

Smart People or Smart Contexts? Cognition, Ability, and Talent Development in an Age of Situated Approaches to Knowing and Learning

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Intelligence, expertise, ability and talent, as these terms have traditionally been used in education and psychology, are socially agreed upon labels that minimize the dynamic, evolving, and contextual nature of individual–environment relations. These hypothesized constructs can instead be described as functional relations distributed across whole persons and particular contexts through which individuals appear knowledgeably skillful. The purpose of this article is to support a concept of ability and talent development that is theoretically grounded in 5 distinct, yet interrelated, notions: ecological psychology, situated cognition, distributed cognition, activity theory, and legitimate peripheral participation. Although talent may be reserved by some to describe individuals possessing exceptional ability and ability may be described as an internal trait, in our description neither ability nor talent are possessed. Instead, they are treated as equivalent terms that can be used to describe functional transactions that are situated across person-in-situation. Further, and more important, by arguing that ability is part of the individual–environment transaction, we take the potential to appear talented out of the hands (or heads) of the few and instead treat it as an opportunity that is available to all although it may be actualized more frequently by some.

In the wake of the cognitive revolution, learning theorists and researchers treated learning and knowing as if they were self-contained processes taking place in the confines of individual minds (Fodor, 1975; Newell & Simon, 1972). Intelligence, giftedness, talent, ability, and cognition were also considered features (or possessions) of individual minds (Pea, 1993). This line of thinking, rooted in Cartesian dualism (Descartes, 1637/1978), is founded on the separation of the learner from the learning context, effectively isolating the body from its mind, the self from its world, the content from its context, and ability from those situations in which one is competent (Barab et al., 1999; Turvey & Shaw, 1995). Especially in discussions of talent, intelligence, giftedness, and related topics, researchers have traditionally located constructs in the minds of those considered talented or intelligent, or gifted, or not.

Educators too have fallen victim to a circular logic: Traditional, entity-based theories, placed knowledge in the head of the learner, which led to the creation of educational systems that focused on transmitting content into individual minds.

Decades later, the same educational systems remain in place, implicitly reinforcing the value of traditional conceptions of learning and ability. Given this history, it is not surprising that many attempts to conceptualize learning lead back to traditional conceptions and instructional strategies. Lim, Plucker, and Im (in press) found evidence that even Korean college students' implicit theories of intelligence are surprisingly similar to those of Americans, and they hypothesized that application of American-style instructional strategies, including an emphasis on standardized testing, could be leading Korean students to think of intelligence in “Western” ways. However, in spite of the overarching influence of Cartesian dualism on educational thought, many contemporary thinkers from a variety of domains describe knowing not simply as a psychological construct existing in the head but as an interaction (or what Dewey, 1938, referred to as a *transaction*) of individuals and physical and social situations (Barab, Hay, Barnett, & Squire, 2001; Brown, Collins, & Duguid, 1989; Greeno, 1998; Kirshner & Whitson, 1998; Stanford Aptitude Seminar [SAS], 2001; Sternberg & Horvath, 1998).

Talent development, while also victim to the same circular logic, implies consideration of a much broader set of perspectives on learning, providing an opportunity to step out of dualistic thinking. In this article, we offer an overview of five

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theoretical perspectives that couple individuals and environments as the minimal ontology for describing knowing and learning. Central to these perspectives and to the argument being advanced in this thesis is the belief that

A clearer understanding of human cognition would be achieved if studies were based on the concept that cognition is *distributed* among individuals, that knowledge is socially constructed through collaborative efforts to achieve shared objectives in cultural surroundings, and that information is processed between individuals and the tools and artifacts provided by culture. (Salomon, 1993, p. 1, italics in original)

From this perspective, ability does not reside (and talent development does not occur) in the head of the learner, but is best conceptualized as a collection of functional relations distributed across persons and particular contexts through which individuals appear knowledgeably skillful. Through these relations, and the context in which these relations are actualized, individual and environment are functionally joined and in some cases talented transactions occur (Snow, 1992). Personal identities are also constituted through these relations, especially those identities (and sets of relations) that the learner perceives as meaningful (Barab & Duffy, 2000; Csikszentmihalyi, 1993; Michael, 1996).

To build a theoretical grounding for a perspective of ability and talent development based on this relational and dynamic conception of knowing, we first review and analyze traditional concepts of ability, intellectual talent, and giftedness. While talent may be reserved by some to refer to individuals possessing exceptional ability, in our descriptions neither ability nor talent are possessed and, as such, we treat ability and talent as two different terms that may (or may not) be used to describe functional transactions among person-in-situation. We then discuss five areas of theory and research that hold promise for reconceptualizing talent development, and propose a new conceptualization of talent development. Finally, we consider implications for educational systems that strive to engage and foster intellectual ability and talent development. We view discussions of ability and talent development as a specific case of the more general problem of placing knowing solely (or primarily) in the head of the individual.

TRADITIONAL VIEWS ON INTELLIGENCE, ABILITY, AND TALENT

Traditional conceptions of intelligence, ranging from general factors and related approaches (Cattell, 1987; Jensen, 1998; Spearman, 1904) to differentiated models (Carroll, 1993; Guilford, 1967; Thurstone, 1938), view intelligence as a construct that resides within the individual. Although many of these theories acknowledge the role of the environment in the development of intelligence, the focus is firmly placed on the

individual as the locus of control and unit of interest. Approaches to talent development based on these traditional conceptions of intelligence are common and popular. For example, the Talent Search model initiated at Johns Hopkins University now works with more than 250,000 children per year at several university-based regional centers across the country (Stanley, 1980; Stanley & Benbow, 1981). Many school districts around the country base their gifted education and talent development programs on the identification of high ability children using instruments focused primarily on individual capabilities tested in impoverished contexts using paper-and-pencil items (e.g., Callahan, Tomlinson, Hunsaker, Bland, & Moon, 1995; Hunsaker & Callahan, 1995).

A few contemporary approaches include reference to the environment when they discuss intelligence. For example, Sternberg's (1985) triarchic theory includes environmental interactions within its contextual subtheory, Ceci's (1990) bioecological approach notes the role of context, Das, Naglieri, and Kirby's (1994) PASS theory describes specific cognitive processes that may be influenced by the environment, and Gardner (1983) emphasizes cultural context throughout his theory of multiple intelligences. These theorists discuss the role of the environment or context, yet none of them directly articulate explicit processes for how these interactions occur. When they do refer to intellectual talent, they describe a trait that exists in the individual's mind with allusions to context simply being about the application of talent—not its ontological existence.¹ Perhaps the most well-known theory of giftedness, Renzulli's (1978) three-ring conception, focuses on the interaction among above average ability, creativity, and task commitment. Other conceptions of giftedness vary qualitatively from Renzulli's approach, but most still focus on the qualities of the gifted individual (see Sternberg & Davidson, 1986). Although these broader theories of intelligence and giftedness are much more comprehensive than earlier conceptions of ability regarding environmental factors, the focus remains on the individual during her interactions with the environment.

Educational approaches to talent development based on these broader theories (e.g., Renzulli & Reis's, 1985, Schoolwide Enrichment Model, several of the strategies described in Coleman & Cross, 2001, and Karnes & Bean, 2001) are becoming more prevalent, but the traditional pull-out or "find the gifted child" model remains a common

¹We see the same thing currently in much theorizing about cognition. Much of the discussion of context by cognitive scientists has been in terms of how context enriches the cognition of individuals (what Lave, 1997, referred to as the "cognition plus" view). This is in contrast to how cognition is produced by individuals (the "interpretive" view) or, perhaps more accurately stated, how individuals (including their cognitions) and contexts codetermine each other through practice ("situated social practice"). The last view acknowledges the transactional nature of the interaction in that individuals, environments, and even sociocultural relations all have the potential to be impacted and transformed by the interaction.

approach across much of the country and the world. These strategies, similar to the theoretical assumptions upon which they are based, are predominantly focused on the individual as the unit of analysis or, more accurately, on establishing through an assessment procedure that a student is intellectually gifted and then providing environments in which gifted individuals can thrive academically. In contrast, new areas of theory and research hold promise for the reconceptualization of talent development efforts. In particular, talent can be taken out of the hands of the few and talent development can become an opportunity available to all.

Limitations of Traditional Perspectives

The absolute separation of mind and matter that lies at the core of traditional approaches to talent development polarizes learner and context, postulating the distinct unidirectional and linear flow of cause onto effect (Pepper, 1942/1970). In the case of ability, talent, and giftedness, the individual impacts or acts on the environment. This has resulted in a set of post-Cartesian dualisms: stimulus versus response, behaviorist versus cognitive, reactive versus motivated, innate versus learned, talented versus incompetent—all of which stem from the overriding dualism separating individual and environment (Swenson & Turvey, 1991):

This polarization of learner from environment creates problems that in effect isolate the self from its world, the body from its mind, the content from its context, and the parts from the whole. The history of such dualistic thinking reveals its inadequacies as a way of explaining thought and knowledge in that it sets up an incommensurability between knower and known, with one language to describe that which is known and another to describe the individual doing the knowing. (Barab et al., 1999, p. 355)

Dualistic lines of thought in which ability and talent is considered a possession of the individual still dominate most lay and many theoretical conceptions of talent. In 1992, Snow commented on the problems of traditional theories of aptitude:

The conceptual limitation derives from our tendency to think of persons and situations as independent variables, rather than [to see] *persons-in-situations* [italics added] as integrated systems. To build the aptitude theories of tomorrow, we need a language for describing the processes that connect persons and situations—the processes that operate in their interface. (p. 19)

Traditional notions that place ability in the head of the individual have been challenged not only on philosophical grounds but also on psychological grounds—especially as they relate to perception. For example, ecological psychologists have performed numerous studies to support the contention that the environment contains numerous opportunities for action for an individual with the requisite abilities to act on

these opportunities (Turvey, 1996). These studies have examined what Gibson (1979/1986) referred to as environmental affordances—namely, possibilities for action that the environment offers to individuals. For example, Gibson, et al. (1987) studied crawlable surfaces, while others have studied sittable and steppable heights (Mark, Balliet, Craver, Douglas, & Fox, 1990; Pufall & Dunbar, 1992; Warren, 1984). These studies lend support for the hypothesis that in explaining perception it is *not* necessary to infer symbolic calculations on the part of the individual; what is needed is a better understanding of how the individual becomes apprised of these affordances or possibilities for action—in other words we need to know more about physics to accompany our psychology (Barab et al., 1999; Kim, Turvey, & Carello, 1993; Turvey, 1996). Central to the ecological psychology perspective (discussed more later) is the assumption that perception is a property of the individual–environment system and not the individual mind (Gibson, 1979/1986).

