On Claims That Answer the Wrong Questions

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Anderson, Reder, and Simon (1996) contested four propositions that they incorrectly called "claims of situated learning." This response argues that the important differences between situative and cognitive perspectives are not addressed by discussion of these imputed claims. Instead, there are significant differences in the framing assumptions of the two perspectives. I clarify these differences by inferring questions to which Anderson et al.'s discussion provided answers, by identifying presuppositions of those questions made by Anderson et al., and by stating the different presuppositions and questions that I believe are consistent with the situative perspective. The evidence given by Anderson et al. is compatible with the framing assumptions of situativity; therefore, deciding between the perspectives will involve broader considerations than those presented in their article. These considerations include expectations about which framework offers the better prospect for developing a unified scientific account of activity considered from both social and individual points of view, and which framework supports research that will inform discussions of educational practice more productively. The cognitive perspective takes the theory of individual cognition as its basis and builds toward a broader theory by incrementally developing analyses of additional components that are considered as contexts. The situative perspective takes the theory of social and ecological interaction as its basis and builds toward a more comprehensive theory by developing increasingly detailed analyses of information structures in the contents of people's interactions. While I believe that the situative framework is more promising, the best strategy for the field is for both perspectives to be developed energetically.

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Anderson, Reder, and Simon (1996) organized their paper as a response to four claims that they imputed to researchers who are working in the situative perspective. These alleged claims, and Anderson et al.'s counterclaims, are answers to questions that are implicit in their discussion. If these were the right questions, their answers would be persuasive. I disagree, however, with all four of the questions, which are answered differently by the claims that they attribute to the situative view and by their counterclaims.

How is it possible to disagree with someone's questions? It has to do with presuppositions, including assumptions about the meanings of terms. Consider an example. Someone might refer to me as a colleague of Anderson, Reder, and Simon. A second person might object, saying that the first person made the following claim: James Greeno works at the same university as John Anderson, Lynne Reder, and Herbert Simon. That alleged claim is clearly incorrect, as our institutional affiliations show.

The claim that is imputed to the first person answers a question something like the following: "Is Greeno a member of the same university faculty as are Anderson, Reder, and Simon?" However, the first person may have implicitly answered a different question, something like, "Are Anderson, Reder, Simon, and Greeno all members of the same scientific community, who work on the same or closely related problems and who take each others' findings and conclusions into account in their work?" If this is the question, then the first person made a quite different claim, which is correct; we are colleagues in the sense of being participants in the same scientific community. As evidence of this, we have had many enjoyable and productive discussions of scientific matters and have published articles in the same journals and other publications.

We can understand this example as a disagreement about the answer to a more general question, "On what kinds of interactions should we focus when we are considering collegial relations between colleagues?" The second person's question presupposes an answer that focuses on affiliations with academic institutions. The first person's question presupposes an answer that focuses on interactions involving substantive scientific study and discourse. Of course, both questions are meaningful and useful; they both organize information and concepts in significant ways. In ordinary conversation, we get along with ambiguous terms such as "colleague," which we use in multiple senses, and we clear up confusions like the one in this example by explaining which sense is intended. In developing scientific theories, however, issues of meaning with substantive implications need to be debated. Part of our job is to develop conceptual systems that provide coherent explanations of the phenomena of our subject-matter domains, and we need to try to reach agreement about the meanings of terms such as "learning," "transfer," and "abstraction" that refer to concepts that organize information and concepts in our scientific work.

In discussions of the situative and cognitive perspectives, proponents of the two sides tend to talk and write past each other because they address different questions. This does not mean that the two views cannot be compared and debated, as some might think. By identifying the pre-
Suppositions of the different questions, we can clarify substantive differences between the perspectives and thereby understand better what theoretical and educational issues are at stake in the debate.

In this response to Anderson et al.'s article, I argue that their discussion of differences between the situative and cognitive views depends on assumptions of the cognitive perspective that are presupposed in the implicit questions that their alleged claims answer. These presuppositions, which affect the meanings of the implicit questions, are in dispute. Therefore, their persuasive answers to those cognitive questions do not settle the issue between the situative and cognitive perspectives. I will explain some alternative questions that involve the same issues, which rest on presuppositions that are more consistent with the situative perspective on learning, reasoning, and understanding. The evidence that Anderson et al. presented in support of their answers to the cognitive versions of the questions is also consistent with reasonable answers to the situative questions.

The issue between the perspectives, then, has to be addressed more broadly than by disputing these four claims. Regarding the issues that Anderson et al. discussed, I state more general questions that are answered differently by the framing assumptions of cognitive and situativity. These differences involve general theoretical concerns such as choosing the level of aggregation at which to focus primarily in theoretical analyses and explanations. Evaluation of the alternative perspectives, therefore, requires consideration of the general merits of the two research programs. The evaluative grounds that I propose are both theoretical and practical. Regarding theory, we can consider which perspective seems more promising for developing an explanatory system with broader scope and more coherence (compare Kitcher, 1981). Regarding educational practice, we can consider which perspective is more likely to generate research that will inform discussions of educational reform more productively. All four of the issues considered by Anderson et al. involve important aspects of these general considerations.

Throughout this paper, I refer to assumptions and concepts that I associate with what I call "the situative perspective." I intend this phrase to refer to a broad collection of scientific work being developed by many people. I hope that my views agree with those of others who are contributing to the development of this approach; indeed, most of what I write here I have learned from discussions with many colleagues and from reading their work. Even so, what I present here is my personal version of these assumptions and concepts, and others should not be held accountable for them. I also refer to assumptions and concepts that I associate with what I call "the cognitive perspective." This also refers to a broad collection of scientific work done by many people, including me, during the past four decades. I hope that my exposition distinguishes between the assertions that I attribute to Anderson et al. in their article and general assumptions and concepts that I believe are commitments of the cognitive perspective. The assumptions and concepts that I attribute to the cognitive perspective are based on my understanding of that perspective, of course, and researchers working in that perspective, including Anderson, Reder, or Simon, may disagree with some of the positions that I associate with cogntivity. Part of the conceptual work of science is to understand the commitments of the various theoretical alternatives that we are working on, and I hope that a contribution of this paper may be to clarify some of the issues that distinguish the cognitive and situative perspectives generally, recognizing that the positions of individual researchers using each of the perspectives will also differ somewhat.

