activities carried out in education institutions, and educators are forced to compromise so much that the original intent was lost.

Given the cognitive opportunities of ICT, it serves as a tool to mediate activities with respect to the guiding principles. Pea (1993) quotes various studies where ICT is used to achieve these desired activities in Mathematics and Science education. In these classrooms, graphic computer representations provide manipulable 'virtual realities' with action properties analogous to their real-world counterparts for modelling and reasoning about domain phenomena (Russell and Corwin, 1990; Tinker, 1992). In a more recent study of a "virtual laboratory" (V-Lab) for movement sciences, Rice and her colleagues (1999) show how students investigate real-world phenomena in the ICT-based laboratories, collect their own data and transform them into data display to be interpreted as results of their investigations.

Such a perspective highlights how students and teachers encounter ICT as mediational tools incorporated in settings with authentic goals and purposes for students, and settings that are explicitly interpreted with other experiences of knowing and understanding as they get organised at other times. As ICT enters the sociocultural setting of the school, it "weaves itself into learning in many more ways than its original promoters could possibly have anticipated" (Papert, 1993, p. 53). There is a context for the ICT experiences that encompasses activities peripheral to the particular times and formats of the ICT interaction itself. Salomon (1993, p. 189) proposes:

> No tool is good or bad in itself; its effectiveness results from and contributes to the whole configuration of events, activities, contents, and interpersonal processes taking place in the context of which it is been used.

Therefore, the study of ICT in education cannot be fractured from the learning environment in which it is situated. ICT may trigger changes in the activities, curriculum and interpersonal relationships in the learning environment, and is reciprocally affected by the very changes it causes (Salomon, 1993). The study needs to consider the social processes that ICT supports during the circumstances of use, and how the ICT experience is integrated into the discourse of learning.
Unit of Analysis: The Activity system

The discussion so far has established the relationships between ICT, cognition and its sociocultural setting. A systematic method of inquiry is necessary for demonstrating the intimate mechanisms that link ICT, cognition and its sociocultural setting. The study of ICT in education must ground its research in a unit of analysis that allows one to observe the actual processes by which sociocultural setting and cognition shape and are shaped by ICT tools. However, given the cultural, historical and institutional dimensions of the setting, it may lead to fragmented approaches towards sociocultural research. Therefore, when considering the unit of analysis, Vygotsky (1934) advises:

By unit we mean a product of analysis that, as distinct from elements, retains all the basic properties of the whole. These properties of the whole are not distributed among its living parts. It is not the chemical formula of water, but the study of the molecule and molecular movement that is the key to explaining the properties of water. Similarly, the living cell that preserves all the basic qualities of life of the living organism is the real unit of biological analysis.

(Cited in Wertsch, 1985, p. 194)

There is a basic unit common to the analysis of both sociocultural setting and individuals' cognitive processes. This unit of analysis "consists of an individual engaged in goal-directed activity under conventionalised constraints" (Cole 1985, p. 158). The centrality of activity to the sociocultural theory of cognition is reflected in Leont’ev’s (1981, p. 46-47) assertion that:

Human psychology is concerned with the activity of concrete individuals, which takes place whether in a collective - that is, jointly with other people - or in a situation in which the subject deals directly with the surrounding world of objects - e.g. at the potter’s wheel or the writer’s desk ... if we removed human activity from the system of social relationships and social life, it would not exist ... the human individual's activity is a system in the system of social relations. It does not exist without these relations.

The concept of activities as systems in the system of social relations can be adopted for the study of ICT in education. Activity system as a unit of analysis allows one to observe the actual processes by which cognition shapes and is shaped by its context, where the context is the activity system. It integrates the subject (individual participant), the object, the tools and the dynamic nature of human activities. Cole and Engeström (1993) represent the idea of activity systems with an expanded version of the classical mediational triangle.