At a more applied level of critique, the anthropologist Jean Lave (1986, 1993, 1997) researched the discontinuities in performance of mathematical activity by the same persons in different settings, suggesting that the competence of the individual is situationally specific. For example, in the Adult Math Project in California (Lave, 1977, 1986; Reed & Lave, 1979) they found that during price arithmetic calculations in the supermarket, shoppers almost never made an error in the final outcome. In 90% of the observed episodes the shopper correctly solved the problems and identified the best buy, while the same individuals averaged only 57% correct when attempting comparable problems in a math testing situation. Another example was reported by Saxe (1992) who studied children selling produce in open markets in Brazil. In this research, psychologists posed as difficult customers so as to present a number of arithmetic problems to the children. They found that the children's arithmetic was correct 99% of the time in the market, but their performance on the same problems on a math test was successful only 65% of the time. Herndon (1971) cites a similar observation of a high school teacher who observed one of the lowest achieving kids in his class keeping score for a bowling league, where he was able to manage up to eight bowling scores at once without making an error. Commenting back in the classroom, Herndon said

I figured I had this particular dumb kid now. Back in eighth period I lectured him on how smart he was to be a league scorer in bowling. Naturally I then handed out bowling-score problems ... The brilliant league scorer couldn't decide whether two strikes and a third frame of eight amounted to eighteen or twenty-eight or whether it was one hundred eight and one half. (pp. 94–95)

These studies, in which people perform differently in different settings even when performing comparable or the same problems, challenge the validity of official competence and performance distinctions in which talent is considered to be a

possession of the individual and not an outcome of persons-in-situations (Lave, 1997).

From a motivational standpoint, recent research provides evidence that the perspective of talent residing solely within the individual has important limitations. For example, attribution theory suggests that internal, stable attributions (e.g., "I am an intelligent and talented person") may be difficult to maintain in light of challenging assignments, whereas internal, unstable attributions (e.g., "I succeeded or failed because of my effort") place a greater sense of responsibility on the person-in-situation and leads to achievement motivation (Weiner, 1992). Conversely, students who are not succeeding can quickly descend into learned helplessness if they believe that they are not talented and will not succeed, regardless of their level of effort (Diener & Dweck, 1978). The creation and maintenance of stable internal attributions for success and failure produce further complications when the label of "good student" or "bad student" is attached to a learner. Teachers treat students differently based on teacher expectancies of student ability, often resulting in increased or decreased student achievement (Jussim & Eccles, 1995). At the policy level, beliefs in stable internal attributions can also manifest themselves in practices such as tracking and inflexible ability grouping, which also tend to lower or raise teacher expectations and subsequent student achievement (Goodlad, 1983).

Advances in research over the last 20 years have further illustrated the weakness of traditional approaches to ability and talent in light of learning and thinking styles, the importance of context, and other factors (Snow, 1997; SAS, 2001; see also Marsh, Byrne, & Shavelson, 1988; Plucker & McIntire, 1996; Simonton, 1999, 2001). As educational psychologists, we know much more about human learning and achievement than we did only a generation earlier, yet educators often use instructional strategies that are based on conceptions of talent and ability that are decades old (Bransford, Brown, & Cocking, 2000). An example from our own work involves the experiences of a student during an intensive academic summer program for "talented" students. The student, who attended an urban high school, took a course that required a great deal of group work, self-regulation, and creativity due to its constructivist, problem-based curriculum. Her performance throughout the first half of the course was very poor, and her social interactions with her peers began to deteriorate. The two teachers for the course initially questioned, using on a traditional "talent in the head" model, how the student could have been admitted into the program, given her apparent lack of ability.

Around that time, the class had a social event at a local swimming pool and the teachers discovered that the student had never been in a pool before. This led to a frank discussion during which the student revealed that she was very uncomfortable in a classroom with bright, suburban students. Furthermore, the standard mode of instruction in her high school was lecturing, of which very little occurred in the summer program. She was completely out of her instructional element. The student was considered to be lacking in "talent" according

to traditional conceptions: Her performance, in a technology rich, well-designed curriculum was below average, therefore, she had low ability. In contrast, we argue that instead the difficulties can be found at the nexus of person-in-situation, in that her potential to act was a poor fit for this specific environment (SAS, 2001) and that, as a result, the interaction did not support the emergence of talent. In the aforementioned case, when the teachers made adjustments to the curriculum to address this student's concerns, her performance improved significantly.

We have described limitations of traditional perspectives, critiquing these on philosophical, perceptual, practical, and motivational grounds. Central to these criticisms is the conviction that talent cannot be characterized in purely cognitive terms (as an internal stable trait), nor does it have a purely environmental explanation that locates its origins in a changing environment (or in a person's permissible relations with it; Lave, 1986). Instead, we will advance a perspective on talent that acknowledges person-in-situation and locates talent fundamentally in the active relations of individual and environment. However, prior to this ecological description of talent, we review the theoretical grounding of our conceptualization of talent development in five distinct areas: ecological psychology, situated cognition, distributed cognition, activity theory, and legitimate peripheral participation.

ECOLOGICAL PSYCHOLOGY

Although Plato espoused a line of thinking that advanced an animal-environment dualism, Aristotle posited that the knower and the known are united in a functional interdependency (Lombardo, 1987). Consistent with Aristotelian thought, a line of thinking emerged that challenged the static, analytic, and segmented thought of absolute dualism. Theories founded on this Aristotelian ecological heritage have become more pronounced, with examples occurring in fields ranging from robotics and artificial intelligence (Brooks, 1991; Clancey, 1993), to the physical and life sciences (Pattee, 1979; Swenson & Turvey, 1991), to the social and behavioral sciences (Bruner, 1996; Ennis, 1992; Greeno, 1989; Roschelle & Clancey, 1992; SAS, 2001). Despite the different subject matter, what remains invariant across these domains is the belief that individuals are firmly seated within a context that co-determines their perspectives and understandings of "content." This belief, predicated on a relational ontology, provides a set of assumptions regarding reality and how we come to know about it that is *alternative* to more mechanistic or organismic explanations (Pepper, 1942/1970).

Recognition of the interdependence of individuals and their environments is clearly evident in ecological psychology (Gibson, 1979/1986; Turvey & Shaw, 1995). Ecological psychology is based on the premise that perception is a property of an *ecosystem*, not an individual, and is co-determined through the individual-environment interaction. An ecosystem consists of an individual plus a mutually compatible environment (or equivalently, an environment plus a mutually

compatible individual). Gibson (1979/1986) introduced the relational terms *affordance* and *effectivity*. As previously noted, an affordance is a specific combination of properties of an environment, taken with reference to an individual, that can be acted upon—opportunities for action (Gibson, 1977). Reciprocally, an effectivity is a specific combination of properties assembled by an individual, taken with reference to the environment, that allow for the dynamic actualization of a possibility for action (Shaw & Turvey, 1981).

Different features of the environment afford activities for an agent who has appropriate effectivities. For example, a pool is *swimmable* for someone who has the ability to swim. The student in the summer program mentioned previously would have had a better chance to foster her talents if the instructors had realized initially that the learning context in large part prevented her success (i.e., the affordances and effectivities were mismatched). A central commitment of ecological psychologists is that an individual's perception of the environment can be explained without the postulation of mental representations or an objective reality (Kim et al., 1993; Mark et al., 1990; Pufall & Dunbar, 1992). This is because when one expands their unit of analysis to consider person-in-situation, much of the knowing that was traditionally placed in the head of the learner can now be found in the interaction:

There is a reason to suspect that what we call cognition is in fact a complex social phenomenon. The point is not so much that arrangements of knowledge in the head correspond in a complicated way to the social world outside the head, but that they are socially organized in such a fashion as to be indivisible. "Cognition" observed in everyday practice is distributed—stretched over, not divided among—mind, body, activity and culturally organized settings which include other actors. (Lave, 1988, p. 1)

Perception and action, from this perspective, are properties of an agent–environment system, not of an individual, or of an environment alone (Turvey, 1992; Turvey & Shaw, 1995). One implication of this theory is that it is *not* necessary to posit inferences to symbolic calculations on the part of the observer; what is needed is a better understanding of the coupling or transaction between environmental affordances and how the perceiver becomes apprised of these possibilities for action—the perception-action system (Turvey & Shaw, 1995). Swenson (1999) argued that "the place to look for meaningful content is not in the normal physical descriptors of individual particles [nor in the individual], but instead in the variables of the flow itself" (p. 21). It is within this coupling, in the flow itself, that ecological psychologists place the ability to act intelligently. In addition, and consistent with pragmatist lines of thought (Dewey, 1938), what makes one individual's cycle of perception-action more "intelligent" (or functional) than another is not some objective representational meaning but its contextualized functional value—that is, its usefulness in terms of the particular contexts in which it is applied. Although

Gibson's (1979/1986) work was primarily concerned with perception, his ecological coupling of individual–environment and meaning–context has implications for, and is consistent with, current views of situated cognition.

SITUATED COGNITION

In contrast to theories that depict truth as an objective substance existing in the world or those that conceive of knowing as a product of human mental activity, ecological views maintain that knowing is an activity that is co-determined by individual and environment (Brown et al., 1989; Prawat & Floden, 1994). Cognition is explained in terms of the relationship between learners and the properties of specific environments (Gibson, 1979/1986; Young, 1993). From this perspective, separating the learner, the material to be learned, and the context in which learning occurs is impossible and irrelevant. Knowledge is more aptly phrased *knowing about*, and knowing is a perceptual activity that always occurs within a context (Prawat & Floden, 1994). Only after the event, or in anticipation thereof, can *knowing about* be discussed as a thing (Suchman, 1987). Barab and Duffy (2000), consistent with the situativity perspective,² described the central tenets that characterize *knowing about*:

Knowing about refers to an activity—not a thing; knowing about is always contextualized—not abstract; knowing about is reciprocally constructed within the individual–environment interaction—not objectively defined or subjectively created; and knowing about is a functional stance on the interaction—not a "truth." (p. 28)

The important point about this characterization is the fundamentally situated treatment of knowing. Plucker and Stocking (2001) have discussed the importance of not separating learners from their various contexts in their discussion of gifted adolescents. They argue that the traditional approach for viewing the affective development of high achieving students (i.e., a one-time administration of a self-concept instrument) is limiting and ineffectual. Rather, researchers should acknowledge that many of these students move frequently among various educational contexts (e.g., different classes, afterschool experiences, weekend classes, summer programs, interactions with family and friends, interactions within the larger community), and that the intellectual and affective experiences of these students will only be usefully understood when researchers consider the multiple interactions of individual and context that occur in the daily lives of these students.

