CHAPTER

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PARADIGM SHIFTS AND INSTRUCTIONAL TECHNOLOGY: AN INTRODUCTION

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In his well-known essay on the nature of scientific revolutions, Kuhn (1972) theorized that scientific research proceeds through long, relatively stable periods of normal science intermittently punctuated by briefer, more tumultuous times in which new paradigms for research may emerge. He characterized normal science as "research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice" (p. 10).

A scientific achievement represents a paradigm for Kuhn if it raises a compelling set of researchable questions and attracts a following of workers intent on pursuing those questions. The paradigm supplies its practitioners with "topics, tools, methodologies, and premises" (Lehnert, 1984, p. 22). It provides purchase in attacking what might previously have been considered intractable problems. A paradigm is not fixed, however, but is refined and extended through use. In Kuhn's words, it becomes "an object for further articulation and specification under new and stringent conditions" (1972, p. 23). Over time, competing paradigms may emerge, potentially leading to one paradigm's abandonment in favor of another. Such shifts are always revolutionary occurrences. As Kuhn observed, "the transition between competing paradigms cannot be made a step at a time, forced by logic and neutral experience. Like the gestalt switch, it must occur all at once (though not necessarily in an instant) or not at all" (1972, p. 150).

One interesting feature of Kuhn's theory of scientific revolutions is what he referred to as the "incommensurability of the pre- and post-revolutionary normal-scientific traditions" (1972, p. 148). Adherents to a new paradigm adopt an altered *Weltunanschauung*, prescribing a new way of observing, reflecting on, and describing the world. Though the notion of incommensurability is a source of controversy among philosophers of science (Biagioli, 1990; Kitcher, 1978), Kuhn held that the effect of a paradigm shift is to produce a divided community of researchers no longer able to debate their respective positions, owing to fundamental differences in terminology, conceptual frameworks, and views on what constitutes the legitimate questions of science.

In this chapter I argue that, seen from a Kuhnian perspective, instructional technology (IT) has undergone several such paradigmatic shifts in its relatively brief history. As a result of these shifts, the field has been balkanized into a number of smaller communities, each utilizing different research practices and espousing largely incommensurable views of learning and instruction. I argue further that there now appears to be a new paradigm emerging within IT, arising from yet another perspective on these same issues. This developing paradigm, for which the acronym CSCL has been coined (Koschmann, 1994a), focuses on the use of technology as a mediational tool within collaborative methods of instruction. Before pursin.~ this analysis, however, let me address some potential concerns about the legitimacy of applying Kuhn's theories to the body of work devoted to the uses of technology in instruction.

First in this regard is the issue of natural versus artificial science. In *Sciences of the Artificial*, Simon (1969) defined natural science as "a body of knowledge about some class of things—objects or phenomena—in the world; about the characteristics and properties that they have; about how they behave and interact with each other" (p. 1). The historical events on which Kuhn focused, such as Lavoisier's discovery of oxygen and Copernicus' development of a new model of the solar system, were clearly examples of this type of endeavor. The central thrust of work in IT, on the other hand, has been to produce practical artifacts to support instruction rather than to discover new principles about the natural world. Simon proposed an alternative category of scientific inquiry (i.e., artificial science) for work in areas devoted to the production of teleological objects designed to serve a particular goal or purpose. The issue, therefore, is whether or not it is appropriate to generalize Kuhn's descriptions of conduct within the natural sciences to work within an artificial science, such as IT.

A second, and related, concern has to do with the role of theory in the emergence and dissolution of research paradigms. Thagard (1992) has argued that although there have been noteworthy conceptual shifts in the social sciences, such as the shift in psychology from behaviorism to more cognitive approaches, they are different from the revolutionary shifts that have occurred in the natural sciences. He made a critical distinction between theories and approaches. Thagard defined a theory as a "coherent collection of hypotheses, [which] serve to explain a broad range of *empirical* generalizations and facts" and an approach as "a general collection of experimental methods and explanatory styles" (1992, p. 225). He concluded that because the social sciences have failed to produce any broad, unifying theories comparable to Newton's theories of mechanics or Darwin's theory of natural selection, the conceptual shifts that have marked past research in these fields were "more the result of methodological considerations than evaluations of explanatory coherence" (p. 225). Thagard's position is of interest here because I argue that the shifts that have occurred in IT were in fact driven by shifts in underlying psychological theories of learning and instruction.

Whereas it is quite true that instructional technology, as a field of study, is different in many respects from the scientific disciplines described by Kuhn, this does not mean that it could not be productively studied by the same means. Although the practices of research and standards of evidence utilized within a field such as IT may be quite different from those employed within the natural sciences, there is no reason to believe that the cultural factors that organize and lend structure to the field would be any different from the analogous factors operating within the disciplines studied by Kuhn. By the same token, Thagard's distinction between theories and approaches, although important to his typology of conceptual shifts, does not preclude an historical analysis of work within IT. Although the underlying theories of learning and instruction that I argue have informed work in IT do not meet Thagard's standard for a "theory," the fact that they have resulted in paradigmatic shifts in practice is the important issue here. Whether we choose to call the fundamental reconceptualizations underlying these shifts "changes in theory" or "changes in approach" is of little consequence to this discussion.