**Issue 1: Which Explanatory Concepts Should Be Basic?**

This issue involves the proposition that Anderson et al. gave as "Claim 1: Action is Grounded in the Concrete Situation in Which It Occurs . . . ." It means that the potentialities for action cannot be fully described independently of the specific situation, a statement with which we fully concur. However, the claim is sometimes exaggerated to assert that all knowledge is specific to the situation in which the task is performed." Against this claim, which they attributed to the situative perspective, stands their argument that while some knowledge is "tightly bound" to the context of its acquisition, other knowledge is not. As they said, "How tightly learning will be bound to context depends on the kind of knowledge being acquired . . . . In other cases, how contextualized the learning is depends on the way the material is studied" (p. 6).

**Questions about Generality and Presuppositions about Levels of Analysis**

The claim and the counterclaim that Anderson et al. discussed are answers to a question something like the following:

**Cognitive Question 1:** How tightly bound (or contextualized, or specific, or grounded) is knowledge to the context, in which it is acquired?

Generality of learning is an important issue, of course. Any set of framing assumptions for the study of learning must provide ways of formulating questions about generality. In the situative perspective, the question about generality is more like the following:

**Situative Question 1:** Does activity that occurs in one type of situation have aspects that were learned as practices and interactions with the resources available in that type of situation, and does it have aspects that were learned as practices and interactions with resources in some quite different type of situation?

If the situative and cognitive perspectives differ in their questions, does the difference matter? It does. But to address the difference, we have to move the discussion to a different level and consider the presuppositions that lie behind the different questions. A difference in terminology between the two questions provides a significant clue. Cognitive Question 1 is phrased in terms of knowledge and contexts of performance. Situative Question 1 is about activity and situations in which activity occurs and is learned. As Cobb and Bowers (1996) have noted, the situative view focuses on practices in which individuals have learned to participate, rather than on knowledge that they have acquired. The question that I believe is at issue is something like:

**General Question 1:** At what level of analysis should we locate the basic concepts of our explanations of activity?
The cognitive and situative perspectives differ in this. The cognitive perspective's basic concepts (Rosch, 1973) and explanatory schemata (Kitcher, 1981) are about processes and structures that are assumed to function at the level of individual agents. These processes and structures include knowledge as well as perception, memory, inference, decision, and so on. The situative perspective adopts a different primary focus of analysis. Situativity focuses primarily at the level of interactive systems that include individuals as participants, interacting with each other and with material and representational systems. This shift in level is signaled by phrases such as "participation structures," "distributed cognition," and "communities of practice." Of course, individuals participate in multiple communities, and in their trajectories of participation, individuals develop personal identities that are shaped by and are formative of their activities in the various communities in which they participate (E. Wenger, in press).

In studies of the activities of groups, the main explanatory concepts of situativity involve properties of social practices, which have been studied mainly with the methods and conceptual frameworks of ethnography, ethnomethodology, discourse analysis, symbolic interactionism, and sociocultural psychology. These concepts include normal routines of collaborative work, distributions of accountability and authority, mutual availability of and attention to information sources, mutual understanding in conversation, and other characteristics of interaction that are relevant to the functional success of the participants' activities (e.g., Clancey, in press; Clark & Schaefer, 1989; Goodwin, 1995; Hutchins, 1995; Ochs, Jacoby, & Gonzalez, 1994; Rogoff, 1990; Sacks, Schegloff, & Jefferson, 1974; Suchman, in press). In studies of individual activity, the system-oriented approach is taken in ecological psychology (e.g., Turvey, 1990, 1992) and analyses that use dynamic-systems theory (e.g., Thelen & Smith, 1994). The main explanatory concepts are properties of the interactions of agents with material systems, including trajectories of movement by an agent in relation to locations of objects in the environment and coordination of movements by an agent with movements of objects in the environment. The idea of analyzing systems in which individuals participate as the basic level of analysis is not new, of course. These current studies are developing a psychological tradition that has been present, but not prevalent, throughout our history. Dewey (1896) argued for this in a classic paper that is just over 100 years old this year, as well as in his other writings (e.g., Dewey, 1929/1958). Other proponents of this interactionist perspective, in various forms, have included Bartlett (1932), Bateson (1979), Gibson (1979/1986), Kantor (1945), Lewin (1936, 1946), Mead (1934), and Vygotsky (1934/1987).

As Cognitive Question 1 and Situative Question 1 indicate, generality is conceptualized differently in the two perspectives. In cognition, generality depends on acquiring knowledge in the form of abstract representations and also acquiring procedures for applying the representations in many situations. (See pp. 13–14 for more about abstraction.) In situativity, generality depends on learning to participate in interactions in ways that succeed over a broad range of situations. (See pp. 11–13 for more about generality across situations.)

Is General Learning Consistent with Situative Assumptions?
Anderson et al. cited evidence from cognitive research that they interpreted in cognitive terms, showing that "it is not the case that learning is wholly tied to a specific context." In the situative perspective, these findings simply provide an affirmative answer to the second part of Situative Question 1, showing that activities in some situations include aspects of practices that have been learned in different types of situations. Research in the situative perspective also has provided many such examples. One is a study by Beach (1995) of two groups of Nepalese men. One was a group who had been students and were learning to be shopkeepers. The other was a group of shopkeepers to whom schooling had been unavailable previously, who were learning school mathematics when Beach studied their activity. Beach discovered ways in which the learning of shopkeeping was influenced by the students' former school practices, as well as ways in which the learning of school mathematics was influenced by the shopkeepers' commercial practices. Other examples that involve occurrences of practices that are characteristic of school mathematics include Hutchins's (1995) analyses of ship navigation, Martin and Beach's (1992, discussed by Martin, 1995) analysis of operating a computerized drill press, and Hull, Jury, Ziv, and Schultz's (1994) analysis of work teams in high-performance manufacturing. These findings are not inconsistent with the situative perspective, any more than is evidence obtained in situative research that children's mathematical activity in school is sometimes influenced significantly by practices of quantitative and numerical reasoning that they engage in outside of school (e.g., Brenner, 1985, discussed by Lave, Smith, & Butler, 1988). Many studies find, as Lave (1988) noted, that the analyzed reasoning activities reach mathematically correct conclusions, but do not make significant use of the kinds of algorithms typically taught in school. Instead, the reasoning activities that are observed make use of resources that support those activities in the situations they are in. An important conclusion based on these findings is that people can learn adaptively in situations where they engage in activities. More specifically, learning of algorithms that are typically taught in school is not a necessary condition for successful reasoning in many everyday activities. This has important implications for cognitive theory and for discussions about school learning. It is important for theory because it shows that we need to understand reasoning that is adaptive in ways that are not explained well by current versions of cognitive theory. It is important for discussions of education because it shows that if a goal of education is for students to reason successfully in their everyday activities outside of school, school mathematics programs that are limited to teaching algorithmic skills do not reach important aspects of those reasoning activities.