In Brown et al.'s (1989) seminal piece on situativity theories and the culture of learning, they advanced the belief that learning

²Greeno and Moore (1993) preferred the term *situativity* over *situated cognition* to denote the contention that situativity is fundamental to all cognitive activity and not simply one kind of cognition.

is always situated and progressively developed through situated activity. They contended that learning involves more than *acquiring* a set of self-contained entities. It actually involves *building* a contextualized appreciation of these entities as tools, as well as for the situations through which these tools have value. Greeno (1989), in a similar vein, argued that thinking is situated in context, comprised of a relation between cognitive agents and the situations in which they are acting. In general, situativity theorists explain cognition in terms of the relations among learners and the properties of specific environments (Bredo, 1992; Clancey, 1993; Greeno, 1997; Lave, 1997; Young, Barab, & Garret, 2000). From a situativity perspective, *knowing about* is described as a dynamic process distributed across the knower, that which is known, the environment in which knowing occurs, and the activity through which the learner is participating when learning or knowing occurs. In this way, situativity theory allows for the “unification of the world, the individual, and the relations among these reciprocal components” (Barab et al., 1999, p. 360).

The claim that thinking is best conceived as an activity involving concrete particulars of the situation, as opposed to abstracted symbolic representations in the mind, is apparent in Lave’s (1988) discussion regarding the observation of de la Rocha, who conducted a study of individuals participating in a Weight Watchers diet program. In this case, the interviewer asked an individual what would happen if he wanted to serve three fourths of his day’s normal portion, which was two thirds of a cup of cottage cheese. These individuals, even though they had taken advanced mathematics courses, instead of performing the symbolic calculation, actually dispensed two thirds of a cup of cottage cheese and divided it into four equal parts, and reserved one of the quarters—using the concrete particulars of the situation. We have insufficient data to determine if the same answer would have been provided if the individual was *not* outfitted with these resources. In other words, do we credit the correct response to the individual or to the situation? The argument underlying this paper is that this question is moot; instead, we should be trying to understand how some individuals are able to take advantage and function effectively within context, aided by whatever physical and social resources they use (Greeno, 1997; Salomon, Perkins, & Globerson, 1991). This situated (or ecological) view of knowing not only captures the world and individual participation as it is, but stresses the opportunities for learners to reveal their ability and talent.

This notion of situativity in general and situated action in particular is evident in Gladwin’s (1964) discussion contrasting the methods in which the Europeans and the Trukese navigate the open sea. Whereas the former use a plan related to navigational principles, the latter begin with an objective and use local environmental circumstances—the color of water, the waves, winds and clouds, birds, and so forth. What is interesting about the Micronesian navigator is that navigation seems to be distributed across the interaction of individual and environment, as opposed to some preconceived plan.

Gardner (1983) has used the same example to argue for the existence of multiple intelligences. The grocery shoppers, the children in Brazil, the student in our summer program and many other examples from the literature all provide examples of *knowing about* being a situated activity.

DISTRIBUTED COGNITION

Central to the preceding two sections is the conviction that perception and cognition are not properties or possessions of individual minds but are dynamic and contextualized acts or sets of relations distributed across individuals and social and physical resources (e.g., textbooks, collaborators, previous experiences, and computer representations) and the contexts through which they function. Said another way, knowing and context are irreducibly co-constituted, and learning is fundamentally connected with and constitutive of the contextual particulars through which it occurs (Barab & Kirshner, 2001; Cobb & Yackel, 1996). A learner’s ultimate understanding of any object, issue, concept, process, or practice, as well as her ability to act competently with respect to using these, can be attributed to, and is distributed across, the physical, temporal, and spatial occurrences through which her competencies have emerged. It is in this sense that cognition is embodied, situated, or, as described in this section, distributed.

The distributed nature of cognition was discussed by Hutchins (1993) who studied how navigating a vessel is accomplished through a cooperative effort among its crewman, interacting with one another and the tools available on the ship. The shared experiences on the ship among the crewmen enable them to communicate with each other. Each crewman has specific responsibilities in terms of navigating the ship (e.g., quartermasters share among themselves the task of the plotter, bearing tracker, the bearing time-recorder), and manipulates appropriate tools for the task. The result of this cooperation is the community knowledge for how to navigate the ship. It is the group knowledge, as well as the tools on the ship, that enable the proper navigation of the naval vessel. Hutchins concluded that in a complex activity involving joint problem solving among a team of individuals (such as a group of students working on a collaborative project), individual minds cannot be considered the only locus for structures that organize thinking. It is impossible, and of little value, to divide this shared knowledge and credit individual owners—instead this knowledge is distributed across multiple individuals and resources—and it is, in part, the structure of this distribution that must be described (Cole, Engeström, & Vasquez, 1997).

Pea (1993) similarly argued that the ability to act intelligently is *accomplished* or *engaged* rather than *possessed*. Pea describes intelligence as an activity that is present in the tools, modes of representation, human collaborators, and other artifacts an individual uses to act intelligently. He added

When we look at actual human practices, we see that human cognition aspires to efficiency in distributing intelli-

gence—across individuals, environment, external symbolic representations, tools, and artifacts—as a means of coping with the complexity of activities we often call “mental.” (Pea, 1993, p. 81)

Integral to thinking on the phenomena of distributed cognition is the conviction that resources typically conceived as external to the individual thinker, fundamentally change the nature and function of the system through which competent action emerges. These system changes then affect conceptions of what, how, and why one needs to know (Cole & Engeström, 1993; Perkins, 1993; Salomon, 1993). If, as Pea (1993) and others have argued, social, historical, and possibly other external processes are to be taken as integral parts of competent action, then traditional notions of cognition and intelligence (which relegate these processes to the individual mind) ought to be re-examined (Salomon, 1993). Competent action is described as neither external nor internal, but instead is reconceived as external, internal, and that which is actualized through the transaction of both components (Barab et al., 1999; Barab & Kirshner, 2001).

Barab et al. (2001) studied learning within a technology-rich environment by tracking the emergence of shared understanding and products through an examination of student and teacher practices. They observed students participating in a one-week camp in which they worked in groups with three-dimensional modeling software to develop a virtual world. Barab et al. traced the history of transactions that accounted for the emergence, evolution, and diffusion of learner practices in the learning environment.

These tracings revealed the reciprocal nature of learning and doing, with building conceptual understanding occurring in relation to local conditions and practices. Through building their models, students engaged numbers and equations by direct manipulation of their virtual objects, supporting them in building an understanding of quantitative relationships of astronomical phenomena without defining these through their formalisms. As such, it was significant to hear one student say, “Wow, finally a use for math!” Consistent with how students came to understand other conceptual tools, mathematics was not introduced as a set of rules to be memorized but as a collection of useful tools to support students in their activity of building 3-D worlds, with their understandings coevolving through their actions. This perceived applicability of the material is considered to be a key factor in creating the task commitment often observed in talented children and adults (Bloom, 1985; Csikszentmihalyi, 1991; Renzulli, 1999).

At one level, conceptualizing knowing and doing as inseparable is simply a theoretical commitment that we have chosen, and their interrelations are present because we have chosen to situate them in this manner. However, at another level, we believe “that situating our learning environments and our interpretations in terms of this commitment allows us to develop more useful learning environments and interpretations of the student experience in these environments than if we maintained the dualistic tradition” (Barab et al., 2001, p.

33). Only through acknowledgement of the distributed nature of knowing (and talent) can meaningful learning contexts be fostered. It is also in this way that knowing, ability, and talent are considered properties of systems, not individuals

ACTIVITY THEORY

Conceptions of distributed intelligence in which individual functioning is considered to be distributed across and situated in the transaction among the subject, available tools, and the community context resonates with system views of thinking in which entire systems, not individual or environmental components, are conceived as the minimal ontological descriptors for describing activity (Barab, 2002; Ford & Lerner, 1992). In defining the various components of a system through which cognition is situated, we have found it useful to draw on the theoretical perspective of activity theory (Barab, Barnett, Yamagata-Lynch, Squire, & Keating, in press; Engeström, 1987, 1999; Leont’ev, 1974), referring to a line of theorizing and research that was initiated by Leont’ev, Vygotsky, and Luria at the beginning of the 20th century. Activity theory is a psychological and multidisciplinary theory with a naturalistic emphasis that offers a framework for describing activity and provides a set of perspectives on practice that interlink individual and social levels (Engeström, 1993; Nardi, 1996).

When referring to *activity*, activity theorists are not simply concerned with *doing* as disembodied action, but are referring to *doing* to transform some object, with a focus on the contextualized activity of the entire system—not on isolated activity (Engeström, 1987, 1993; Kuutti, 1996). An activity system consists of a subject (individuals or groups that act, and whose agency is selected as the point of view for the analysis) and an object (that which is acted upon), as well as the components that mediate the relations of subject and object. The mediating components are tools (conceptual and physical), community, rules, and divisions of labor (Engeström, 1987). This collective system constitutes the minimal meaningful context through which to understand human praxis, such as talent (Barab, 2002). In other words, activity is distributed across subjects (those considered talented or not talented) and the tools they use, all of which occurs as part of some expanded community context.

Returning to the 3-D modeling environment discussed earlier, Barab, Barnett, et al. (in press) used activity theory as an analytical lens for understanding the transactions and pervasive tensions that characterized course activities. Specifically, they focused on the relations of subject and object (virtual reality models and astronomy understandings) and how, in their course, object transformations leading to deep scientific understandings were mediated by tools (both technological and human), the overall classroom microculture (emergent norms), division of labor (group dynamics and student–instructor roles), and rules (informal, formal, and technical). Reflecting on their analyses, they interpreted the various course tensions and innovations in the framework of the overall course activity system, modeled in general form

using Engeström’s (1987) triangular inscription for modeling the basic structure of human activity (see Figure 1). Note that each of the components Engeström hypothesized as constituting *activity*, of which knowing is but one type, are depicted in bold at the corners of the triangle. The figure captures the multiple and interacting components that, from an activity theory perspective, constitute activity.

Figure 1, as an analytic characterization of course activity, captures the interacting dynamics of course activity. In this figure, Barab, Barnett, et al. (in press) illustrate the pervasive tensions of the course, characterizing them in the form of dilemmas within each component of the triangle (e.g., subject: passive recipient vs. engaged learner). Tensions within a component are listed under each component. Cross-component tensions are illustrated by dotted arrows and are viewed as part of the transaction, not as individual or environment (see a, b, c in Figure 1). Viewing the class as an activity system allows an understanding of how dualities, analyzed as pervasive tensions, lead to outcomes that are inconsistent with students’ developing astronomical understandings. An appreciation of these tensions fueled changes in the course.