Conducting a Kuhnian analysis of IT is an instructive exercise, requiring a reexamination of the theories that have motivated work in the field and the practices by which technological innovations are designed and evaluated. Focusing on foundational theories and research practices, as opposed to the form and intended role of the designed artifacts, represents a novel way of conceptualizing past (and future) work. I begin this analysis by looking briefly at some of the past paradigms for research in the field. This serves as background to the more central question of this chapter; that is, does the emerging body of work devoted to CSCL constitute a new paradigm for research in IT?

PAST PARADIGMS OF INSTRUCTIONAL TECHNOLOGY

There are many ways of using technology to support instruction. Before computers, a number of other forms of technology—film, radio, and television—had been introduced into the classroom with varying degrees of success (Cuban, 1986). It was not until the advent of computers, however, that instructional technology came into its own as a broad area of study and my analysis, therefore, focuses on the use of computer-based technologies.[1] One can identify several past paradigms for the instructional use of technology, both within and outside of the classroom. In this section, I describe three—Computer-Assisted Instruction (CAI), Intelligent Tutoring Systems (ITSs), and the Logo-as-Latin Paradigm.

Because the paradigms we are about to consider are paradigms in educational technology, I endeavor to address four questions for each—two theory-based, and two relating to practice. First, what is the implicit *theory of learning* upon which the paradigm was constructed? Formulating an answer to this question will in many cases entail an exploration of the paradigm's epistemological commitments and its underlying philosophy of mind (Ernest, 1995). Second, what is the *theory of pedagogy;* that is, the underlying model of instruction implicit to the paradigm? Of particular interest here, of course, is the role of technology within this model. Shifting to the practical aspects of the paradigm, the third question explores its *research methodology* (i.e., How are claims warranted? What counts as scientific evidence? What are the methods by which this evidence is gathered?). The fourth and final question concerns what Kuhn called the "legitimate" (1972, p. 10) research problems of the paradigm, that is, what are the important *research questions* that the paradigm was established to address?

Developing an historical analysis of past paradigms for research in IT is an ambitious project to which a full book could be devoted. Because the focus of this volume is on the development of CSCL as an emerging area of work, I only provide a cursory sketch of the paradigms that have come before.[2] An exploration of this background material is essential, however, to developing an understanding of the context within which work in CSCL arises.

CAI Paradigm

Because the term *Computer-Assisted Instruction* (CAI), along with related terms such as *Computer-Based Instruction* and *Computer-Aided Learning,* is used in

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[1] The term *computer* should be construed broadly enough, however, to include emerging technologies such as high-bandwidth networks, wireless telecommunications, interactive television, and video conferencing.

[2] For the reader interested in exploring this body of work in greater detail, there are a number of references that could serve as points of departure. O'Shea and Self (1983) provided an excellent overview of early work done within the CAI tradition. Larkin and Chabay (1992) highlighted some of the connections among more recent work in CAI and ongoing work within the ITS tradition. Wenger (1987) provides a very thoughtful analysis of work within the ITS tradition. The contrast between constructivist theory and more traditional approaches to instructional design are taken up in a book edited by Duffy and Jonassen (1992). Finally, three edited collections (Jones & Winne, 1992; Lajoie & Derry, 1993; Rutkowska & Crook, 1987) straddle the division between constructivist theories of education and traditional ITS research.

a variety of ways in the IT literature, some clarification is required. In the early literature, CM was used generically as a blanket term for all uses of computers in education (e.g., Steinberg, 1991). Later, it came to represent a default background against which other more specific approaches were contrasted (e.g., Wenger, 1987). In the current discussion, however, I use the term in a more specific sense to refer to a particular paradigm in the design and evaluation of instructional technologies. I have chosen IBM's release of Coursewriter I, the first CM authoring tool (Suppes & Macken, 1978), in 1960 to serve as the inaugural event for the emergence of this paradigm.[3] The advent of courseware building tools made it possible for individuals without formal training in programming or computer science to develop their own computer-based teaching aids. Because many CM developers have backgrounds in teaching (Larkin & Chabay, 1992), applications developed under this paradigm tend to be straightforward and practical instructional tools designed around the identified needs of the classroom.[4]

Because of these close ties between CAI developers and education practitioners, CM applications tend to reflect the beliefs and attitudes of the general education community. Cuban (1993) described what he referred to as the "dominant cultural norms" with respect to learning, instruction, and the nature of knowledge. These beliefs, though rarely made explicit, are pervasive within the education world and are embraced by students, teachers, school administrators, and members of the surrounding community. In this view, learning is seen as the passive acquisition or absorption of an established (and often rigidly defined) body of information. The teacher's role is to "acquire formal knowledge, find efficient ways of sharing it, and determine whether pupils have learned what was taught" (Cuban, 1993, p. 248). Instruction, then, becomes a process of transmission or delivery. Reflecting the influence of prior work in programmed instruction (Skinner, 1968) and instructional design (Gagn~, 1968), CAI applications utilize a strategy of identifying a specific set of learning goals, decomposing these goals into a set of simpler component