An Implication for Theory
By choosing individual mental processes as the basic conceptual level, the cognitive-research strategy is committed to a factoring assumption that is questionable, and that is not a commitment of the situative perspective. Cognitive research rests on an assumption that we can analyze properties of cognitive processes and structures and treat the properties of other systems as contexts in which those processes and structures function. This strategy has signifi-
cant advantages, as Simon explained in The Sciences of the Artificial (Simon, 1981), and it has been successful and productive in supporting the advances in cognitive science that have been so rewarding over the past 40 years or so. It supports research practices for studying many questions, including Cognitive Question 1. According to the factoring assumption, learning in one situation results in some knowledge that the learner has then acquired. In other words, some acquired knowledge has become a property of the person. We can then study the generality of the knowledge by observing the person’s behavior in a range of situations. This depends on the assumption that the person’s knowledge is the same in all of those situations. The range of situations in which the person’s behavior is the same tells us how general that knowledge is. (Of course, the knowledge may be forgotten, and we need to be able to take that into account. Relevant information can be obtained by testing the generality of the knowledge in the initial situation.)

The situative perspective does not assume a factoring of activity into knowledge and contexts (Some analyses based on factoring of knowledge from interaction provide acceptable approximations, but those are special cases.) Because the primary focus of analysis is on properties of interactive systems, which include individuals as participants, and the basic explanatory concepts are properties of interaction involved in the coordination of behaviors of the various system components, the issue of generality of learning involves the range of situations in which someone’s learning has made her or him a more effective participant. Situative research recognizes that success in contributing to the activities of groups across a wide range of situations can contribute significantly to an individual’s identity as a valuable participant in those activities (e.g., Jacoby & Gonzalez, 1991).

Perhaps the reason that situativity is sometimes thought to imply a restriction of knowledge to specific situations (Anderson et al.’s imputed Claim 1) is that in the situative perspective, the participation of each individual is considered in relation to the other individuals and the material and representational systems that contribute to the activity that occurs. When an analysis of an individual’s knowing is proposed, the analysis should be an account of the ways that the person interacts with other systems in the situation. Just presenting hypotheses about the knowledge someone has acquired, considered as structures in the person’s mind, is unacceptably incomplete, because it does not specify how the other systems in the environment (including other people) contribute to the interaction. This apparently has led many of our colleagues, including Anderson et al., to the misconception that situative analyses cannot allow for generality of learning.

An Implication for Discussions of Educational Practice

The difference in analytical focus between the cognitive and situative perspectives is especially important for the educational issue of assessment.

In the cognitive perspective, there are significant questions about the information that we obtain from standard tests. For example, it is important to assess students’ general strategies in reading and in mathematical problem-solving, and it is unclear whether this can be done with standard paper-and-pencil tests. Even so, in the cognitive view, the difficulty is technical, in the sense that the cognitive perspective assumes that strategies for reading or problem-solving are parts of each individual student’s knowledge, and it should be possible, at least in principle, to design tests to assess them.

On the other hand, in the situative perspective the problem of assessment is fundamentally harder. The situative view is that students learn how to participate in social practices, many of which include activities such as reading texts and using mathematical methods to make inferences. When students take a test in reading or mathematics, they are not just displaying their knowledge of how to read or do mathematics. A test is one kind of situation in which knowing how to read or do mathematics matters, and when students take tests they show how well they can participate in the kind of interaction that the tests afford (e.g., O’Connor, 1989). However, asking how well someone knows how to read or do mathematics is, in the situative view, a very general question. In contrast to the behaviorist and cognitive views, where a domain of skills needs to be sampled, the situative view requires sampling across a domain of situation types in which participation involves the kinds of knowing that are of interest. It requires that the way in which we characterize the person’s performance captures the various kinds of situations in which the person’s reading or mathematical activity is significant. The kinds of participation that produce high scores on standard tests may or may not provide a useful sample of the kinds of participation that we need to know about. Intuitively, at least, the special character of test situations actually makes them quite unpromising as the basis for our inferences about students’ progress. (These issues are discussed more extensively in a report of a study commissioned by the National Academy of Education Panel on the National Assessment of Educational Progress; Greeno, Pearson, & Schoenfeld, 1996.)

The issue of assessment is, of course, just one aspect of education in which problems are formulated differently in the cognitive and situative perspectives. Some others relate to the other claims that Anderson et al. attributed to the situative view.

Issue 2: How Should the Social Conditions of Learning Be Arranged?

Next, I discuss Anderson et al.’s “Claim 4: Instruction Needs to be Done in Complex, Social Environments.” The statement of this alleged claim of situativity is ambiguous. It can be read as, “All instruction needs to be done in complex, social environments,” or as, “Some instruction needs to be done in complex, social environments.” However, because they wrote that “there are, of course, reasons sometimes to practice skills in their complex setting,” Anderson et al. must have intended to impute the stronger claim to situativity, otherwise the two positions would agree. Their counterclaim was that, “It is better to train independent parts of a task separately because fewer cognitive resources will then be required for performance” (p. 9).

Questions about Conditions of Learning and Presuppositions about Goals and Outcomes of Education

I infer that the question that Anderson et al. discussed is something like:

Cognitive Question 2: Will complex skills be acquired more successfully if instruction in various independent
subskills is presented separately or in situations where all of the subskills are needed? In particular, will skills of complex social activities be learned more successfully if their independent subskills are learned first in situations involving individual practice?

Even if their version of the question is accepted, things are more complicated than their discussion indicated. The question of relative efficiency of part learning versus whole learning involves a tradeoff, as has been well established in psychological research for many decades (e.g., Woodworth, 1938). Learning the parts in isolation is generally easier, as Anderson et al. pointed out, but part learning has the additional requirement of learning how to do the parts in combination, and if that requires considerable time and effort, the parts and combination method can be harder than whole learning.

However, Anderson et al.’s version of this question, like Cognitive Question 1, also rests on presuppositions of the cognitive perspective. The issue of how to arrange sequences of learning activities is important in any framework, but different assumptions frame different versions of the question. Considered from the situative perspective, the question is something like the following:

Situative Question 2: Which combinations and sequences of learning activities will prepare students best for the kinds of participation in social practices that we value most and contribute most productively to the development of students’ identities as learners?

Cognitive Question 2 focuses on acquisition of skills, and Situative Question 2 focuses on students’ development of participation in valued social practices and of their identities as learners. These questions differ in their presuppositions about how to formulate the major goals of education. That is, they presuppose different answers to the following question:

General Question 2: Should we consider the major goals and outcomes of learning primarily as collections of sub-skills or as successful participation in socially organized activity and the development of students’ identities as learners?