The figure further illustrates the mediated transaction among subject and object, and captures the theoretical commitment that activity is distributed across sociocultural contexts. Although the illustration depicted in Figure 1 obscures the multiple and varied strings of actions that characterize activity in situ (thereby neglecting the dynamic, evolving nature of activity systems as well as the

transactional functions within and between activity systems), it does have the benefit of accounting for activity as a contextualized set of events that are distributed across physical tools and rich contexts, all of which are embedded in a rich sociocultural history. From this perspective, *knowing about*, or exhibiting talent, as types of activity, should also be conceptualized in terms of the sociohistorical contexts through which they are manifested.

In contrast to analysis methods that treat interacting system components in isolation, the methods of analyses used by activity theorists provide a means to account for the complexities of course dynamics. First, the methods acknowledge that subject–object relations and outcomes of understanding all exist as part of a context. This recognition of context shifts the unit of analysis from the individual or the environment to the system. Second, it looks for explanations in the activity (person-acting-in-situation) and not in the mind of the individual nor the environmental components. By treating activity as a contextualized set of events that are distributed across physical tools and rich contexts, all of which are embedded in a rich sociocultural history, activity theory has much to offer in tackling the theoretical and methodological questions that are central to theories that suggest cognition is practice-bound or situated. An important feature of activity theory is the acknowledgment that each current system is nested, physically, socially, and historically within various other activity systems. In the next section on talent development, we describe how talent is best conceived as one’s ability to participate as

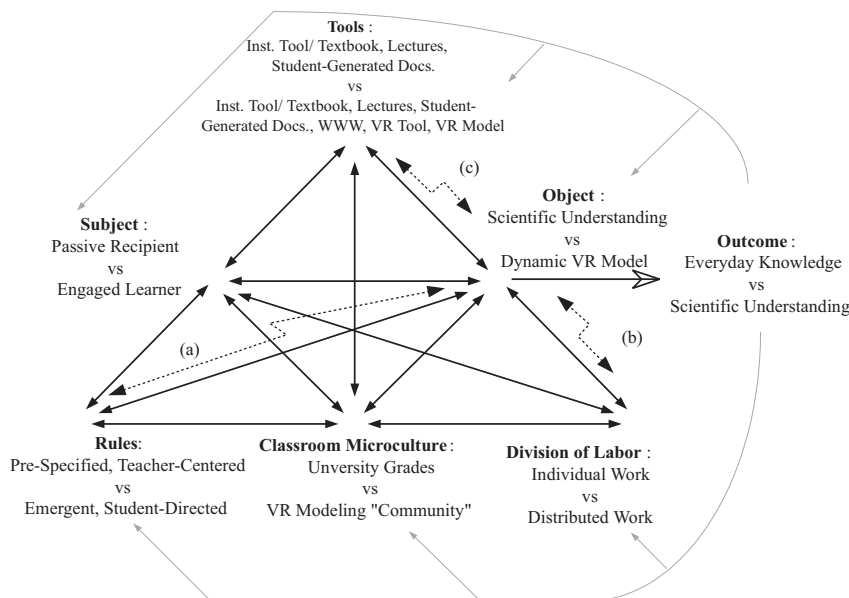


FIGURE 1 The basic structure of human activity. The figure illustrates the mediated relationship between subject and object, and the interrelations among the various components of the system. Specifically, it illuminates the systemic dynamics and pervasive tensions of the course activity of students participating in the VSS course (see Barab, Barnett et, Yamagata-Lynch, et al., in press).The figure illustrates the mediated relationship between subject and object, and the interrelations among the various components of the system.

part of these various systems. We later discuss how talent is best developed through participation that is nested as a part of these various systems.

LEGITIMATE PERIPHERAL PARTICIPATION

Current theorists, both within and outside schools, have been exploring the lessons learned from apprenticeship learning. After examining five apprenticeship situations, Lave and Wenger (1991) noted that in the successful cases there is little observable teaching, yet large quantities of learning. In these examples, the practice of community creates the potential “curriculum” in the broadest sense. In their view, learning is not simply one kind of activity, rather learning—or, alternatively, talent development—is viewed as an aspect of all activity.

The process of learning, which is always situated, must be described in relation to the context through which it occurs. Of prime importance are one’s reasons for learning. This line of thinking led to the notion of legitimate peripheral participation, in which the primary motivation for learning involves participating in authentic activities that move one towards becoming more central to a community of practice. For example, Barab, Barnett, and Squire (in press) have been researching a Community of Teachers (CoT) over a period of 2 years. A CoT is a professional development program for preservice teachers working toward teacher certification. The program is highly field-based in that each member is expected to commit to one school where he or she will do all fieldwork. These students are not assigned to a teacher, but rather, spend time visiting the classes of and talking with teachers who are a part of the program. An apprentice relationship is formed for the duration of the program with one of the teachers based on a social negotiation and a mutual determination that the relationship will be beneficial. Similarly, each student joins an ongoing community of preservice teachers and remains a part of that community for the duration of their studies. Students in the community attend seminars together and, as with any community, a continuum of experience exists with veterans (seniors or students with teaching experience) at one extreme and newcomers (sophomores) at the other. Students complete the program not through an accumulation of credits but through building a Portfolio of Expectations that demonstrates their competence as an effective teacher.

In CoT, developing the talent of teaching is not memorizing facts and principles through specific coursework, but instead involves a social negotiation as students integrate seminar readings with their field experiences in the schools. One fosters understanding (i.e., supports the process of being a teacher) by attending seminars, teaching in their chosen placements, doing readings, and integrating these experiences into their portfolio. Lave (1988) suggested that learning is more than simply receiving a body of factual knowledge; rather,

learning is a process that involves becoming a different person with respect to possibilities for interacting with other people and the environment. In the CoT program, the “old-timer” (an individual who has been a member of the community for an extended period) is expected to be better prepared for teaching than when he or she first entered the program. Talent development, in this case, involves the construction of new identities as the individual becomes enculturated into a community of learners. The individual is no longer the same individual with new skills, but is a new person who has become more enculturated into the practice of teaching, negotiating meanings based on his or her joint experiences as a student in the K-12 schools, while at the same time being a student in a seminar committed to preparing teachers and transforming the schools within which students are working.

Lave and Wenger (1991) further argued that in many apprenticeship situations the desire to become central to a community of practice makes learning legitimate and of value for the individual. We propose extending this observation to the development of talent: As one develops her talents in a specific domain, her status in the community moves along a trajectory from the periphery to a more central role in the community. For example, initially the newcomer to the CoT program mostly listens and receives support, but slowly he begins to take on responsibilities such as leading seminars, sharing classroom experiences, and building a portfolio, until eventually he becomes responsible for mentoring newcomers. However, in many school contexts “there is no cultural identity encompassing the activity in which newcomers participate and no field of mature practice for what is being learned, exchange value (grades) replaces the use value of increasing participation” (Lave & Wenger, 1991, p. 55). This is not to imply that schools are devoid of a situation, rather that increasing participation is not the primary motivation for learning.

OUR CONCEPTION OF ABILITY AND TALENT

Taken as a whole, these five perspectives suggest that ability does not exist as a collection of symbols or even relations within the head of an individual, but rather must be understood as a function of a person’s thinking in a situation (SAS, 2001). Existing conceptions of ability (or talent) and traditional views of talent development must be reconceptualized to account more fully for advances in our understanding of human learning and achievement. While talent may be reserved by some to refer to individuals possessing exceptional ability, in our description neither ability nor talent are possessed and, as such, we find little utility in distinguishing among them. Rather, we view intellectual ability and talent as different terms to describe the same process, a process that is best described using relational terms such as talented transactions. Further, although the use of the term *talent development* has become popular (Feldhusen, 1998; Gagne, 1995; Renzulli, 1994; Simonton, 1999, 2001; Treffinger, 1998; Van

Tassel-Baska, 1998), we know of very few definitions of the construct and only one that accounts for the transactional nature of development that is being advocated for in this manuscript (SAS, 2001, pp. 49–54). In part, constructs such as ability and talent (or creativity) have the mixed blessing of people having widely held implicit theories of these constructs. Their unofficial definitions, therefore, are often taken for granted, making definition even more difficult.

Our view of ability and talent are influenced by the diverse body of work on talent development as well as the theoretical perspectives discussed above, but with a different emphasis. In our view, *intelligence*, *expertise*, *ability*, and *talent*, as these terms have traditionally been used in education and psychology, are socially agreed upon labels that minimize the dynamic, evolving, and sociocultural nature of individual–environment relations. Instead of a property of individuals, we characterize ability or talent as *a set of functional relations distributed across person and context, and through which the person-in-situation appears knowledgeably skillful*. In other words, ability and talent arise in the dynamic transaction among the individual, the physical environment, and the sociocultural context (see Figure 2). This transaction involving person-in-situation forms the minimal meaningful ontology for describing talent, ability, or even knowing. We are not discounting the contribution of individuals to the production of talented interactions, but rather we are reacting to the failure of traditional perspectives to account for the contexts and sociocultural structures and relations through which talented interactions emerge.

The argument being advanced suggests that intellectual ability could not exist in the form in which it is realized except in relation to the context. Our view of ability and talent extends Gibson's (1979/1986) ecological notions regarding perception to account for talent and cognition more generally. Gibson's core contribution was his claim that an individual profile of abilities (effectivities) can only be understood with respect to environmental affordances. Whereas Gibson's work was focused on structural properties of information taken with respect to the individual, our perspective also includes those sociocultural structures and frameworks that fur-

ther come to define what is considered talented behavior and how it is shaped. For example, children in Brazil, shoppers in California, or students in our courses can appear talented in their everyday contexts, but appear challenged in more formal school settings. In addition to the distributed or relational description of talent, our perspective treats ability not as a cause but as an *effect*—an effect that is actualized as part of the person-in-situation *flow* itself.

Given our relational and fundamentally situated description of ability, we view talent development as a transactional process that involves active transformation of individual, environment, and the sociocultural world. Talent development is a process that involves *doing*, not acquiring (Barab & Duffy, 2000; Sfard, 1998). In this manner, talent is a social entity, both one that is socially produced and socially validated (Dewey, 1938). Clearly, at some level talent development involves the transformation of the individual. However, similar to Gibson's (1979/1986) ecological description of effectivities, talent development involves the transformation of the individual in relation to the contexts through which the individual transformation is realized.