[3]In providing an historical account of past work in IT, I have identified specific events to mark the emergence of each of the paradigms described. By coincidence, each of these selected events occurred at or near the beginning of a new decade. This pattern was quite accidental, however, and not meant to imply that a shift in paradigms need be expected every ten years. Indeed, each selection was somewhat arbitrary and for every chosen event there were alternatives, before and after, that could have served in its place. Selecting alternative events would not only change the dates on which some of the shifts occurred, but could in some cases change the order of their emergence. This type of historical gerrymandering, however, would in no way alter the central claim of the chapter, namely that shifts in research practice *have* occurred in instructional technology, resulting in the creation of several distinct communities of practice.

[4]At least this has been the intent. Cuban (1986) has argued that the failure of various technology-driven initiatives to achieve an appreciable impact has been due largely to a failure on the part of the designers to fully appreciate the expectations and requirements of classroom practitioners.

tasks, and, finally, developing a sequence of activities designed to eventually lead to the achievement of the original learning objectives.

Evaluative research in education has been, and to a large extent continues to be, dominated by a tradition that is both behavioristic and experimentalist (Lagemann, 1989). Work in CAI can be seen as upholding this tradition (BIaisdeII, 1976). Sharing the positivist's distrust of nonpublic, mentalistic phenomena, CAI researchers construe learning as a measurable difference in displayed proficiency. Learning, so defined, serves as a dependent variable in CAI research while the introduction of some form of technological innovation represents the experimental intervention. The use of control conditions is common in CAI studies—either through actual matched samples or through the use of pre- and post-treatment testing in which experimental subjects serve as their own control.

CAI studies are designed to address the question: What are the instructional benefits of an introduced technology? Research under this paradigm, therefore, has had as a central concern the issue of *instructional efficacy.* The paradigm itself has undergone some refinement over the years. Early work related to programmed instruction focused on parameters of reinforcement and their effects on learning (e.g., Coulsen, Estavan, Melaragno, and Silberman, 1962; Gilman, 1967). These were carefully controlled laboratory studies very much in the style of the behavioristic school (Skinner, 1968). Later work (e.g., Merrill, Schneider, & Fletcher, 1980) has attended to other kinds of variables and adopted a "systems" orientation (Dick, 1987) involving testing in more authentic contexts and the use of multiple dependent variables. Throughout its history, the tradition has favored technology-driven research in which the emergence of some form of technology (e.g., microcomputers [More & Ralph, 1992], hypertext, CD ROMs [Riding & Chambers, 1992]) stimulates a research to evaluate its effects on learning outcomes.

Though CAI is the oldest paradigm for work in IT, it is by no meills an abandoned one. Applications designed under this paradigm range from early drill-and-practice programs to more recent network-based World Wide Web documents.[5] They account for the bulk of instructional software now in actual classroom use, and evaluating the instructional effects of such applications continues to be an active area of research.

ITS Paradigm

The emergence of the next paradigm was the direct result of an immigration, which began in the early 1970s, of workers from the field of Artificial Intel-

[5] I by no means wish to suggest by this that *all* Web applications should be viewed as extensions of the CA] paradigm. The World Wide Web is very much a work in progress and I only wish to observe that at least some of its current applications, in their design and methodojogies of evaluation, are consistent with the traditions of CAI research.

ligence (AI) research into the educational arena. Carbonell's thesis defense (1970) was cited by Wenger (1987) as the event that marked the onset of this influx. Research in AI is founded upon the conjecture that cognition is, in some sense, a computational process that can be studied through the construction of "intelligent" systems that serve as functional models of the otherwise inaccessible processes of the human mind (Pylyshyn, 1989). If machines can be programmed to display intelligent behavior, there is no reason, at least in principle, that systems could not be designed to assume the role of a skilled teacher. Since one-on-one tutoring is commonly considered the gold standard against which other methods of instruction are measured (Bloom, 1984), the paradigm is founded on the proposition that education could be globally improved by providing every student with a personal (albeit machine-based) tutor (Lepper, Woolverton, Mumme, &Gurtner, 1993).

Information Processing Theory (Simon, 1979) served as one of the founding premises for work in AI. It held that problem solving (human and otherwise) could be seen as a process of defining a representation of a problem space consisting of an initial state, a goal state, and a set of operations for moving from one state to another. By this view, representation became a central issue for understanding both problem solving and cognition in general. Learning, in this light, becomes the process by which the problem solver acquires a proper representation of a problem space. Instruction, then, consists of activities designed to facilitate the acquisition of such a representation by the learner. The role of technology in this process is really not so different from the role that it assumes within the CAI paradigm. The differences are more in degree than in kind. In both cases, the designed application serves instruction by posing problems and by providing feedback to the learner. The difference is that ITSs aspire to do this in a more interactive fashion and with respect to a more complex set of skills.