In the cognitive perspective, learning and development are viewed as progress along a trajectory of skills and knowledge, and there is much value in that view of learning. Alternatively, in the situative perspective, learning and development are viewed as progress along trajectories of participation and growth of identity (e.g., Lave & Wenger, 1991; Rogoff, in press; Rogoff, Baker-Sennett, Lacs, & Goldsmith, 1995; E. Wenger, in press). This implies consideration of the practices of learning in school as an important part of what students learn. Methods of instruction are not only instruments for acquiring skills; they also are practices in which students learn to participate. In these practices, students develop patterns of participation that contribute to their identities as learners, which include the ways in which they take initiative and responsibility for their learning and function actively in the formulation of goals and criteria for their success.

Is Efficacious Individual Practice Consistent with Situative Assumptions?

Anderson et al.’s support of their counterclaim included some evidence that part training and combination training can be more efficient than whole training (which has been known for some time), some reports of cooperative learning that was not superior to comparable individual learning, and some impressions apparently based on the authors’ practical experience that practicing individual skills can contribute significantly to learning and that group learning is often problematic.

The situative framework does not imply that group learning will always be productive, regardless of how it is organized, or that practices of individual exercise cannot contribute significantly to a person becoming a more successful participant in social practices. The commitment of situativity is to focus on the contributions of learning activities to the learners’ development of greater efficacy in their participation in valued social practices and to the development of their identities as capable and responsible learners. Successful participation in social practices can include the ability to give virtuoso performances, provide information for discussions, and compose reports or scientific papers that advance the functions of communities. Practices of individual exercise are often an essential part of the preparation of an individual to make these contributions. The dispute is about whether to understand these processes simply as the acquisition of skills, in which it does not matter whether students understand how what they are learning relates to anything other than school, or as part of the students’ growth toward mature participation in valuable social practices and the development of their identities as responsible, self-directed learners.

Implications for Theory

The difference between the cognitive and situative perspectives’ characterizations of goals and outcomes of learning are corollaries of their different levels of analytical focus. In addition to assuming that activity can be factored into cognitive processes of agents, including knowledge, and the influences of other systems, which are treated as contexts (Issue 1), Cognitive Question 2 presupposes a further factoring of knowledge into subskills, some that involve social interaction and others that are independent of the social aspects of activity. The cognitive perspective also assumes that some learning contexts are social and others are not. The situative perspective disagrees with the presuppositions that social and individual subskills are separable components of a person’s knowledge and that differences between learning by participating in groups and learning in individual exercises constitute a meaningful distinction between social and individual learning. Instead, in the situative view, “social” and “individual” are perspectives that can be adopted in discussions—in scientific theorizing or in everyday discourse—to describe and explain activity. Everything that people can do is both social and individual, but activity can be considered in ways that either focus on groups of people made up of individuals, or focus on individuals who participate in groups.

The situative view, which recognizes that learning is participation in social practice, assumes that all instruction occurs in complex social environments. For example, a student studying alone with a textbook or a computer tutor may not have other people in the same room at the time, but the student’s activity is certainly shaped by the social arrangements that produced the textbook or the computer program, led to the student’s being enrolled in
the class where the text or program was assigned, and pro-
vided the setting in which the student's learning will make a difference in how the student participates in some social activity, such as a class discussion or a test. For another example, I am alone in my study as I write this, but I certainly am engaged in a socially organized activity, responding to Anderson et al.'s article.

When we recognize that all learning involves socially organized activity, the question is not whether to give instruction in a "complex, social environment" but what kinds of complex, social activities to arrange, for which aspects of participation, and in what sequence to use them.

In a trajectory of participation and identity, acquisition of skills and routine knowledge can be an important aspect of learning, but its importance comes from its contribution to broader functions. Considering the participation of individuals in communities, routine skills and knowledge are aspects of the contributions that individuals can make to the more general success of the communities in which they participate. Considering the growth of individuals' identities as learners, successful acquisition of routine skills and knowledge can contribute significantly to the sense of competence and efficacy that is important in students' concepts of themselves. By arranging learning activities in ways that make skills and routine knowledge functional for students' contributions to broader social activities and meaningful for their development as learners, students' efforts and successes in learning can make sense to them in ways that are not available when the curriculum is organized primarily as a trajectory of skill and knowledge acquisition for its own sake.

**Informing Discussions of Educational Practice**

The difference between situative and cognitive perspectives has a major effect on the way alternative educational methods are evaluated. In the cognitive perspective, the question is how to arrange for the collection of skills and understandings to be acquired most efficiently. Evaluation of a method of instruction is mainly addressed to whether it results in the acquisition of more or less of the desired collection of skills and understandings.

If we take the situative perspective, discussion of alternative arrangements for learning needs to include consideration of the values of having students learn to participate in the practices of learning that those arrangements afford. In the case of mathematics, when students receive didactic instruction that optimizes skill acquisition they learn to participate by solving preset, well-defined problems according to procedures that are presented for them to observe and practice in exercises. Alternative learning arrangements can also provide opportunities for students to participate more actively in formulating and evaluating problems, questions, conjectures, conclusions, arguments, and examples. The situative focus on practices of learning calls attention to these activities and encourages consideration of the opportunities that students have to become successful in activities of inquiry, as well as acquiring skills. The situative concern for including activities of inquiry is more than just a call for more varied activities in school learning. Participation in activities of formulating and evaluating goals and progress of learning activity can place students in a different relation with their learning and with its subject-matter content, which can make their participation more personally and socially meaningful and can contribute more constructively to their development as active, responsible learners.

As Anderson et al. pointed out, there are many aspects of any activity that people need to learn, and different aspects can be learned more successfully in different learning situations. This is not inconsistent with situative assumptions. Social practices include things that people do by themselves, and it is very likely that some of the things that people need to learn require practices of individual exercise. But it does not follow that it is optimal to have to learn all of the parts of a practice that can be learned individually before having any experience with the parts of the practice that involve other people. In mathematics education, especially, the prevalent practice has been to require students to learn many routine procedures of operating on symbolic expressions with little opportunity to participate in activities involving formulation and evaluation of problems, questions, examples, conjectures, conclusions, explanations, and arguments, and this prevalent practice is dubious if we take the situative view that emphasizes the learning activities that students engage in. Several groups are developing and studying learning arrangements in which students participate in group activities of inquiry from the beginning of their mathematical learning in school and continuing throughout their careers as students (e.g., Ball, 1993; Cobb et al., 1991; Cognition and Technology Group at Vanderbilt, 1994; Goldman, Greeno, McDermott, & Pake, 1996; Lampert, 1990b; Schoenfeld, 1994; Silver, 1993). The activities that these programs support include discourse that involves formulating and evaluating mathematical conjectures and arguments and construction of problems and examples, rather than only acquiring skills, knowledge, and understanding of prepared materials.