The basic mediational triangle represents the basic structure of human cognition that results from tool mediation (see Figure 1). Drawing upon Vygotsky's (1978) higher and elementary mental functioning, 'unmediated' (elementary) functioning occurs along the base of the triangle; while 'mediated' (higher) functioning are interactions between the subject (individual) and object (task) mediated by mediating artefacts (tools), at the vertex of the triangle (Engeström, 1987). The tool through which the subject interacts with the world depends on his/her object in the activity system, and this shapes the interpretation, relevance and meaning of the mediational tools.
To account for the collective and dynamic nature of human activities the crucial components of community, rules and division of labour are added to the basic mediational triangle. Individuals must exist in communities where there is division of labour with the "continuously negotiated distribution of tasks, powers, and responsibilities among the participants of the activity system". The relations between the individual (subject) and community are mediated by the community's collection of mediating tools, and rules. Rules are "the norms and sanctions that specify and regulate the expected correct procedures and acceptable interactions among the participants" (Cole and Engeström, 1993, p. 7).

Taking the activity system as a unit of analysis provides important insights into the study of ICT in education. First, it provides a conceptual map to the major loci among which human cognition is distributed in the learning environment, with ICT as one of the mediating tools. Second, it includes other people who must be taken into account simultaneously with the subject as constituents of the activity systems. And third, institutionalised activities are more robust and enduring than an individual goal-directed activity, making analysis less problematic (Cole and Engeström, 1993).

The Study of WinEcon in Economics Courses

The success of WinEcon in an economics course depends on the way the ICT package is situated within the learning environment. The gap between the cognitive opportunities and actual use of WinEcon will continue to be immense as long as nothing is done to radically alter the conditions and circumstances prevailing in economics courses. The enculturation into the economics way of thinking results from the combined effect of many important sociocultural factors, and from multiple participants and tools in the learning environment. Activity system as a unit of analysis, represented by the expanded version of the basic mediational triangle, captures the activities mediated by students, teachers, ICT tools and non-ICT tools in the learning environment.

In this paper, the activity systems are the ICT and non-ICT lessons in the economics courses during the period of the study. Taking an activity system of a WinEcon lesson, the specific elements in the learning environment fit into the various components in the mediational triangle. The subject is the individual student and the object is assumed to think 'in an economics way'. A pool of ICT and non-ICT tools (including WinEcon) in the computer room mediate the interactions between the subject and object. These tools consist of WinEcon, other ICT packages, whiteboard, whiteboard markers, notebook, pens, data projector, projector screen, overhead projector, and textbooks. The subject belong to a community in which "each participant made significant contributions to the emergent understandings of all members, despite having unequal knowledge concerning the topic under study" (Palincsar, Brown, & Campione 1993, p.43).

The community consists of his/her classmates and teachers situated in the sociocultural setting of the computer room mediated by rules and division of labour. The rules include general rules like computer lab rules and regulations, and more specific ones like the procedures to navigate WinEcon. The role that each participant of the community plays fall under the division of labour.

Situating the Activity Systems: The 'Culture-as-Garden' Metaphor

To situate the activity systems within the broader context of the economics course, Cole's (1995) garden-as-culture metaphor is adopted. Culture and garden share a basic idea about creating an artificial environment with optimal conditions for growth of young organisms,
mediated by tools and other organisms. Cole (1995, p. 196) draws a parallel between the role of the sociocultural researcher and the gardener that both "must attend simultaneously to two classes of concerns: what transpires inside the system ('garden') they study (or design and study) and what transpires around it". These two classes cannot be addressed independently of each other, as the garden is dependent on the larger ecological system within which it is embedded.

Cole (1995) applies the garden metaphor to the Fifth Dimension, a specially designed learning environment for promoting the all-around intellectual and social development of six to twelve year old children. Applying the garden metaphor to the study of ICT in education will provide a more adequate and detailed account of the activity systems, and address the criticism that research of ICT in education is "too micro-focused and unwilling to engage with wider concerns (such as education and society at large)" (Kenway, 1996, p. 228). Knowledge of the operations and interdependence of the cultures, at various levels of context, will empower research studies to provide a better understanding of where and how ICT is situated in the academic course to enculturate students into the discipline-specific way of thinking.