Much more striking differences are seen, however, in the evaluative methods which comprise the paradigms. Unlike the CAI paradigm which reflects the standards and methods of the general educational research community, the ITS paradigm applies an approach adopted from research in AI. AI research is dedicated to the task of providing an account, in computational terms (i.e., algorithms and representational schemes), of various aspects of human cognition. The process by which this is accomplished was described by Lehnert (1984) as follows:

1. Propose a theory to explain the phenomenon.
2. Implement the theory in a computer program designed to simulate the phenomenon.
3. Run the program.
4. Analyze the program's output. (p. 24)

When I refer to the **ITS paradigm, therefore, I am r~f~rring** to work that applies the methods of AI research to the task of understanding skilled tutoring in complex domains. Competent tutoring in such domains raises several problems in representation—how to represent the knowledge of an expert in the domain, how to represent the pedagogical expertise of the tutor, and how to represent the (possibly faulty) understanding of the student user (Wenger, 1987).

Research conducted under this paradigm leads to the generation of a different set of research questions from those addressed within the CAI tradition. Whereas instructional efficacy is the *sine qua non* for CAI researchers, the critical issue for ITS researchers is *instructional competence;* that is, does the application faithfully emulate the behavior of a skilled tutor? The focus, therefore, is on the fidelity of the system's performance, rather than its effect on student learning outcomes.[6] This shift in priorities has been a source of misunderstanding among researchers working within the two paradigms. To an ITS researcher, a completed program serves as an existence proof for a theory, whereas to a CAI researcher, no project is complete until the application's value has been demonstrated in the classroom.

In the end, however, these two paradigms have more in common than is usually appreciated. Although one is implicitly behavioristic in its approach and the other explicitly cognitive, both assume an epistemological stance that is realist and absolutist (Doerry, 1994; Ernest, 1995). Both reflect prevailing notions of knowledge as given and of teachers as the final authority (Schommer, 1990). There is an implicit commitment to the existence of a "correct" representation and a view of the tutor as an agent for effecting the learner's acquisition of this representation. Furthermore, like the CAI developers before them, ITS researchers embrace a rather conventional view of teaching as delivery, what has been termed a *transmission model* of instruction (Pea, chapter 7, this volume). Wenger (1987), for example, argued that "the ability to cause and/or support the acquisition of one's knowledge by someone else, via a restricted set of communication operations" was the central problem of ITS design (p. 7). As we see, however, later paradigms represent a departure from these received norms, both in their underlying epistemological frame of reference and in their models of instruction.

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[6]This is not to say that there has been no research on the efficacy of Intelligent Tutoring Systems. However, most research within the ITS paradigm (as I have defined it here) has concerned itself with issues other than efficacy (e.g., what accounts for expertise [Koedinger & Anderson, 1990], how to provide plausible explanations to the student IClancey, 1983], how to represent the student's faculty understanding [VanLehn, 1982], the pragmatics of student! tutor interaction (Woolf & McDonald, 1984]). Although recent research in instructional design (e.g., "structural learning" [Scandura & Scandura, 1988], 1D2 [Merrill, Lin, & Jones, 1990]) is reminiscent of earlier ITS work in its emphasis on knowledge representation, its behavioristic evaluative traditions align it more comfortably with the CAI paradigm.

Logo-as-Latin Paradigm

The next paradigm arose from an epistemological perspective that holds knowledge to be acquired through "a process of subjective construction on the part of the experiencing organism rather than a discovering of ontological reality" (von Glasersfeld, 1979, p. 109). This view of learning, which is explicitly relativistic and fallibilist (Ernest, 1995), is referred to as *constructivism.*[7] It had its origins in the work of the developmental psychologist Piaget, who introduced a theory of learning whereby new information interacts with prior knowledge through a process of assimilation and accommodation (Piaget, 1985). This constructivist view of learning inspired the development of a number of instructional methods (e.g., "learning by discovery" [Shulman & Keisler, 1966]; Open-Classroom Learning, [Kohl, 1969]; Experiential Learning, [Koib, 1984]; Inquiry Learning [Bateman, 1990]) all dedicated to the proposition that learning occurs most propitiously under circumstances of personal inquiry and discovery.

Papert (1980) argued that the activity of programming computers could play an important role in constructivist learning.[8] Computer programs are particularly interesting artifacts for a learner to construct because, unlike term papers and other traditional class projects, they are executable. In building an executable artifact, such as a microworld or a computer-based simulation, the learner in effect "teaches" the computer, thus providing a new role for technology in learning. Instead of serving as a stand-in for the teacher, as was the case in the CAl and ITS paradigms, the computer becomes "tutee" (Taylor, 1980), allowing the learner to assume the role of teacher. The assumption here is that by engaging in the activities of programming—designing, building, and debugging programs—the learner acquires cognitive benefits that extend beyond simply learning to code in a particular language. A substantial research literature has accumulated that addresses the question of just what these benefits might be (Mayer, 1988; Palumbo, 1990; Pea & Kurland, 1987; Salomon & Perkins, 1987). Much of this research involves learning to program in Logo, a powerful programming language designed by Wally Feurzeig in the mid-1960s for use by young children (Papert, 1980). Because much of this work focuses on learning to program in the service of more general educational objectives, I have termed this research approach the *Logo-as-Latin Paradigm* (Koschmann, in press).