Many people who are working on educational reform are exploring the idea, consistent with the situative perspective, that we should rearrange the sequence of learning activities to include more group activities earlier. In medical education, engineering education, and other fields of professional training, there are major efforts to design learning programs that include group activities involving complex problems early on. As an example, in problembased learning in medicine (e.g., Koschmann, Kelso, Feltovich, & Barrows, 1996), students working in groups, led by a tutor, analyze realistic cases in which they discuss alternative diagnostic hypotheses as well as general properties of the biological systems that physicians need to understand. Their activities do not exclude individual study. Information from textbooks that everyone is expected to read plays an important role in the discussions, and individuals in the group have assignments for specialized reading that provides information needed for the cases. The individual work, however, is meaningfully related to activities that make more sense, medically, than taking exams to show that text information has been absorbed.

Regarding the effectiveness of group learning activities compared to individual instruction, Anderson et al. mentioned some conclusions reached in an NRC committee report (Druckman & Bjork, 1994), in which Reder participated, which stated that cooperative learning is not "an academic panacea." I doubt that anyone has expected that it would be, but in any case, the report's conclusion is certainly correct. There are, however, reasons to persist in the
effort to develop effective ways to arrange and support learning in group activities. One important reason is recognition (emphasized in the situative theoretical perspective) that practices of learning are an important part of what students learn. If the only learning in which students participate in a subject involves collective watching and listening, individual exercise, and display of individual knowledge on tests, students have opportunities to become adept in the practices of collective watching and listening, individual exercise, and displaying their individual knowledge on tests. Those practices have value, but they omit coherent development of many useful capabilities that may be even more valuable in students' lives. Learning to learn through the activities of inquiry involving discourse that includes formulating and evaluating questions and problems, as well as solutions and conclusions, and proposing and criticizing explanations, arguments, and examples is crucial to meaningful participation in the activities of our society. These practices of active learning have major importance in individuals' work and in their lives as citizens; therefore, to the extent that we exclude these practices from our students' learning activities, we seriously short-change them.

One of the contrasts between these perspectives involves two ways in which behavior changes as people learn. The things people become able to do as a result of learning are more complicated and more systematic than the things they were able to do earlier. When a learning sequence is considered as a trajectory of skill/knowledge acquisition, it is natural to arrange activities that are systematic from the beginning, which will progress from being very simple to being more complex in line with analyses of behavioral prerequisites (e.g., Gagné, 1965) and with processes of chunking in cognitive analyses (e.g., Anderson, 1983; Newell, 1990). There are alternative ways to progress through the space. Early activities can be more complex and less systematic, so that as students progress their behavior becomes more systematic.

When a learning sequence is considered as a trajectory of participation, it is natural to arrange activities that are somewhat more complicated at the beginning in order for participation in those activities to be more personally and socially meaningful and to allow students to foresee their participation in activities that matter beyond school. Activities with these properties have been termed "authentic" in some discussions (e.g., Brown, Collins, & Duguid, 1989; Collins, Brown, & Newman, 1989). When students participate in these more complicated activities, their behavior is often less systematic from the point of view of concepts and methods of subject-matter domains. (Of course, it is usually very systematic in other terms, and support for maintaining coherent activity structures is an obligation of the design and management of learning environments.) Then as learners progress, they behave more systematically in the complex activities that they are engaged in and become able to participate in even more complex activity settings.

Cognitive Question 3: Does knowledge transfer between tasks?

Anderson et al. argued for their counterclaim using the large body of experimental evidence that demonstrates that transfer can occur.

As with the other implicit questions that Anderson et al. discussed, there is an alternative formulation of Question 3 in the situative perspective, which is something like:

Situative Question 3: When someone has become more successful at participating in an activity in one kind of situation, are there other kinds of situations in which that person will also be more adept?

The two versions of Question 3 differ in the presuppositions that I discussed regarding Issue 1. The cognitive version presupposes a factoring between knowledge and tasks. In the cognitive view, a task is a kind of context, so my earlier discussion of the knowledge/context factoring applies here as well. The situative version of Question 3 presupposes the framing assumption that activity should be analyzed at the level of interactive systems. In the situative view, "knowledge" is a misleading term because it attributes something like a substance or structure to the knower. A more process-evoking term such as "knowing" refers more appropriately to regular patterns in someone's participation in interactions with other people and with material and representational systems, and "generality of knowing" is a more accurate phrase than "transfer of knowledge."

Is the Occurrence of "Transfer" Consistent with Situative Assumptions?

Some psychologists (e.g., Detterman, 1993) have claimed that learning does not have general consequences; that is, they have argued for a negative answer to both Cognitive Question 3 and Situative Question 3. That claim deserves to be attacked, in my opinion, and I join Anderson et al. in insisting that people can learn in ways that have very general consequences for their behavior, for reasons that include the voluminous literature that Anderson et al. cited.

On the other hand, Anderson et al.'s discussion perplexes me because they presented Claim 2 as an inherent part of the situative perspective, and that does not fit with my understanding of what investigators working in this perspective have written. It surely does not fit with what I have written, as Anderson et al. must realize, since they cited the paper that I wrote with David Smith and Joyce Moore (Greene, Smith, & Moore, 1993), in which we used, as the leading example to illustrate our analyses, the studies of transfer by Scholckow and Judd (Judd, 1908) and by Hendrickson and Schroeder (1941), which Anderson et al. also cited.

Is there something wrong with this picture? Greene et al. (1993) is an example of the situative perspective—indeed, an example that Anderson et al. cited prominently to identify the general view that they oppose. The point of Greene et al.'s paper was to begin to develop a way of understanding phenomena involving transfer in the situative perspective—indeed, "transfer" was the first word in the paper's title. Yet Anderson et al. attributed "Knowledge Does Not Transfer Between Tasks" as a "claim of situated cognition."

Issue 3: What About Transfer?

Questions about Transfer and Presuppositions about Levels of Analysis

In Anderson et al.'s discussion of "Claim 2: Knowledge Does Not Transfer Between Tasks," the question they discussed is something like:
I do not believe that the situative perspective implies a commitment to Anderson et al.’s Claim 2, and while I do not presume to be a spokesperson for others who take the situative view, I do not believe that researchers working in this perspective have taken the position that Anderson et al. imputed to us. The issue is how the question of generality and transfer should be formulated, not whether “transfer” occurs. For example, I disagree with Anderson et al.’s interpretation of the passage quoted by them on p. 7 from Lave’s (1988) book. They attributed to Lave the claim “that there is relatively little transfer beyond nearly identical tasks to different physical contexts,” giving the following passage as an example.