Figure 2 shows the blueprint of the theoretical framework informing the study of WinEcon in an economics course. The activity system with its interacting components is in the innermost circle. Nothing is unidirectional in such an interactive system. Changes that are initiated by any of the components have an impact on the others. Although WinEcon is initially seen as a powerful change agent (an independent variable), it gradually becomes reciprocally affected by the very changes that it has caused (a dependent variable) (Salomon 1993, p. 190).

The next circle represents the academic course with elements such as mode of assessment, curriculum, layout of the classrooms and ICT rooms, and entry requirement to the course. The next higher level of context is the education institution where the course is situated. Elements to consider include the type, location, layout and ethos of the institution, ICT facilities, type of students, parents, peers, home computers, and time-tabling of ICT and non-ICT lessons. The education system is in the next circle with elements such as education policies, investment on ICT, and the recruitment, training and retention of teachers. The outermost circle is the society at large that consists of elements such as education software developers, publishers, and public perceptions of institution and teachers, research culture and expectations of employers.

A sociocultural approach towards the study rejects the view that ICT can be studied in isolation, or as the single variable in the learning environment holding all other things constant. Instead it must be studied within the learning environment and the broader context in which it is situated. The discussion in this paper has provided a theoretical window through which the activity systems in the academic course, with ICT as one of the mediating tools, can be described and interpreted. With the blueprint of the theoretical framework constructed, research questions may be formulated and research can proceed to study where and how ICT is situated in the academic course such that it supports the enculturation of students to think in a discipline-specific way.

**Design and Methods**

The main study consisted of two phases. Phase one was a survey of all economics departments, offering A-level Economics, in the UK with site licenses to WinEcon during the academic year 1997/98. The survey served as a screening phase to identify and select a subgroup from this target population for phase two of the study. It also provided a descriptive
account of the ecological setting in which the 3 departments are situated. Questions from the following related topics were included in the survey: pedagogical techniques of using WinEcon; department's experiences of using WinEcon; effects and reciprocal effects of WinEcon on the learning environment; future use of WinEcon in the course.

Phase two was a collective case study that involved the economics departments in Berkeley, Celtic, Oxforn School (names of schools and people have been changed to ensure anonymity). All 3 schools have been among the top 50 schools, in terms of A-level results, since the introduction of the league table. They were selected by opportunistic sampling from among 3 other departments that had met the following characteristics: WinEcon has been used for at least one academic year; WinEcon is in the department's scheme of work; WinEcon is used at least twice a month in each economics class; and WinEcon is supported by and is supporting other ICT or non-ICT activities in the course.

To provide an intensive and in-depth examination of the enculturation process of the students in the learning environment mediated by WinEcon, both qualitative and quantitative methods were employed for the collective case study. The methods in the multiple-strategies process included participant observations, face-to-face interviews with teachers, students' questionnaire and assessment, and focus group interviews with students (see Table 1). They involved gathering accounts of different realities that have been constructed by various groups and individuals in the learning environment. And hence, enhanced the scope, density and clarity of constructs developed during the course of the case study, and prevented the researcher from accepting too readily the validity of initial impressions based on one approach.

The design and methods of the study discussed in this section allowed for a holistic approach towards the study of the units of analysis in their natural setting. Although the study may be an exploratory one, its designs and methods were informed by the theoretical principles laid out in the preceding sections. These guiding principles continually reminded me throughout the study that an account from a particular observation, interview, questionnaire, or assessment must be understood and interpreted by reference to a larger background, and that account provided a general description of the background that could illuminate it.

**Conclusion**

The study described in this paper investigates and describes what actually take place when ICT is used in a context, and the meanings that human participants bring to that context. The theoretical framework may be adopted to explore research questions such as:

- Where and how are the cognitive opportunities of ICT perceived and taken up in the academic course? (Given the object of the activity system, and the constraints imposed by its sociocultural setting.)
- How are the activity systems designed such that ICT supports the enculturation process of thinking in a discipline-specific way?
- What are the roles of the different components in the activity system? (To have a focus of attention, one may choose the role of the teacher, student, tools, rules or community.)