[7]This is admittedly a bit of a gloss—constructivism is more a shared orientation than a unified school of thought. Within the community of workers collectively labeled as "constructivists" can be found a number of competing perspectives including *radical construciwism* (von Glasersfeld, 1979), *ecological constructivism* (Steler, 1995), *social constructivism* (Bauersfeld, 1995), and advocates of Cognitive Flexibility Theory (see chapter 2, this volume), sometimes labeled *information-processing constructivists* (Steffe & Gale, 1995).

[8]Because of its important role in stimulating later research, I have selected the publication of Papert's *Mindstorms* as the inaugural event for the emergence of this paradigm.

Exploring the cognitive benefits of programming can be 5~n as one part of a broader movement in educational psychology to identify mechanisms for fostering the development of general skills for learning and problem-solving (Bruer, 1993; Segal, Chipman, & Glaser, 1985). As a consequence, researchers working within this paradigm have utilized the standard research methods of educational psychology in assessing the cognitive benefits of learning to program. Whereas research under the CAl Paradigm is concerned with instructional efficacy, Logo-as-Latin research focuses more specifically on the issue of *instructional transfer.* Programming instruction is treated as the experimental intervention, and subsequent performance on other related tasks serves as the dependent variable. The use of control groups is common. Studies, so constructed, have investigated the effect of learning to program on planning (De Corte, Verschaffel, & Schrooten, 1992), metacognition (Clements & Gullo, 1984), and other aspects of cognitive performance (Lehrer & Littlefield, 1993)Y

Constructivist research takes as its central concern the issue of cognitive self-organization (Cobb, 1994). In so doing, it adopts the view of mind as a phenomenon residing within the head of the individual. This is a view that is deeply steeped in western philosophical traditions and that is foundational to most current research in psychology and education. It is not universally held, however. There are competing views that place the mind within the surrounding sociocultural environment. As we see in the next section, these alternate views have important implications for education and the use of technology therein.

CSCL: AN EMERGING PARADIGM IN INSTRUCTIONAL TECHNOLOGY

I argue in this section that we are currently witnessing the emergence of a new paradigm in IT research; one that is based on different assuml)tions about the nature of learning and one that incorporates a new set of research practices. Although there is a noted lack of agreement among the prevhtisly described paradigms with respect to their theories of learning and pedagogy, all three approach learning and instruction as psychological matters (be they viewed behavioristically or cognitively) and, as such, are researchable

~Itis worth noting that not all Logo-as-Latin research is based on Logo; nor does all research involving programming in Logo necessarily represent Logo-as-Latin research. There have been, for example, related studies exploring the cognitive benefits of programming In Prolog (Scherz. Goldberg, & Fund, 1990; Verzoni & Swan, 1995). Conversely, there is considerable research using Logo that is *not* concerned with the issue of transfer. This is true, for example, of much of **the** research done by Papert and his associates (e.g., Harel & Papert, 1991). Following in the tradition of classical Piagetian research, much of Papert's work with Logo has tended to consist of case studies designed to document children's achievements while working with computers.

by the traditional methods of psychological experimentation. This newly emerging paradigm, on the other hand, is built upon the research traditions of those disciplines—anthropology, sociology, linguistics, communication science—that are devoted to understanding language, culture, and other aspects of the social setting (cf. Scott, Cole, & Engel, 1992). As a result, it reflects a different view of learning and instruction, one that brings these social issues into the foreground as the central phenomena for study (Hutchins, 1993). This perspective has been influenced by a number of recent movements in the socially oriented (as opposed to the psychological) sciences. I briefly describe three, although there were certainly others that have contributed to this *Zeitgeist.*[0]

Socially Oriented Constructivist Viewpoints

Constructivism originally arose out of Piaget's research in developmental psychology and has developed into an important perspective in educational research (cf. Steffe & Gale, 1995). Within the constructivist camp, there is a growing interest in the social context within which learning occurs. Notable in this regard is the research of the so-called *neo-Piagetians,* who have emphasized the importance of peer interaction for cognitive development (Doise & Mugny, 1984). In educational research (particularly in mathematics education), a school of thought known as *social constructivism* has emerged (Bauersfeld, 1995; Cobb, 1994). As a constructivist perspective, it takes a nonabsolutist, fallibilist view of knowledge as constructed, but, unlike other constructivist positions, views this construction to be an essentially social process (Ernest, 1995).