We characterize this individual transformation as the education of intention and attention. Intention refers to the goals or motives of the individual and attention refers to the immediate situational (material and social) processes and structures to which the individual attends—again, neither intention nor attention resides solely within the individual. Instead these are distributed among the individual, environment, and the sociocultural world. The selection of goals determines what is relevant at the intention and attention levels. The critical role of intention in talent is its ability to set the focus of attention, isolate it from other potentially distracting influences, and serve as an attractor around which behavior takes shape (Barab et al., 1998).

Whether a particular individual–environment interaction is considered talented is very much socioculturally determined. Therefore, an important part of exhibiting talented behavior involves understanding how to act in a manner that is consistent with those ways that have been socioculturally endorsed—that is, functional for a particular group. As such, talent development involves becoming more able to engage in interactions that “live fruitfully and creatively in subsequent experiences” (Dewey, 1938, p. 28). Consistent with the goals of positive psychology³, this places talent in the reach of all learners, treating it less as an endowment of a few specialized individuals and instead as an opportunity for all individ-

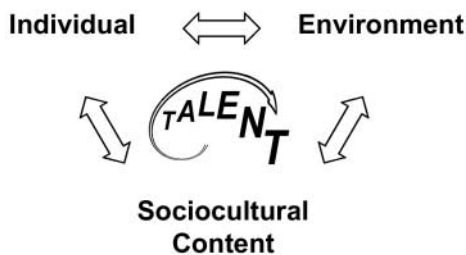


FIGURE 2 Visual representation of the emergence of talent, which is conceptualized as emerging from the dynamic transaction among the individual, the physical environment, and the sociocultural context.

³The goal of positive psychology is to focus on personal strengths as opposed to the disease model that has predominated much of the social sciences for several decades. As Seligman and Csikszentmihalyi (2000) note, positive psychology encourages movement from a focus on pathology to one on prevention, positive personality characteristics, and a focus on individuals' strengths. The emphasis on pathological foci is also apparent in nearly all aspects of education, with the possible exception of organized athletic teams in which strength-based approaches are more common.

uals. Further, by equating talent with useful participation, and by treating it as a potential of effective individual-environment transaction, we have expanded the definition of what constitutes talent and who can appear talented, advocating that all learning can be understood as talent development. *This commitment, coupled with the above argument positioning talent in the transaction, suggests that no one is talented, yet everyone can exhibit talents.* In the next section we discuss the design of learning environments that will best support talent development.

ENGAGING ABILITY AND SUPPORTING TALENT DEVELOPMENT

The argument made thus far is that ability does not emerge or exist in a contextual vacuum, and, as a result, talent development situated within the context of schools may lead to a very different understanding than talent development taking place outside the context of schools. All too frequently, learning taking place in the context of schools contributes to knowledge that is inert (Cognition and Technology Group at Vanderbilt [CTGV], 1993; Lave, 1997; Whitehead, 1929) and fails to engage talented interactions outside of the school walls. This arrangement also hinders students' efforts to develop the ability and motivation to learn independently throughout their lives and, we believe, severely hampers the development and potential engagement of talented interactions. This is due in part to the fact that many formal schooling contexts are predicated on the knowledge acquisition metaphor, with the goal being to determine the most efficient means of transferring knowledge into the head of the learner. In other words, the focus of much schooling practice is on developing talented individuals, not establishing rich contexts that engage talented interactions with all individuals. In this article, we have challenged the concepts of ability and talent as things, and instead argued that ability and talent are relational acts involving the individual, the physical environment, and the sociocultural relations through which talented transactions may occur.

To clarify, the ecological or situativity theorist is not concerned with supporting the learner's acquisition of knowledge, but instead focuses on establishing functional transactions through which individuals increase their potential to effectively participate in subsequent transactions. With respect to supporting learning, the overriding question becomes

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? (Greeno, 1997, p. 9)

This question is of central importance when educators adopt an ecological (person-in-situation) unit of analysis, leading to an emphasis on how various social circumstances influence

individuals' potential to engage talented transactions, and how individuals develop this potential through transactions with the social and physical features of the environment. In other words, educators must support the development of smart contexts—not simply smart individuals.

A central assumption underlying this article is that ability is not a trait existing within an individual, but instead is a description of entire systems through which some individuals appear to be talented. In this way of thinking, the *individual-environment transaction* can be labeled as "gifted," or not, and the responsibility of the educator is to establish contexts for learning that support individuals in becoming more adept at functioning as part of multiple systems. Although content knowledge is necessary for successful participation, educators must place increased emphasis on the context through which talented transactions are engaged and on increasing the potential of individuals to engage these transactions.

Through participation in learner-owned interactions, students come to participate in, and even create, situations through which they appear talented and excellent. Clearly, some students appear to excel at schooling simply for the sake of learning or because of a preparedness or readiness to perceive systems of relations that others find less visible (SAS, 2001). However, most young students require support and guidance in appreciating socially agreed upon meanings and in understanding how school activities have relevance to their broader lives. A central responsibility of educators is to engage students in experiences that expand their functioning with respect to those practices that are considered to be of value for the greater culture. Drawing on his expertise, the educator is responsible for initiating the students into those practices and meaningful relations that are reflective of the types of relations occurring in the culture at large. This initiation cannot be handed to the student all at once. Rather, this coupling must emerge from individual-environment interactions. Student-owned—not textbook- or teacher-owned—interactions provide meaning and value to the subject matter, and build connections to the student's life and activity more generally (Lave, 1997). For example, the student reported in Barab, Hay, Barnett, and Squire (2001) saw the value of, and therefore wanted to learn, mathematical formalisms because they were necessary for the development of the virtual reality solar system he was modeling.

The important point is that the emphasis is on supporting meaningful student-environment couplings, not on "smart" individuals for whom ability and talent are treated as constructs solely within the individual. This shifts the focus of instruction and instructional design. Instead of treating the student as an object to be changed, she is treated as an active agent who coproduces meaning and context. The focus is on the creation of contexts and support of children in successful transactions with these contexts. In this way, *educators do not design learning or talented individuals; instead, they design contexts for engaging talent development and support successful participation.* The important question is what types of

contexts can most usefully engage the emergence of talented interactions. The central challenge for educators is to develop participatory structures that bring together the individual, environment, and sociocultural relations. Throughout this discussion we described a number of such educational systems for talent development, next we discuss additional examples of the types of talent development contexts that we are advocating.

Learning and Talent Development as Contextualized Activity

Given the contextualized nature of knowing,⁴ students need to learn the information in the context of those situations in which it is used and through which it is actualized (Dewey, 1938). In response to this concern, and with the goal of developing these types of contexts, the CTGV introduced anchored instruction (see CTGV, 1990, 1993). Briefly, anchored instruction refers to instruction in which the material to be learned is presented in the context of a specific topic or problem (anchor) that serves to establish a macro-context that provides meaning to the material. In contrast to the disconnected sets of “application problems” located at the ends of textbook chapters, macro-contexts refer to stories that take place in semantically rich, open-ended environments (CTGV, 1993). The work of the CTGV has focused primarily on video-based macrocontexts intended to overcome inert knowledge by anchoring learning within the context of meaningful problem-solving activities. In contrast to the disconnected sets of “application problems” located at the end of textbook chapters, macrocontexts refer to stories that take place in semantically rich, open-ended environments (CTGV, 1993).

As an example, *Journey to Cedar Creek* is an anchored lesson or story presented on videodisc in which students watch a 15-min story where Jasper, the main character, purchases an old cabin cruiser. Students must determine if Jasper can make it home given that the running lights are broken and there is only a small temporary gas tank. To make a correct decision students must revisit various scenes on the videodisc where they obtain facts such as how much gas the temporary tank can hold, how much money Jasper has left, when sunset occurs, distance home, and gallons per hour. An accurate solution to

the problem requires “picking up” relevant information and eventually applying the distance-rate-time formula. Students must discover and satisfy 17 mathematical subproblems necessary for determining if Jasper can return home. In these lessons, there is no separate content (e.g., the distance-rate-time formula) and medium (e.g., the videodisc story in which Jasper’s problem is introduced), there is simply a context (i.e., determining if Jasper can make it home). Young (1993) designed the Jasper Planning Assistant software to help students externalize their problem-solving actions within the *Journey to Cedar Creek* solution space. The software affords students the opportunity to record their plans, to save facts, to bring up scenes from the video, and it also poses multiple-choice questions about the Jasper story, as well as rating scale items of confidence and interest. Student responses are time-stamped and saved into a logfile for summary and analysis, providing the researcher a window into the problem-solving activities of the learner as they unfolded. Talent in this context involves the application of successful problem-solving strategies towards the production of a correct solution (Young, 1993).

In another project, Barab and Landa (1997) worked with teachers and students to develop integrated units, treating the core element of these elements as an anchor. During the Students’ Rights Unit, as one example, students were expected to generate a bill of rights that was representative of the views of students in the school. In this unit, students learned about percentages and graphs in a context of determining various group preferences—which is consistent with why one might use percentages outside of schools. Similarly, students working on personal historical maps did not learn mapping and compass skills through didactic instruction, rather they learned these skills in various contexts, in an attempt to navigate to specific locations. The design focus in these projects was to support the development of contexts in schools that aided students in learning the material in a manner that was consistent with those situations in which they would use the material outside of schools (Greeno, 1997). Further, the focus was not solely on person, but instead focused on person-in-situation, aiding students in developing an appreciation of those situations in which they could be talented. In understanding person-in-situation, Barab (1999) conducted interviews over time with the students, examined their portfolios and teacher assigned tests, and observed class presentations.

Another example involved high school students participating in a summer program on invention and design (Gorman, Plucker, & Callahan, 1998). Students in this context were told that the historical setting for the class was immediately before Alexander Graham Bell filed his telephone patent in 1876, and they were asked to work in groups to design a telephone, build a working prototype, write a patent application, and present and defend their design and prototype to a person acting in the role of a patent examiner—a role undertaken by an inventor from AT&T. Students had access to a variety of materials, most of which would have been available to inventors around the time of the Bell patent, and they were

⁴This is not to imply that practices, principles, and resources learned in one situation (such as schools) cannot be used in other situations (such as, outside of schools)—although there is clearly a base of literature indicating the difficulty of promoting such transfer (Detterman & Sternberg, 1993; Gick & Holyoak, 1993; Greeno, 1989; Lave, 1988). Rather, we believe that the situation in which information is learned has its own set of constraints and affordances that contribute to an individual’s understanding of what is learned and when it can be applied. Therefore, transfer requires that the learner was initially attuned to specific invariance, as related to the variance, so that he or she will perceive similar invariance as related to the variance in the transfer situation (Detterman, 1993; Greeno, Smith, & Moore, 1993).

also provided with access to various patents, notebooks, and paperwork from many of the inventors who worked on voice transmission technology in the late 1900s. Most of the students had little knowledge of circuit design, the physics of sound, and other important content. The instructor, an experienced physics teacher, circulated among the groups and delivered minilectures on these topics to students who appeared to need the information. The teacher occasionally stopped all the groups and delivered a 20 to 30 min just-in-time lecture on content with which most of the class was having difficulty. These lectures were infrequent, and the teacher usually imbedded the content in a historical context which added further to the real-life application of the creative skills and content. Similar to Barab and Landa (1997), multiple data sources such as interviews, artifacts, observations, and pre-post interviews were collected in order to capture an understanding of person-in-situ.