However, I must qualify that the theoretical framework constructed is based on my own interpretations of sociocultural theories. Given the importance of meaning making in these theories, it will not come as a surprise if this framework collapses under intense firing from other sociocultural theorists. Although sociocultural theories of cognition capture the collective and dynamic nature of human cognitive activities, there is a lack of generally
accepted frameworks. Studies of such nature may then be criticized for a lack of rigor, validity and reliability.

Moreover, the accounts of such studies should be treated as tentative goals, as ideas to be considered, not as prescriptions to be followed. Researchers that provide rules or procedures for teachers regarding the use of ICT in any particular academic courses, and expect them to be treated as gospel, are fundamentally wrong. Instead, research studies of ICT in academic courses should provide insights of ICT uses in these courses, to be shared and discussed, reflected upon and debated among researchers and educators. Only then, will the studies be contributing to the repertoire of useable knowledge.
References


Figure 1: The Expanded Version of the Basic Mediational Triangle

Figure 2: Studying ICT in an Economics Course: Applying the Garden Metaphor to the Activities Systems
Table 1. Outline of Methods in the Multiple-Strategies Process for the 3 Departments.

<table>
<thead>
<tr>
<th>School</th>
<th>Oxforn School (5 - 23 Oct 98)</th>
<th>Celtic School (26 Oct - 20 Nov 98)</th>
<th>Berkeley School (11 - 29 Jan 99)</th>
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</table>
| **Participant Observation** | - 7 ICT lessons (all WinEcon).  
- 9 non-ICT lessons. All lessons are 1 hour.  
- Assemblies, break times, transition between lessons, free periods, fire drills, and after school activities. | - 8 ICT lessons (4 WinEcon, 2 BizEd, 2 Powerpoint).  
- 14 non-ICT lessons. All lessons are 35 minutes.  
- Break times, transition between lessons, free periods, and after school activities. | - 6 ICT lessons (4 WinEcon, 2 BizEd).  
- 18 non-ICT lessons. All lessons are 35 minutes.  
- Break times, transition between lessons, and free periods. |
| **Face-to-Face Interviews with Teachers** | - 2 one-hour planned interviews with each of the 2 teachers. First interview (week 1), the other (week 3).  
- All 4 interviews in classrooms.  
- Unplanned informal interviews in any situation, such as over a cup of coffee. | - 2 one-hour planned interviews with each of the 2 teachers. First interview (week 1), the other (week 3).  
- 2 interviews in classrooms, 2 in the resource room of the department.  
- Unplanned informal interviews. | - 2 one-hour planned interviews with each of the 2 teachers. First interview (week 1), the other (week 3).  
- 3 interviews in classrooms, 1 in the staff room.  
- Unplanned informal interviews. |
| **Student's Assessment** | - 30-minute session during student's free period.  
- Administered by researcher at the end of week 2. | - 30-minute session during student's free period.  
- Administered by researcher at the end of week 2. | - 30-minute session during Economics lesson.  
- Administered by researcher at the end of week 2. |
<p>| <strong>Student's</strong> | - 15-minute session | - 15-minute | - 15-minute |</p>
<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Focus Group Interviews with Students</th>
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<tbody>
<tr>
<td>• Administered by researcher at the end of week 1. session during student's free period.</td>
<td>• 1 30-minute session for assessment. 1 1-hour session for perceptions of use of WinEcon. 3 focus groups of 4-6 students; except one group with 3. Conducted in week 3. Conducted in classrooms during free periods.</td>
</tr>
<tr>
<td>session during student's free period.</td>
<td>• Conducted in week 3. Conducted in classrooms during free periods.</td>
</tr>
<tr>
<td>session during Economics lesson.</td>
<td>• Conducted in classrooms during free periods.</td>
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</table>

**Questionnaire**
- Administered by researcher at the end of week 1.

**Focus Group Interviews with Students**
- 1 30-minute session for assessment.
- 1 1-hour session for perceptions of use of WinEcon.
- 3 focus groups of 4-6 students.
- Conducted in week 3.
- Conducted in classrooms during free periods.