Soviet Sociocultural Theories

Another important influence was the research of Soviet psychologists interested in the cultural basis of human intellect. Perhaps the best known of these was Vygotsky, who formulated the theory of *cultural-historical psychology* (van der Veer & Valsiner, 1991). His *General Genetic Law of Cultural*

'~1'wo other movements not discussed here but worthy of mention are Symbolic Interactionism and Social Constructionism. Symbolic Interactionism has its roots in the writings of the American Pragmatist philosophers, particularly George Herbert Mead (Blumer, 1969). As an analytic framework, however, it shares many of the concerns of the other approaches described here, especially the Soviet sociocultural theories and Situated Cognition (Star, 1996). Social Constructionism is another related movement that represents a research tradition in social psychology and sociology (Gergen, 1985; Harr~, 1986). Constructlonism (the "N" word rather than the "V" word) is dedicated "to the task of describing what the 'inner' life of a 'lingulstlcally situated person' in a socially constructed world is like" (Shotter, 1993, p. 161). Evidence of this inner life is extracted from the study of day-to-day communicative activities, discursive practices, rhetoric, and argumentation (Billig, 1987). Social Constructionists, like the socially oriented constructivists, are explicitly nonabsolutist in their views of the nature of knowledge.

Development stipulates that learning always occurs on two planes: first on the inter-psychological, and only later on the intra-psychological (Wertsch, 1985). As a mechanism for learning on the inter-psychological plane, Vygotsky hypothesized the existence of a construct that he termed the *zone of proximal development* (Vygotsky, 1978). This zone represents the enhanced capabilities of a learner working in the presence of a more skilled coworker or teacher.

The cultural-historical approach to learning developed by Vygotsky focused largely on the role of language in intellectual development (Brushlinsky, 1990). A related school, represented most prominently by the Russian researchers Leont'ev (1974), Galperin (1992), and Rubenstein (Brushlinsky, 1989), focused its attention on the role of activity in human development." One articulation of the so-called Activity Theory, attributed to Rubenstein (Brushlinsky, 1990), asserts that "The subject not only reveals and manifests himself in his actions and in the acts of his independent creative activity: he is created and defined in them. That is why the things he does can be used to determine and mould his character~' (p. 67). Activity Theory takes, as its unit of analysis, human goal-directed activity in its cultural context (Leont'ev, 1974). It focuses, therefore, on signs, symbols, rules, methods, instruments, and other artifacts that serve to mediate this activity.

Vygotsky's cultural-historical psychology and the work of the later Activity Theorists has subsequently developed a following both in educational research (Forman & Cazden, 1985; Griffin & Cole, 1987; Newman, Griffin, & Cole, 1989) and in the specialized area of computer science dealing with human/computer interaction (Kuuti, 1996).

Theories of Situated Cognition

The term *situated,* as in "situated learning" or "situated cognition," has assumed a variety of meanings in different disciplinary contexts. It refers to a specific theory in linguistics and philosophy of language (Barwise & Perry, 1983), a reaction in the Al community to symbolic models of cognition (Clancey, 1993; Winograd & Flores, 1986), a program of study in anthropology (Suchman, 1987), and a way of reconceptualizing educational practice (Brown, Collins, & Duguid, 1989; Greeno, 1989; Lave & Wenger, 1991). It is the latter two senses that concern us most directly here. In theories of situated cognition, learning is viewed as a process of entry into a community

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"The Russian *dyeyafyetnost* is commonly translated into English as "activity." Many Russian scholars, however, are not completely comfortable with this translation. German has two words, *Aktivitat and Totigkeit,* that both translate to "activity." The latter is composed from the adjective *twig,* meaning busy or engaged. It is used in expressions such as *in Tatigheit setzen,* meaning to engage or put into action. Consequently, this term comes closer to capturing the meaning of the Russian *dyeyatyetnost* than the usual English translation.

of practice, to wit: “To learn to use tools as practitioners use them, a student, like an apprentice, must enter that community and its culture. Thus in a significant way, learning is, we believe, a process of enculturation” (Brown, Collins, & Duguid, 1989, p. 33). Within this perspective, the context (both social and material) within which learning occurs comes under careful scrutiny, arising from a view “that agent, activity, and the world mutually constitute each other” (Lave & Wenger, 1991, p. 33).

Taken together these perspectives—social constructivism, Soviet sociocultural theories, and situated cognition—provide the intellectual heritage from which CSCL has emerged as a new paradigm for research in instructional technology. Although they arise within different disciplines and utilize different metaphors of social process (Geertz, 1980), they all represent a gestalt-like shift in point of reference relative to the views taken by the paradigms described previously. This shift in point of reference, leading to a foregrounding of the social and cultural context as the object of study, produces an incommensurability in theory and practice relative to the paradigms that have come before.