In two other projects, Barab and Hay (2001) and Barab, Squire, and Dueber (2000) used the Internet to connect students and real-world practitioners working in authentic contexts. Barab and Hay's (2001) Scientific Apprenticeship Camp project was designed to match 24 inner-city middle school learners with scientists. Participants worked in groups of four as they conducted scientific research and developed a scientific presentation under the expert mentorship of a practicing scientist. Students visited the scientist's laboratory, collaborated over the Internet, and eventually presented their findings to family and friends, interested public, and other scientists. Barab, Squire, and Deuber's (2000) Technology Participation project used emerging technologies to create an authentic learning context where 28 preservice teachers at a university and 7 practicing K-12 teachers collaborated in the conduct of real-world tasks. This partnership provided the foundation for supporting a learning community of preservice and practicing teachers that situated both in collaborative practices that were authentic and valuable to all involved. Both projects immersed students in contexts of collaboration with real-world practitioners so that students could become knowledgeably skillful with respect specific practices in the context in which those practices were used. We administered pre- and post-assessment tests, carried out semistructured interviews, examined the nature of the dialogue in the online discussions, and developed rubrics to evaluate presentations and final products. Although we did not carry out pre-post interviews, these were supplemented by more in-situ observations and the use of portfolio analysis to capture person-in-situation.

In summary, in the interactive and participatory contexts being advocated here, ongoing participation, rather than the development of hypothesized mental representations evidenced on post-assessment measures, becomes the focus of instruction and assessment. Talent exists as part of student practices and is distributed across those resources (including people) with which the student interacts (Brown et al., 1989; Young, 1993). Talent development is not an isolated activity that is context-independent and externally arranged; instead,

talent development (participation) is recontextualized as a participatory process involving practice, and meaning is contextualized as part of an ecological system (Barab et al., 1999). Accordingly, both talent and talent development are treated as contextualized acts. To be redundant yet succinct, the focus is on contextualized participation and not simply knowledge acquisition. It is through supporting and researching participation in context that we can best foster and recognize talent.

Researching Person-In-Situ

In the wake of the cognitive revolution in the early 1970s, a history of methodological practices emerged that began with the individual mind as the unit of analysis. Given this unit, controlled experiments, clinical interviews, and other techniques designed to eliminate extraneous variables or to enable the sort of intense microanalysis needed to produce information processing models and simulations were given methodological preeminence (Barab & Kirshner, 2001). The SAS (2001, pp. 162–163), focusing on aptitude suggested that traditional paradigms and research methods neglected the importance of affect (or feeling) and conation (or will) as well as the role of context. In capturing a more dynamic and contextualized unit, researchers have employed a variety of methods from anthropology, cultural-historical psychology, educational psychology, and cognitive science (see, for example, Barab, Hay, & Yamagata-Lynch, 2001; Chaiklin & Lave, 1993; Cobb, Stephan, McClain, & Gravemeijer, 2001; Cole, 1996; Greeno, 1998; Hall, 1996; Jordan & Henderson, 1995; Lidz, 1987; Roth, 2001; Royer, Cicero, & Carlo, 1993; Siegler & Crowley, 1991; SAS, 2001) with a focus on describing the nexus of individual(s), environment, and sociocultural context.

In our work, we have used various methods to capture persons-in-situations, ranging from the building of path diagrams from computerized log files (Barab, Fajen, Kulikowich, & Young, 1996), to building networks of activity based on video analysis (Barab, Hay, & Yamagata-Lynch, 2001), to building thick descriptions over time based on multiple interviews, responses to questionnaires, portfolio analysis, and participant observations (Barab, Barnett, & Squire, in press; Plucker & Gorman, 1995, 1999). Throughout our different projects, we have

1. Consistently examined performance in rich contexts, trying to understand the role of environmental tools and context in mediating the production of talent.
2. Focused on trajectories over time instead of simply taking isolated snapshots or examining only post performance.
3. Used multiple methods for data collection and analysis, realizing that capturing talent requires looking in multiple places with multiple lenses and then coordinating these findings to develop a holistic account of person-in-situ.

Although an extended discussion on research methods is beyond the scope of this article and is taken up elsewhere⁵, we have highlighted three key challenges that emerge when the researcher adopts person-in-situ as his or her unit of analysis. The development of these methods remains one of the core challenges for situativity theorists and, more specifically, for those arguing for an ecological perspective of ability and talent development.

CLOSING THOUGHTS

In this article we have argued that ability and talent should not be viewed as constructs possessed by individuals but, instead, as sets of relations that are actualized through dynamic transactions. In providing a theoretical grounding for this conceptualization, we have noted the deficiencies of traditional perspectives and briefly discussed more recent perspectives including those from ecological psychology, situated cognition, distributed cognition, activity theory, and legitimate peripheral participation. We have argued that instead of advocating for the systematic and didactic separation of individual from environment, an ecological or relational model points to the importance of fully contextualized experience through which individuals, environments, and the sociocultural structures and relations transact. In this line of thinking, the place to look for talent is not in the head or in the environment, but in the variables of the “flow itself.” Talent, or evidence of being knowledgeably skillful, is thus considered present when individuals, frequently using multiple resources and always interacting as part of the sociocultural world, demonstrate their propensity for forming particular relations.

Given this relational perspective, classrooms should not be considered merely as the sites where talent development takes place, but should actually be conceptualized as the context for a specific cultural milieu through which students develop understandings of what constitutes a talented interaction—an interaction that is partly defined and validated in terms of the day-to-day practices and rituals of the school culture. As a result, educators need to select the daily rituals and activities carefully so that students learn skills and participate in practices that are consistent with those environmental and sociocultural structures and processes outside of schools. As Dewey (1938) continuously argued, educators need to support transactions and experiences that will live fruitfully and creatively in subsequent experiences.

This recommendation mirrors the philosophy behind Renzulli and Reis’s (1985) Schoolwide Enrichment Model.

When using this model, schools are encouraged to create a resource-rich environment in which students can pursue their interests and eventually create a product by modeling the rituals and practices of practicing professionals in the domain of interest. Renzulli (1994) has recently taken this model a step further, encouraging schools to use his contextual approach as a comprehensive school reform (CSR) model, which we view as a step in the correct direction. However, several dozen CSR models are being used in American schools (e.g., Northwest Regional Educational Laboratory, 1999) with thin and mixed evaluations of effectiveness. The degree to which CSR models promote excellence and talent development among all students, and not just among specific groups of students, has yet to be determined. Many of the models appear to be aimed at increasing the achievement of average or underperforming students, with the assumption that high achievers will benefit similarly from the reforms. Do these CSR models promote talent development more effectively, and do they involve more students than traditional models? Answering this question will provide critical information for reforming education.

Drawing primarily on the learner-as-processor metaphor, there has emerged a long history of assessment practices focusing on the individual (or, more accurately, the structures in the individual’s head) as the unit of analysis. These practices came about in the context of traditional conceptions of ability (see Snow, 1997; Van Tassel-Baska, 1998) and a positivist epistemology in which clinical interviews, controlled experiments, and other techniques intended to minimize extraneous variables were given methodological preeminence (Brown, 1992; Schoenfeld, 1992). Many of us were enculturated into the practices associated with educational research within the confines of these traditions. This line of thinking led many of us to describe individuals, and not their contextualized functioning as part of the world, as gifted, talented, or able. However, for researchers adopting a relational perspective with respect to what it means to know and learn, these classical methods are inadequate and even unethical (Barab & Kirshner, 2001). Adopting an ecological perspective not only has implications for supporting talent development and for characterizing the site of intelligence, but also for assessment and evaluation more generally. Educators are just beginning to explore innovative means of assessment that are sensitive to individual–environment relations and that account for contextualized particulars while allowing for cross-contextual comparisons (Hickey & Zuiker, in press; SAS, 2001). However, having measures of ability and talent that respect local context, experiences, strengths, and interests are essential if we are to have ethically valid interpretations of what constitutes talented transactions and who is considered able to engage in these types of transactions.

In this article, we have analyzed the problems caused by viewing talent development through the lenses of traditional conceptualizations of ability, intelligence, and talent. We briefly reviewed the potential contributions of a new concep-

⁵See the special issue on “Rethinking Methodology in the Learning Sciences” for some examples and further discussion of the methodological challenges (Barab & Kirshner, 2001). Also, see SAS (2001) for discussions directly related to talent development.

tualization of ability and talent development, with an emphasis on design challenges faced by educators who seek to foster emerging excellence. We look forward to participating in the continuing dialogue as educators explore the creation of new environments to support the development of ability and talent, new techniques to observe the talent development that is occurring, and new insights that develop as we explore these issues collaboratively. Most importantly, we hope that our discussion can prompt educators, researchers, and policy makers to more equitably apply the labels of gifted or talented, realizing the value of the perspective that *nobody has talent, yet everybody can engage talented transactions*. Through these discussions, educators can come to characterize entire contexts as gifted, and to develop educational innovations that support learners in functioning as part of, and creating, such contexts.