It is puzzling that learning transfer has lasted for so long as a key conceptual bridge without critical challenge. The lack of stable, robust results in learning transfer experiments as well as accumulating evidence from cross-situational research on everyday practice, raises a number of questions about the assumptions on which transfer theory is based. (Lave, 1988, p. 19, emphasis added)

I do not understand how Anderson et al. interpreted this passage as a claim that transfer does not occur. It seems clear that Lave’s concern—which I share—is about the theoretical concepts and assumptions that we use in formulating questions and explanations of the phenomena of learning regarding its generality.

**Implications for Theory**

The cognitive theory of transfer has been developed significantly, and there is a need for a comparable theory of learning with general results in the situative framework. If the question is, “How much does knowledge transfer?” then knowledge must be like a substance that is acquired during learning and later moved to a new situation where it either is or is not used. This fits well with the cognitive idea that learning is the acquisition of structures that are stored in memory and are or are not retrieved and applied in new circumstances. The situative perspective, however, focuses on consistency or inconsistency of patterns of participatory processes across situations. These patterns have contents and structures of information that are important features of social practice.

The goal of Greeno et al.’s (1993) paper was to begin to develop a theoretical framework for explaining learning with more or less generality in terms of the situative perspective. Very briefly, we argued that learning can be understood as improved participation in interactive systems (i.e., the situative view). Such improvement involves becoming better attuned to constraints and affordances of activity systems so that the learner’s contribution to the interaction is more successful. A test for transfer involves transforming the situation in which an activity was learned. To succeed in the transfer test, the activity—that is, the interaction of the learner with the other systems in the situation—has to be transformed in a way that depends on how the situation is transformed. Whether this transformation is easy or hard for a learner depends on how the learner was attuned to constraints and affordances in the initial learning activity. If the initial learning was accomplished with attunements to constraints and affordances that are invariant across the learning-to-transfer transformation, transfer should occur easily. If the learner was initially attuned to constraints and affordances similar to the constraints and affordances in the transformed situation, so that a relatively easy transformation of the learner’s initial attunements will succeed in the test situation, then transfer should occur, but not as strongly. And if the learner accomplished the initial learning with attunements that are simply not preserved in the learning-to-transfer transformation, then there should be no positive transfer and, in some cases, there may be interference. As an example, for the transfer experiments involving shooting at targets under water (Hendrickson & Schroeder, 1941; Judd, 1908), we hypothesized that students given instruction about friction would be more likely to become attuned to constraints involving features such as the apparent angular disparity between the trajectory of a projectile before it enters the water and its trajectory through the water, and attunement to that constraint, or related constraints, would be more likely to support transfer when the water level was changed.

It is important to note that our account of transfer in terms of transformations of constraints, affordances, and attunements is a generalization of standard stimulus-response, production-system, and schema-theoretic accounts, rather than a contradiction of them. Associations and mental representations are a special case of attunements, and there are activity systems for which those concepts provide analyses that are reasonable approximations. Analyses such as Singley and Anderson’s (1989) account for transfer in terms of patterns and associations that are acquired in initial learning and are components of the procedures that can succeed in the transfer situation. Such accounts are a special case of the more general concept of invariants of transformations of interactional activity, and those accounts are also successful in some situations. But it is likely that there are also activity systems for which those concepts do not provide reasonable approximations, such as the examples studied by Beach (1995), and in those cases the more general concepts are needed.

**Implications for Discussions of Educational Practice**

The issue of generality of learning is important because much of the school curriculum is designed on the assumption that school-based knowledge is inherently general because it is abstract (see pp. 13–14 for more on this). In mathematics, especially, there is much evidence that school-learned algorithms are often not used in reasoning away from school, which is what the passage from Lave (1988) quoted by Anderson et al. asserts. The situative perspective does not imply that school-learned procedures cannot be used in nonschool situations. The situative perspective does imply that school is a learning situation with its own practices and characteristics of performance, as Lave, Smith, and Butler (1988) argued. We cannot safely assume that, by learning the procedures of symbol manipulation which they have traditionally been taught in school mathematics, students’ participation in other kinds of interactions will be strongly influenced. Much effort by those who are working for the reform of mathematics education is directed toward developing learning situations that can support more general learning.

The kind of theoretical account that Greeno et al. (1993) began has an important implication for designing educational programs. According to this analysis, we cannot
simply treat knowledge as being more or less general, without considering the class of activity settings across which we want learning to transfer. Instead, we need to take into account the kinds of activities in which we want students to learn to be successful, and develop learning environments in which they can develop their abilities to participate in the general kinds of practices that are important for them.

**Issue 4: What About Abstraction?**

On the issue of abstraction, again, the disagreement between cognitivism and situativity is about theoretical formulations, rather than being about an empirical claim.

**Questions and Presuppositions about Abstraction**

The question that Anderson et al. discussed is something like:

Cognitive Question 4: What are the relative advantages and disadvantages of abstract instruction, as opposed to instruction for specific activity, especially for jobs?

They imputed to the situative view "Claim 3: Training By Abstraction Is of Little Use" and argued the contrary, that abstract instruction can be effective.

A version of the question about abstraction that has situative presuppositions is the following:

Situative Question 4: What uses of abstract representations in instruction can contribute productively to meaningful general learning?

Presuppositions of these questions include answers to the following, more general question:

General Question 4: How should we use the terms "abstract" and "specific," as well as other terms such as "concrete" and "general," in our theoretical formulations?

In Anderson et al.'s discussion, they assumed that "abstract" and "specific" are opposites; for example: "choosing between abstract and very specific instruction" (p. 8).

In the situative perspective, the issue of abstraction is part of the issue of representation, and both abstraction and representation are complicated concepts that need to be used carefully and clearly. I believe it is a mistake to assume that the opposite of "abstract" is "specific," as Anderson et al. did. The opposite of "specific" is "general," and the opposite of "abstract" is "concrete," and they have distinct, albeit related, meanings. We should begin by distinguishing between the concepts of abstraction and generality, rather than assuming that these are synonymous. It could turn out that abstractions are general, but that would have to be a conclusion, rather than something we can take for granted. It seems more likely that knowing how to use abstract representations can be a significant part of general knowing, but that knowing abstractions is neither sufficient nor necessary for generality.