The model of instruction underlying work in CSCL is termed “collaborative learning.” Although it is easy to recognize examples of collaborative learning, it is difficult to provide a precise definition. Bruffee (1993) described it as “a reculturative process that helps students become members of knowledge communities whose common property is different from the common property of the knowledge communities they already belong to” (p. 3). This definition, focusing on what collaborative learning is meant to accomplish, resonates with the view of learning as entry into a community of practice. On the other hand, Roschelle and Behrend (1995) described it as “the mutual engagement of participants in a coordinated effort to solve [a] problem together” (p. 70). This latter definition highlights several facets of the method: a commitment to learning through doing, the engagement of learners in the cooperative (as opposed to competitive) pursuit of knowledge, the transitioning of the instructor’s role from authority and chief source of information to facilitator and resource guide. Examples of collaborative learning methods include Expeditionary Learning,[12] Group Investigation (Sharan, 1980), Problem-Based Learning (Barrows, 1994; Barrows & Tamblyn, 1980; Koschmann, Kelson, Feltovich, & Barrows, chapter 4, this volume), Project-Based Learning (Blumenfeld et al., 1991; Soloway, Krajcik, Blumenfeld, & Marx, chapter 11, this volume), and other forms of small-group learning (Noddings, 1989; Webb, 1982).

Over time, interest has grown in the question of how technology might serve to support collaborative methods of instruction (Crook, 1994; Koschmann, 1994a). There have been a number of significant events germane to the emergence of this area of work as a new paradigm in IT. A preliminary

[12] A method utilized in a New American Schools Development Corporation (NASDC) project undertaken by Outward Bound.

exploration of the issues engendered by the use of technology in collaborative education took place in 1983 at the Conference on Joint Problem Solving and Microcomputers held at the Laboratory of Comparative Human Cognition (LCHC; Cole, Miyake, & Newman, *1983).* A later workshop, conducted under the auspices of the NATO Special Program on Advanced Educational Technology, was held in Acquafredda di Maratea, Italy in 1989 (O’Malley, 1995). Because this was the first gathering to adopt the title “computer-supported collaborative learning,” I have chosen this event to mark the emergence of the paradigm. Subsequent CSCL workshops were held, one in 1991 at Southern Illinois University (Koschmann, 1992) and another at Ontario Institute for Studies in Education (OISE) in 1992 (Koschmann, Newman, Woodruff, Pea, & Rowley, 1993). The first international conference on this topic took place at the University of Indiana in the fall of 1995 (Schnase & Cunnius, 1995) and a follow-up is planned for 1997 at the University of Toronto.

As reflected in the chapters of this volume, CSCL applications assume a variety of forms. They can be categorized on a number of dimensions, including the locus of use, how the use is coordinated in time, and the instructional role it was designed to serve. Though the majority of CSCL applications are designed for student use, there is also a need for tools to support teachers engaged in collaborative forms of instruction (see chapter 11, chapter 5). The locus of use may be intra-, inter-, or extra-classroom (Koschmann & O’Malley, 1994). Applications have been designed for use within the classroom (chapter 9, chapter 4, this volume), to connect users across classrooms (chapter 8), and in some cases to create “virtual classrooms” (Hiltz, 1988). Users of an application may coordinate their interaction synchronously (e.g., chat programs) or asynchronously (e.g., e-mail). CSCL applications may serve a number of roles. Technology, for example, can be used to present or simulate a problem for study, helping to situate it in a real-world context (e.g., chapter 4, this volume). Alternatively, computers can be used to mediate communication within (chapter 6), and across classrooms (chapter 8, chapter 5) or to introduce new resources into the classroom (chapter 7). Computers can also provide archival storage for the products of group work, thereby supporting “knowledge building” (chapter 10). Finally, computers can support the creation of representational formalisms that enable learners to model their shared understanding of new concepts (e.g., the Envisioning Machine described in chapter 9).

Unlike the types of issues (i.e., instructional efficacy, instructional competence, instructional transfer) underlying the paradigms described earlier. research in CSCL is concerned with questions such as how is learning reflected in the language of learners (chapter 9)? How do social factors enter into the process of learning (chapter 3)? How is technology actually used in collaborative settings (chapter 6)? Stated differently, the central focus for research in CSCL is on *instruction as enacted practice.* Consistent with the soclocultural outlook of its practitioners, research in CSCL tends to utilize the research methods of the social sciences (for more on this see chapter 7, this volume). Although the paradigm is still very much in its formative stages, several comments can be made concerning the general analytic framework of research in this area First, driven by the types of research questions being asked, work in CSCL tends to focus on process rather than outcome. Second, there is a central concern with grounding theories in observational data (Glaser & Strauss, 1967) and in the construction of thick descriptions (Guba & Lincoln, 1981) of the phenomena under study. As a consequence, CSCL studies tend to be descriptive rather than experimental. A third and final aspect of this emerging body of research is that there is an expressed interest in understanding the process from a participant's viewpoint. As argued by Jordan and Henderson (1995), learning can best be understood "as a distributed, ongoing social process, where evidence that learning is occurring or has occurred must be found in understanding the ways in which people collaboratively *do* learning and *do recognizing* learning as having occurred" (p. 42, italics added). CSCL research focuses, therefore, on participants' talk, the artifacts that support and are produced by a team of learners, and the participants' own accounts of their work. There are a small but growing number of studies that fit this description (cf. chapter 9, this volume; Glenn, Koschmann, & Conlee, 1995; Griffin, Belyaeva, & Soldatova, 1992; Roth, in press).