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REFERENCES

- Barab, S. A. (1999). Ecologizing instruction through integrated units. *Middle School Journal*, 30(8), 21–28.
- Barab, S. A. (2002). Commentary: Human–field interaction as mediated by mobile computers. In T. Koschmann, R. Hall, & N. Miyake (Eds.), *Computer supported collaborative learning* (pp. 533–538). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Barab, S. A., Barnett, M. G., & Squire, K. (in press). Building a community of teachers: Navigating the essential tensions in practice. To appear in *The Journal of the Learning Sciences*.
- Barab, S. A., Barnett, M., Yamagata-Lynch, L., Squire, K., & Keating, T. (in press). Using activity theory to understand the contradictions characterizing a technology-rich introductory astronomy course. *Mind, Culture, and Activity*.
- Barab, S. A., Cherkes-Julkowski, M., Swenson, R., Garrett, S., Shaw, R. E., & Young, M. (1999). Principles of self-organization: Ecologizing the learner–facilitator system. *The Journal of the Learning Sciences*, 8(3&4), 349–390.
- Barab, S. A., & Duffy, T. (2000). From practice fields to communities of practice. In D. Jonassen & S. M. Land (Eds.), *Theoretical foundations of learning environments* (pp. 25–56). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Barab, S. A., Fajen, B. R., Kulikowich, J. M., & Young, M. F. (1996). Assessing hypermedia navigation through Pathfinder: Prospects and limitations. *Journal of Educational Computing Research*, 15(3), 185–205.
- Barab, S. A., & Hay, K. (2001). Doing science at the elbows of scientists: Issues related to the scientist apprentice camp. *Journal of Research in Science Teaching*, 38(1), 70–102.
- Barab, S. A., Hay, K. E., Barnett, M. G., & Squire, K. (2001). Constructing virtual worlds: Tracing the historical development of learner practices/understandings. *Cognition and Instruction*, 19(1), 47–94.
- Barab, S. A., Hay, K. E., & Yamagata-Lynch, L. C. (2001). Constructing networks of activity: An in-situ research methodology. *The Journal of the Learning Sciences*, 10(1&2), 63–112.
- Barab, S. A., & Kirshner, D. (2001). Guest editors' introduction: Rethinking methodology in the learning sciences. *The Journal of the Learning Sciences*, 10(1&2), 5–15.
- Barab, S. A., & Landa, A. (1997). Designing effective interdisciplinary anchors. *Educational Leadership*, 54(6), 52–55.
- Barab, S. A., Squire, K., & Dueber, B. (2000). Supporting authenticity through participatory learning. *Educational Technology Research and Development*, 48(2), 37–62.
- Bloom, B. (1985). *Developing talent in young people*. New York: Ballantine.
- Bransford, J. D., Brown, A. L., & Cocking, R. (Eds.). (2000). *How people learn: Brain, mind, experience and school*. Washington, DC: National Academy Press.
- Bredo, E. (1992). Reconstructing educational psychology: Situated cognition and Deweyan pragmatism. *Educational Psychologist*, 29, 23–35.
- Brooks, R. (1991). Intelligence without representation. *Artificial Intelligence*, 47, 129–159.
- Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, 2(2), 141–178.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32–42.
- Bruner, J. (1996). *The culture of education*. Cambridge, MA: Harvard University Press.
- Callahan, C. M., Tomlinson, C. A., Hunsaker, S. L., Bland, L. C., & Moon, T. (1995). *Instruments and evaluation designs used in gifted programs*. Storrs, CT: National Research Center on the Gifted and Talented.
- Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies*. New York: Cambridge University Press.
- Cattell, R. B. (1987). *Intelligence: Its structure, growth and action*. Amsterdam: Elsevier.
- Ceci, S. J. (1990). *On intelligence—more or less: A bio-ecological treatise on intellectual development*. Englewood Cliffs, NJ: Prentice Hall.
- Chaiklin, S., & Lave, J. (Eds.). (1993). *Understanding practice: Perspectives on activity and context*. Cambridge, England: Cambridge University Press.
- Clancey, W. J. (1993). Situated action: A neuropsychological interpretation response to Vera and Simon. *Cognitive Science*, 17, 87–116.
- Cobb, P., Stephan, M., McClain, K., & Gravemeijer, K. (2001). Participating in classroom mathematical practices. *The Journal of the Learning Sciences*, 10(1&2), 113–163.
- Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational Psychologist*, 31, 175–190.
- Cognition and Technology Group at Vanderbilt. (1990). Anchored instruction and its relationship to situated cognition. *Educational Researcher*, 19, 2–10.
- Cognition and Technology Group at Vanderbilt. (1993). Anchored Instruction instruction and situated cognition revisited. *Educational Technology*, 33, 52–70.
- Cole, M. (1996). *Cultural psychology: A once and future discipline*. Cambridge, MA: Harvard University Press.
- Cole, M., & Engeström, Y. (1993). A cultural-historical approach to distributed cognition. In G. Solomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 1–46). New York: Cambridge University Press.
- Cole, M., Engeström, Y., & Vasquez, O. (Eds.). (1997). *Mind, culture, and Activity: Seminal papers from the laboratory of comparative human cognition*. New York: Cambridge University Press.
- Coleman, L. J., & Cross, T. L. (2001). *Being gifted in school: An introduction to development, guidance, and teaching*. Waco, TX: Prufrock Press.
- Csikszentmihalyi, M. (1991). *Flow: The psychology of optimal experience*. New York: Harper Collins.
- Csikszentmihalyi, M. (1993). *The evolving self: A psychology for the third millennium*. New York: Harper Collins.
- Das, J. P., Naglieri, J. A., & Kirby, J. R. (1994). *Assessment of cognitive processes: The PASS theory of intelligence*. Boston: Allyn & Bacon.

- Descartes, R. (1978). Meditations and passions of the soul. In E. Haldane & O. Ross (Eds.), *The philosophical works of Descartes*. Cambridge, England: Cambridge University Press. (Original work published 1637)
- Detterman, D. K. (1993). The case for prosecution: Transfer as an epiphenomenon. In D. K. Detterman & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition, and instruction* (pp. 1–24). Norwood, NJ: Ablex.
- Detterman, D. K., & Sternberg, R. J. (Eds.). (1993). *Transfer on trial: Intelligence, cognition, and instruction*. Norwood, NJ: Ablex.
- Dewey, J. (1938). *Experience and education*. New York: Collier MacMillan.
- Diener, C. I., & Dweck, C. S. (1978). An analysis of learned helplessness: Continuous changes in performance, strategy, and achievement cognitions following failure. *Journal of Personality and Social Psychology*, 36, 451–462.
- Engeström, Y. (1987). *Learning by expanding*. Helsinki, Finland: Orienta-konsultit.
- Engeström, Y. (1993). Developmental studies of work as a testbench of activity theory: The case of primary care medical practice. In S. Chaiklin & J. Lave (Eds.), *Understanding practice: Perspectives on activity and context* (pp. 64–103). Cambridge, MA: Cambridge University Press.
- Engeström, Y. (1999). Activity theory and individual and social transformation. In Y. Engeström, R. Miettinen, & R. Punamaki, (Eds.), *Perspectives on activity theory* (pp. 19–38). Cambridge, MA: Cambridge University Press.
- Ennis, C. D. (1992). Reconceptualizing learning as a dynamic system. *Journal of Curriculum and Supervision*, 7, 115–130.
- Feldhusen, J. F. (1998). Programs for the gifted few or talent development for the many? *Phi Delta Kappan*, 79(10), 735–738.
- Fodor, J. (1975). *Language of thought*. Cambridge, MA: Harvard University Press.
- Ford, D. H., & Lerner, R. M. (1992). *Developmental systems theory: An integrative approach*. Newbury Park, CA: Sage.
- Gagne, F. (1995). From giftedness to talent: A developmental model and its impact on the language of the field. *Roeper Review*, 18, 103–111.
- Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.
- Gibson, E. J., Riccio, G., Schmuckler, M.A., Stofregen, T. A., Rosenberg, D., & Taonnina, J. (1987). Detectability of the traversability of surfaces by crawling and walking infants. *Journal of Experimental Psychology: Human Perception and Performance*, 13, 533–544.
- Gibson, J. J. (1977). The theory of affordances. In R. E. Shaw & J. Bransford (Eds.), *Perceiving, acting and knowing: Toward an ecological psychology* (pp. 67–82). Hillsdale NJ: Lawrence Erlbaum Associates, Inc.
- Gibson, J. J. (1986) *The ecological approach to visual perception*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc. (Original work published in 1979)
- Gick, M. L., & Holyoak, K. J. (1983). Schema induction and analogical transfer. *Cognitive Psychology*, 15, 1–38.
- Gladwin, T. (1964). Culture and logical process. In E. Goodenough (Ed.), *Explorations in cultural anthropology: Essays presented to George Peter Murdock*. New York: McGraw-Hill.
- Goodlad, J. I. (1983). *A place called school*. New York: McGraw-Hill.
- Gorman, M. E., Plucker, J., & Callahan, C. M. (1998). Turning students into inventors: Active learning modules for secondary students. *Phi Delta Kappan*, 79(7), 530–535.
- Greeno, J. G. (1989). A perspective on thinking. *American Psychologist*, 44(3), 134–141.
- Greeno, J. G. (1997). Response: On claims that answer the wrong questions. *Educational Researcher*, 26(1), 5–17.
- Greeno, J. G. (1998). The situativity of knowing, learning, and research. *American Psychologist*, 53, 5–17.
- Greeno, J. G., & Moore, J. L. (1993). Situativity and symbols: Response to Vera and Simon. *Cognitive Science*, 17(1), 49–61.
- Greeno, J. G., Smith, D. R., & Moore, J. L. (1993). Transfer of situated learning. In D. K. Detterman & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition, and instruction* (pp. 99–167). Norwood, NJ: Ablex.
- Guilford, J. P. (1967). *The nature of human intelligence*. New York: McGraw-Hill.
- Hall, R. (1996). Representation as shared activity: Situated cognition and Dewey's cartography of experience. *The Journal of the Learning Sciences*, 5, 209–238.
- Herndon, J. (1971). *How to survive in your native land*. New York: Simon & Schuster.
- Hickey, D. T., & Zuiker, S. J. (in press). A new perspective for evaluating innovative science programs. *Science Education*.
- Hunsaker, S. L., & Callahan, C. M. (1995). Creativity and giftedness: Published instrument uses and abuses. *Gifted Child Quarterly*, 39, 110–114.
- Hutchins, E. (1993). Learning to navigate. In J. Lave & S. Chaiklin (Eds.), *Understanding practice: Perspectives on activity and context* (pp. 35–63). New York: Cambridge University Press.
- Jensen, A. R. (1998). *The g factor: The science of mental ability*. Westport, CT: Praeger.
- Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *The Journal of the Learning Sciences*, 4, 39–103.
- Jussim, L., & Eccles, J. (1995). Naturally occurring interpersonal expectancies. In Eisenberg (Ed.), *Social development: Review of personality and social psychology* (Vol. 15, pp. 74–108). Thousand Oaks, CA: Sage.
- Karnes, F. A., & Bean, S. M. (Eds.). (2001). *Methods and materials for teaching the gifted*. Waco, TX: Prufrock Press.
- Kim, N-G, Turvey, M. T., & Carello, C. (1993). Optical information about the severity of upcoming contacts. *Journal of Experimental Psychology: Human Perception and Performance*, 19, 179–193.
- Kirshner, D., & Whitson, J. A. (1998). Obstacles to understanding cognition as situated. *Educational Researcher*, 27(8), 22–28.
- Kuutti, K. (1996). Activity theory as a potential framework for human-computer interaction research. In B. Nardi (Ed.), *Context and consciousness: Activity theory and human-computer interaction*. Cambridge, MA: The MIT Press.
- Lave, J. (1977). Cognitive consequences of traditional apprenticeship training in West Africa. *Anthropology and Education Quarterly*, 8, 177–180.
- Lave, J. (1986). The values of quantification. In J. Law (Ed.), *Power, action, and belief*. (pp. 88–111). Boston, MA: Routledge & Kegan Paul.
- Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. Cambridge, England: Cambridge University Press.
- Lave, J. (1993). Situating learning in communities of practice. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 17–36). Washington, DC: American Psychological Association.
- Lave, J. (1997). The culture of acquisition and the practice of understanding. In D. Kirshner & J. A. Whitson (Eds.), *Situated cognition: Social, semiotic, and psychological perspectives* (pp. 17–36). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.
- Leont'ev, A. (1974). The problem of activity in psychology. *Soviet Psychology*, 13(2), 4–33.
- Lidz, C. S. (1987). *Dynamic assessment: An instructional approach to evaluating learning potential*. New York: Guilford.
- Lim, W., Plucker, J., & Im, K. (in press). We're more alike than we think we are: Implicit theories of intelligence with a Korean sample. *Intelligence*.
- Lombardo, T. (1987). *The reciprocity of perceiver and environment: The evolution of James J. Gibson's ecological psychology*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Mark, L. S., Balliet, J. A., Craver, K. D., Douglas, S. D., & Fox, T. (1990). What an actor must do in order to perceive the affordance for sitting. *Ecological Psychology*, 2, 325–366.
- Marsh, H. W., Byrne, B. M., & Shavelson, R. J. (1988). A multifaceted academic self-concept: Its hierarchical structure and its relation to academic achievement. *Journal of Educational Psychology*, 80, 366–380.
- Michael, M. (1996). *Constructing identities*. Thousand Oaks, CA: Sage.