If abstraction is considered as a property of representations, it involves the portability of symbolic or iconic representations that can be interpreted apart from their referents. For students to learn to use many of the abstract representational systems that are important to their participation in society—particularly those of mathematics and science—they need to learn the standard conventions that are used for their interpretation.

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**Is Efficacious Instruction with Abstract Representations Consistent with Situative Assumptions?**

In the situative perspective, use of abstract representations is an aspect of social practice, and abstract representations can contribute to meaningful learning only if their meanings are understood. To the extent that instruction presents abstract representations in isolation from their meanings, the outcome can be that students learn a set of mechanical rules that can support their successful performance on tests requiring only manipulation of the notations, not meaningful use of the representations.

On the other hand, it is perfectly consistent with the situative perspective that abstract representations can facilitate learning when students share the interpretive conventions that are intended in their use. Examples (cited by Anderson et al.) are the studies of hitting targets under water by Scholckow and Judd (Judd, 1908) and by Hendrickson and Schroeder (1941) which Greeno et al. (1993) discussed. As I mentioned previously, Greeno et al. provided a situative analysis based on the hypothesis that the meaningful abstract representation of refraction oriented students to properties of the situation in a way that resulted in their learning a more generalizable way of interacting with the material systems in the situation.

**Implications for Theory**

There is much that we do not understand about the ways that abstract representations function in activity. Part of the power of abstraction is in people's ability to use representations to orient their attention to properties and relations in situations that are important in activity, as in the refraction examples. Another crucial property of abstract representations is that the representational materials themselves—the symbolic or iconic expressions that are written or drawn—can be manipulated as objects, supporting explorations of possibilities and evaluations of relations such as implication or consistency between different statements. There has been a considerable amount of research into the processes of reasoning in some of the formal systems of logic and mathematics, but the question of how these systems can support learning in conceptual domains and reasoning in domains of application has been addressed much less. However, some promising beginnings have been achieved (e.g., diSessa, Hammer, & Sherin, 1991; Godfrey & O'Connor, 1995; Hall & Rubin, in press; Lampert, 1990a; Ochs et al., 1994).

**Implications for Discussions of Educational Practice**

Anderson et al. remarked that "Abstract instruction can be ineffective if what is taught in the classroom is not what is required on the job" (p. 8). That is a useful observation, but the issue goes deeper than job training. Abstract instruction can also be ineffective regarding some important purposes if what is taught in the classroom does not communicate important meanings and significance of symbolic expressions and procedures. An example in mathematics education is the learning that often occurs when students are taught to manipulate the notations of algebra without connecting them to their conceptual meanings. Algebraic formulas are intended to serve as representations of functions—that is, the symbols of formulas refer to numbers, variables, and arithmetic operations, and equa-
tions express relations of equality or equivalence between functions (e.g., “3x - 7 = x + 1” is a relation that holds if x is 4, and “2(3x - 7) = 6x - 14” is a relation that holds whatever x is). Valid algebraic operations can be stated and learned as a set of rules for transforming symbolic expressions, and those rules can be applied without understanding of their meanings. Many students learn rules of algebra in this way; evidence includes the frequent occurrence of systematic “mal-rules” in students’ performance (e.g., Anderson, 1989; Lewis, 1981; Sleeman, Kelly, Martínak, Ward, & Moore, 1989; R. H. Wenger, 1987). An example is the transformation of an expression such as “2(3x - 7)” to “6x - 7,” which uses a close procedural variant of the correct rule, but produces an expression with a quite different meaning.

I have written this before (Greeno, 1989), but it bears repeating. Some teaching of mathematics is a good realization of Searle’s (1980) parable of the Chinese room. In that parable, a person lives inside a room that has baskets of tokens of Chinese characters. The person does not know Chinese. However, the person does have a book of rules for transforming strings of Chinese characters into other strings of Chinese characters. People on the outside write sentences in Chinese on paper and pass them into the room. The person inside the room consults the book of rules and sends back strings of characters that are different from the ones that were passed in. The people on the outside know Chinese. When they write a string to pass into the room, they understand it as a question. When the person inside sends back another string, the people on the outside understand it as an answer, and because the rules are cleverly written, the answers are usually correct. By following the rules, the person in the room produces expressions that other people can interpret as the answers to questions that they wrote and passed into the room. But the person in the room does not understand the meanings of either the questions or the answers.

Searle’s parable was intended as a critique of the view in artificial intelligence that if a program can produce character strings that can be interpreted as answers to questions by people who understand the language, we should say that the program understands the language. Searle’s conclusion, with which I agree, is that the kind of artificial intelligence that performs formal transformations on character strings to produce what human users of a language can recognize as answers to questions should not be said to understand the language. When we teach mathematics as a set of rules that operate on symbolic expressions without teaching the meanings of the expressions or the rules, we succeed in creating that kind of artificial intelligence in the minds of real students.

The example of mathematics learning shows why we need to distinguish generality from abstraction. The problem with teaching mathematics as a set of rules is not just that some students learn to do it incorrectly. The deeper problem is that students who learn the correct rules may not learn to use mathematical expressions to represent mathematical concepts and relations between quantities. They have learned a set of abstractions, but what they have learned is not general. When the practices of schooling are focused on students’ learning to perform correct transformations on symbolic expressions, the result can be to make that knowledge very specific, in the sense that it satisfies requirements of school activity without strengthening students’ general reasoning and understanding.

There is much that we need to understand about the ways that abstract representations can facilitate general learning. Anderson et al. mentioned several findings in which some generalization has been shown by using a combination of abstract representations and more concrete examples. Those examples are encouraging, although many psychological studies apply a standard of generality that is quite modest. Learning that enlarges the class of word problems that students can solve on tests is a valuable improvement in that it will help some students perform more successfully in their school activities. However, such tests are still located in school practice and do not necessarily tap students’ understanding or use of general mathematical concepts. The important question is how to make school learning more beneficial beyond the classroom, providing students with general resources for reasoning both in and with the concepts of subject-matter domains. Anderson et al. recognized that there is a problem when they said that “relatively little time is spent relating algebraic expressions to the real-world situations they denote” (p. 9).

I would add that much instruction could also be strengthened by relating expressions to the general concepts and principles that they denote. This is the problem that motivates much of the effort in mathematics education reform that is focused on “authentic” activities in school learning. As we proceed, I believe we will increase our theoretical understanding of what all this means, as well as our capabilities of arranging more productive learning activities for students.

Conclusion

The controversy between situative and cognitive perspectives is one of the stimulating features of our current scientific enterprise. Exchanges like these provide opportunities for clarifying issues and taking stock. They also afford reflection on the prospects of our field for advancing in the next phase of our work, both regarding theory and informing discussions of educational practice.