It should be acknowledged that while all of the chapters in this book describe work at the confluence of technology and classroom collaboration, not all necessarily espouse a social theory of learning, nor do they all speak to the research issue of instruction as enacted practice. Although this may appear problematic given the description of the paradigm provided here, I think there are a number of ways of accounting for this discrepancy. One possibility, for example, is that some of the current researchers in the area continue to be influenced in their work by past paradigms; that is, that they currently exist with a foot in both worlds. This seems quite plausible, given the relative newness of the paradigm. Another possibility is that there may be more than one paradigm emerging with a commitment to collaborative forms of instruction. In addition to the paradigm described here, there may be one or more other paradigms with a more cognitive orientation. It is difficult to know for sure. In the end, it is always easier to provide an account of paradigms past than it is to describe a paradigm in the process of becoming.

LOOKING INTO THE FUTURE: HEGEL VERSUS KUHN

The four paradigms described in the chapter are summarized in Table 1.1. No clalm is made that this list is necessarily exhaustive. Indeed, it is recognized that there are examples of IT research that do not fit within any of

the paradigms described. Some of this work may be anomalous and does not subscribe to any particular paradigm, but the point is readily conceded that there probably exist additional paradigms that have not been discussed here.[13]

The analysis offered in this chapter provides a new scheme for categorizing work in IT. There have been numerous past attempts to create taxonomies based on the role that the application was designed to play in the instructional setting (Soloway, 1993; Taylor, 1980; Wu, 1993). Taylor's (1980) typology of *tutor, tutee,* and *tool* is probably the best known and is one that has been adopted by a number of other authors (Crook, 1994; Dreyfus & Dreyfus, 1986; O'Shea & Self, 1983). It appears to have several weaknesses, however. By focusing exclusively on the functional nature of the application, opportunities to consider other aspects of the work—such as the theories of learning that motivated it in the first place—are missed. Second, by trying to reduce the diverse set of IT applications into just three categories, considerable resolution is lost. Although more elaborate typologies have been proposed (e.g., Wu, 1993), it is not clear that this is the best direction to be taken. By focusing exclusively on descriptive aspects of the application, we lose the ability to discern larger shifts in philosophy and practice. By contrast, applying a Kuhnian analysis encourages a broader view of practice, one that encompasses underlying theories and methods of research and argumentation.

Various authors have made attempts to divine the direction that IT research might take in the future. In many cases, this is done in the form of a dialectical analysis. This method, developed by the Nineteenth Century philosopher Hegel, is based on the theory that our understanding of a concept proceeds through a three-part process of clarification—a thesis is opposed by its antithesis and is eventually supplanted by a new synthesis (Koschmann, 1994b). For example, Larkin and Chabay (1992) and Duffy and Jonassen (1992) contrasted work in the CA! and ITS traditions in the interest of identifying possible directions for future work. Derry and Laiole (1993) focused on the contrast between ITS and constructivist-motivated research and argued that future work would represent a synthesis of these two approaches. Most recently, Cobb (1994), Crook (1994), and Steffe and Gale

IkUne candidate that comes immediately to mind is research related to 'CSCWriting" (Gruber, Bruce, & Peyton, 1995). There is a substantial body of work devoted to the use of computers in composition (see the Neuwirth and Wojahn chapter for references) that is largely invisible to the IT community because it is embedded in the literature of writing instruction. The question of whether CSCWriting should be viewed as a special disciplinary interest within CSCL or as a paradigm in its own right does not have a clear answer at this point. What is clear, however, is that the two movements share many issues and that there is much that researchers in CSCL could learn from the accumulated experience of the composition community.

(1995) have contrasted constructivist and sociocultural views of learning in the hopes of achieving some form of reconciliation.

The historiographic account presented in this chapter makes this dialectical approach problematic, however. In no case did a newly emerging paradigm appear to be the synthesis of ideas drawn from previous paradigms. The ITS paradigm was less an adaptation of prior work in CAI research than an invasion of a new group of workers bringing with them new standards for design and evaluation. Similarly, the Logo-as-Latin paradigm was not presaged by the CAI or ITS paradigm; it represented an entirely different philosophy about the use of technology in education. Finally, the emergence of the CSCL paradigm could have been in no way predicted by the clash of constructivist and information processing theories of learning.

Ironically, the ultimate lesson of this form of analysis is that the revolutionary changes that Kuhn described as paradigm shifts are always difficult to foresee and, in particular, cannot be adduced from the study of past history. The ideas that have shaped work in IT have, in general, come from outside the field. As a result, the task of identifying the sources of future shifts is a difficult one. Kuhn, himself, despaired at the prospect of ever providing a complete account of how a field-defining, revolutionary idea comes to exist. He lamented, “What the nature of that final stage is—how an individual invents (or finds he has invented) a new way of giving order to data now all assembled—must here remain inscrutable and may be permanently so” (1972, p. 90). And so it may be for our own efforts to foretell the future direction of research in instructional technology.

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