- Nardi, B. (Ed.). (1996). *Context and consciousness: Activity theory and human-computer interaction*. Cambridge, MA: The MIT Press.
- Newell, A., & Simon, H. A. (1972). *Human problem solving*. Englewood Cliffs, NJ: Prentice Hall.
- Northwest Regional Educational Laboratory. (1999). *Catalog of school reform models*. Portland, OR: Author.
- Pattee, H. H. (1979). The complimentary principle and the origin of macromolecular information. *Biosystems*, 11, 217–226.
- Pea, R. (1993). Practices of distributed intelligence and designs for education. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 47–87). Cambridge, England: Cambridge University Press.
- Pepper, S. C. (1970). *World hypotheses*. Berkeley: University of California Press. (Original work published in 1942)
- Perkins, D. N. (1993). Person-plus: A distributed view of thinking and learning. In G. Solomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 47–87). New York: Cambridge University Press.
- Plucker, J., & Gorman, M. E. (1995). Group interaction during a summer course on invention and design for high ability secondary students. *The Journal of Secondary Gifted Education*, 6, 258–272.
- Plucker, J., & Gorman, M. E. (1999). Invention is in the mind of the adolescent: Evaluation of a summer course one year later. *Creativity Research Journal*, 12, 141–150.
- Plucker, J., & McIntire, J. (1996). Academic survivability in high potential, middle school students. *Gifted Child Quarterly*, 40, 7–14.
- Plucker, J., & Stocking, V. (2001). Looking outside and inside: Self-concept development of gifted adolescents. *Exceptional Children*, 67, 535–548.
- Prawat, R. S., & Floden, R. E. (1994). Philosophical perspectives on constructivist views of learning. *Educational Psychology*, 29, 37–48.
- Pufall, P., & Dunbar, C. (1992). Perceiving whether or not the world affords stepping onto or over: A developmental study. *Ecological Psychology*, 4, 17–38.
- Reed, H. J., & Lave, J. (1979). Arithmetic as a tool for investigating relations between culture and cognition. *American Ethnologist*, 6(93), 58–82.
- Renzulli, J. S. (1978). What makes giftedness? Reexamining a definition. *Phi Delta Kappan*, 60, 180–184, 261.
- Renzulli, J. S. (1994). *Schools for talent development*. Mansfield Center, CT: Creative Learning Press.
- Renzulli, J. S. (1999). What is this thing called giftedness, and how do we develop it? A twenty-five year perspective. *Journal for the Education of the Gifted*, 23, 3–54.
- Renzulli, J. S., & Reis, S. M. (1985). *The schoolwide enrichment model: A comprehensive plan for educational excellence*. Mansfield Center, CT: Creative Learning Press.
- Roschelle, J., & Clancey, W. J. (1992). Learning as social and neural. *Educational Psychologist*, 27, 435–453.
- Roth, M. (2001). Situating cognition. *The Journal of the Learning Sciences*, 10(1&2), 27–61.
- Royer, J. M., Cicero, C. A., & Carlo, M. S. (1993). Techniques and procedures for assessing cognitive skills. *Review of Educational Research*, 63(2), 201–243.
- Salomon, G. (Ed.). (1993). *Distributed cognitions: Psychological and educational considerations*. Cambridge, England: Cambridge University Press.
- Saxe, G. B. (1992). Studying children's learning in context: Problems and prospects. *The Journal of the Learning Sciences*, 2(2), 215–234.
- Schoenfeld, A. H. (1992). On paradigms and methods: What do you do when the ones you know don't do what you want them to? Issues in the analysis of data in the form of videotapes. *The Journal of the Learning Sciences*, 2(2), 179–214.
- Seligman, M. E. P., & Csikszentmihalyi, M. (2000). Positive psychology: An introduction. *American Psychologist*, 55, 137–150.
- Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, 27(2), 4–13.
- Shaw, R. E., & Turvey, M. T. (1981). Coalitions as models for ecosystems: A realistic perspective on perceptual organization. In M. Kubovy & J. R. Pomerantz (Eds.), *Perceptual organization* (pp. 343–408). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Siegler, R. S., & Crowley, K. (1991). The microgenetic method: A direct means for studying cognitive development. *American Psychologist*, 46, 606–620.
- Simonton, D. K. (1999). Talent and its development: An emergenic and epigenetic model. *Psychological Review*, 106, 435–457.
- Simonton, D. K. (2001). Talent development as a multidimensional, multiplicative, and dynamic process. *Current Directions in Psychological Science*, 10, 39–43.
- Snow, R. E. (1992). Aptitude theory: Yesterday, today, and tomorrow. *Educational Psychologist*, 27(1), 5–32.
- Snow, R. E. (1997). Aptitudes and symbol systems in adaptive classroom teaching. *Phi Delta Kappan*, 78(5), 354–360.
- Spearman, C. (1904). General intelligence, objectively determined and measured. *American Journal of Psychology*, 15, 201–293.
- Stanford Aptitude Seminar. (2001). *Remaking the concept of aptitude: Extending the legacy of Richard E. Snow*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Stanley, J. C. (1980). On educating the gifted. *Educational Researcher*, 9(3), 8–12.
- Stanley, J. C., & Benbow, C. P. (1981). Using the SAT to find intellectually talented seventh graders. *College Board Review*, 122, 2–7, 26–27.
- Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. Cambridge, MA: Cambridge University Press.
- Sternberg, R. J., & Davidson, J. E. (Eds.). (1986). *Conceptions of giftedness*. Cambridge, MA: Cambridge University Press.
- Sternberg, R. J., & Horvath, J. A. (1998). Cognitive conceptions of expertise and their relations to giftedness. In R. C. Friedman & K. B. Rogers (Eds.), *Talent in context: Historical and social perspectives on giftedness* (pp. 171–191).
- Sternberg, R. J., & Zhang, L. F. (1995). What do we mean by giftedness? A pentagonal implicit theory. *Gifted Child Quarterly*, 39(2), 88–94.
- Suchman, L. A. (1987). *Plans and situated actions: The problem of human-machine communication*. Cambridge, MA: Cambridge University Press.
- Swenson, R. (1999). Epistemic ordering and the development of space-time: Intentionality as a universal entailment. *Semiotica*, 126(1/2), 1–31.
- Swenson, R., & Turvey, M. T. (1991). Thermodynamic reasons for perception-action cycles. *Ecological Psychology*, 3, 317–348.
- Thurstone, L. L. (1938). *Primary mental abilities*. Chicago: University of Chicago Press.
- Traweek, S. (1988). *Beamtimes and lifetimes: The world of high energy physicists*. Cambridge, MA: Harvard University Press.
- Treffinger, D. J. (1998). From gifted education to programming for talent development. *Phi Delta Kappan*, 79(10), 752–755.
- Turvey, M. T. (1992). Affordances and prospective control: An outline of the ontology. *Ecological Psychology*, 4, 173–187.
- Turvey, M. T. (1996). Dynamic touch. *American Psychologist*, 51, 1134–1152.
- Turvey, M. T., & Shaw, R. E. (1995). Toward an ecological physics and a physical psychology. In R. L. Solso & D. W. Massaro (Eds.), *The science of the mind: 2001 and beyond* (pp. 144–169). New York: Oxford University Press.
- Van Tassel-Baska, J. (1998). The development of academic talent. *Phi Delta Kappan*, 79(10), 760–763.
- Vera, A. H., & Simon, H. A. (1993). Situated action: A symbolic interpretation. *Cognitive Science*, 17, 7–49.
- Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: MIT Press.
- Warren, E. H. (1984). Perceiving affordances: Visual guidance of stair climbing. *Journal of Experimental Psychology: Human Perception and Performance*, 10, 683–703.

- Weiner, B. (1992). *Human motivation: Metaphors, theories, and research*. Newbury Park, CA: Sage.
- Whitehead, A. N. (1929). *The aims of education and other essays*. New York: MacMillan.
- Wong, M. M., & Csikszentmihalyi, M. (1991). Motivation and academic achievement: The effects of personality traits and the quality of experience. *Journal of Personality, 59*, 539–574.
- Young, M. (1993). Instructional design for situated learning. *Educational Technology Research and Development, 41*, 43–58.
- Young, M. F., & Barab, S. (1999). Perception of the raison d'être in anchored instruction: An ecological psychology perspective. *The Journal of Educational Computing Research, 20*(2), 113–135.
- Young, M. F., Barab, S. A., & Garrett, S. (2000). Agent as detector: An ecological psychology perspective on learning by perceiving-acting systems. In D. Jonassen & S. M. Land (Eds.), *Theoretical foundations of learning environments* (pp. 147–173). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.