Prospects for Theoretical Advances

During the past 40 years or so, cognitive science has developed an impressive body of empirical and theoretical work about processes of problem-solving, reasoning, understanding, memory, and others, considered as individual cognition. Over roughly the same period, there has been an equally strong development of scientific knowledge and understanding about social interaction using methods and concepts of ethnography, ethnomethodology, symbolic interactionism, discourse analysis, and sociocultural psychology. Until quite recently, these two lines of research have developed quite separately. I believe that the prospects are good for developing a synthesis that will provide a coherent theory of social interaction and of cognitive processes. If that happens in the next few decades, it will be a strong scientific achievement of great importance to education.

If we agree that a synthesis of that kind is an important scientific agenda, we can also agree that more than one route toward that objective should be explored. One possible route takes the theory of individual cognition as its basis and builds toward a broader theory by incrementally
developing analyses of additional components of situations that are considered as contexts for cognitive processes. This approach considers processes of individual cognition as basic and explains social interactions and interactions between people and other systems in terms of individuals' perceptions, goals, inferences, and so on (e.g., Vera & Simon, 1993).

Another possible route takes the theory of social and ecological interaction as its basis and builds toward a more comprehensive theory by developing increasingly detailed analyses of structures of information that are produced by the interactions people have with each other and with the material and representational resources in their environments. This situative approach considers processes of interaction as basic and explains individual cognitions and other behaviors in terms of their contributions to interactive systems. This perspective offers a route from analyses of interactive systems toward more detailed analyses of information structures and processes by which shared information is developed in communication and other collaborative activity. I believe that this situative approach is more likely to support research that will develop an integrated view of social interaction and the informational contents of activity (Greeno, 1994).

Prospects for More Productively Informing Discussions of Educational Practice

Research can contribute to discussions of practice by supporting increased understanding of possibilities. The concepts that are developed and evaluated in research can assist practitioners in their understandings and evaluations of the processes in which they participate, and in their formulating of the visions and goals that guide their practical efforts. By developing conceptual systems that are more empirically inclusive and coherent, we provide resources that are potentially more useful to practitioners in their efforts to reflectively make sense of their activities and experiences and to formulate their goals for continuing progress in their work.

The cognitive and situative perspectives are both valuable for informing discussions of educational practice, but in rather different ways. The cognitive perspective clarifies many aspects of intellectual performance and learning with its emphasis on and clarification of informational structures of skill, knowledge, strategies, and understanding. Educational practice can be strengthened substantially by further development of technologies and teaching methods that are informed by the understanding of learning, problem-solving, memory, and other processes of individual cognition.

The situative perspective can provide a broader framework for understanding and improving educational practice, which can include the important aspects of individual cognitive functioning, but can also go beyond them. As we develop more adequate concepts about systems in which individuals participate, along with other people and with material, representational, and conceptual resources, and develop their identities as contributors and learners along trajectories of participation, we can contribute to the public discussion of educational practices more effectively. In particular, as we develop concepts that give more coherent accounts of learning in terms of social participation and individual identities, our contributions can be more support-
To use the term “situative” to designate a theoretical perspective rather than “situated learning” or “situated cognition,” because those other terms suggest that some learning or cognition is situated but other learning or cognition is not situated. In the situative perspective, all learning and cognition is situated by assumption, so use of “situated” as a modifier of “learning” or “cognition” is syntactically misleading.

This point can be clarified with an analogy. In Rosch’s (1973) terms, there are basic concepts such as table, chair, cupboard, and so on, and other concepts that are not as basic, including more general concepts such as furniture, larger units such as dining room suite, and smaller units such as table leg and chair seat. The cognitive perspective has individual processes such as reasoning and memory at the level of basic concepts, analogies to table and chair, and interactive systems as larger units, analogous to dining room suite. The situative perspective has properties of larger interactive systems such as coordination, normal routine, and mutual understanding at the level of basic concepts such as table and chair, and has individual processes as component parts of the systems, analogous to table leg and chair seat.

The net result of all the studies of whole and part learning seems to be something like this: the parts are easier to learn than the whole and the learner is often happier and better adjusted to the problem when beginning with the parts. He carries over some of the skill and knowledge gained in learning the parts into the subsequent learning of the whole performance. But he finds that putting together the parts is a serious problem requiring much further work. In the end he may have saved time and energy by beginning with the parts—or he may not—much depending on the size and difficulty of the total task and on the learner’s poise and technique. If he can adjust himself to the whole method and handle it properly, he can learn quite complex performances effectively by the whole method. In a practical situation it is probably best to start with the whole method while feeling free to concentrate at any time on a part where something special is to be learned” (Woodworth, 1938, p. 222).

References


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Call for Proposals—James S. McDonnell Foundation Cognitive Studies for Educational Practice

The James S. McDonnell Foundation, St. Louis, Missouri, invites requests for grant support in its program Cognitive Studies for Educational Practice (CSEP). CSEP grant competitions will be held annually with up to five grants awarded in each competition. The Foundation will consider proposals for research projects of up to four years duration that meet program guidelines. Grants in this program are one-time awards and will not be renewed.

CSEP encourages collaborations among university-based researchers and classroom-based educators to apply the theoretical and technical results of cognitive science to address recognized instructional problems and to improve learning, teaching, and teacher preparation. The program particularly welcomes applications from cognitive scientists who believe they have educationally relevant ideas but who have not previously worked on instructional problems and who are proposing to collaborate with practitioners in developing and assessing their ideas.

Project Guidelines: Projects supported within CSEP are expected to address well-articulated and significant problems in K-12 classroom instruction or teacher education and preparation. Projects would have as their goal the development of methods, tools, interventions, and learning environments for eventual use in K-12 classrooms or in teacher education. CSEP grants are intended to support research projects leading to an instructional prototype. Submitted projects should be such as to allow development of the prototype within the single four-year grant period. CSEP does not support work to refine existing prototypes into commercial products, dissemination of prototypes or products, or professional development activities.

Competition and Award Process: Non-renewable grants of up to four years duration will be made to principal investigators affiliated with universities, colleges, schools, or other qualified nonprofit organizations. Previous CSEP awards have had a median annual budget of $160,000. Proposal deadline: June 2, 1997. Awards will be announced in late October 1997.

Application guidelines and information about the CSEP program, including a summary of the projects awarded in 1996, can be obtained by accessing the Foundation's home page at: www.jamf.org or by contacting Susan M. Fitzpatrick, PhD, Program Officer, at CSEP@msf.org or 314-721-1532 (phone).