Learning and Instruction, Cognitive and Situative Theories of

Intermediate article

Sharon J Derry, University of Wisconsin, Madison, Wisconsin, USA
Constance A Steinkuehler, University of Wisconsin, Madison, Wisconsin, USA

CONTENTS

Cognitive theory, which views cognition as symbolic computation, and situativity theory, which views cognition as (inter)action in the social and material world, are two alternative theoretical perspectives on the nature of human learning. These theories are contrasted in terms of their implications for educational research and practice.

INTRODUCTION

During the past 10 years, social science researchers have engaged in heated debate over which of two theoretical viewpoints can best guide both the study of human thinking and the design of environments for productive learning and work.

One view, the symbolic processing perspective, represents the tradition upon which cognitive science was founded. Although this perspective does not represent a unified, homogenous theory, influential theorists from Carnegie-Mellon University (e.g. Anderson *et al*., 1996) have been important voices in this debate, and their position is widely known and accepted. This viewpoint has encouraged not only cognitive scientists, but also the public, to think and talk about the mind using a computational metaphor, a metaphor based on thinking about the mind in terms of digital computers (some, but not all, current thinking based on distributed network computation is more supportive of the alternative viewpoint to be described). The mind is configured as an information processing 'machine' that receives input from the environment through the senses, selectively and actively processes that information by constructing and reconstructing mental symbols and symbol systems representing knowledge and action, and stores some of those constructions as memories for later recall and use, in an indexed 'in-the-head' repository called 'memory'. Cognitive scientists combine experimental methods and computational modeling to advance and test hypotheses and complex theories about the basic computational structures of mind and the symbols and mechanisms of a variety of forms of human thought, such as language acquisition, remembering, problem-solving, decision-making, and emotional response. Many claim that this 'traditional' cognitive program continues to significantly advance our basic scientific knowledge about human thought processes, as well as our knowledge about how to design educational and work environments that facilitate learning and performance.

Here, the symbolic processing perspective is interpreted broadly to include modern socio-cognitive theory. Evolving from Jean Piaget's (e.g. 1952) genetic epistemology, current versions of this view hold that people learn through a process in which their existing conceptual knowledge is challenged and transformed through social and physical interaction with the environment. Although many socio-cognitive theorists do not explicitly advocate a computer metaphor of mind, their viewpoint is nevertheless a symbolic processing one that posits existence and transformation of symbolic structures (schemas, concepts) within the mind.

A view that challenges this position is 'the situativity perspective' (e.g. Greeno, 1997), which references a family of important social science theories including 'situated cognition' (e.g. Lave, 1988), 'sociocultural theory' (Wertsch, 1998), 'embodiment theory' (Glenberg, 1997), 'distributed cognition' (e.g. Hutchins, 1995), and 'activity theory' (Nardi, 1996). Researchers associated with this view are united in their rejection of viewpoints

that separate study of an individual's mind from the environment of which that mind is an integral part. This is not to say that situativity theorists reject cognitive science entirely. However, symbolic theories of learning and thinking are often viewed as special cases of cognition – those cases in which there is conscious reasoning. These theorists point out many ways in which mind is connected to, extended and shaped by the cultures, body, and the physical surroundings of which it is a part, and they do not believe that all cognition involves symbolic representation or, indeed, that all cognition takes place within the mind itself. For example, a researcher using a computer program and consulting an expert in performing a statistical analysis is extending cognitive capacity by relying on social support and employing a cultural artifact (the statistical package) to perform a task that the researcher need not fully understand in all its complexity and depth, given the availability of the social environment and its tools. From the situativity perspective, the cognition is 'stretched' over the entire activity (the problem-solving task) and partly resides in the social context, as well as in the individual's mind. Moreover, the individual need not symbolically represent all cognition within the activity system. For example, a well-designed statistical program would extend cognitive capacity by being so easy and obvious, the researcher would not need to think much in order to use the tool correctly. Intelligent interactions are thus 'afforded' by tool design features, of which the users may not be aware.

Taken together, symbolic processing and situativity theories provide the foundations for an important and growing field of study known as 'the learning sciences', which is currently having tremendous impact on educational research. This article will elaborate and explain these positions in greater detail, discussing their implications for educational research and design of learning environments. A summary of these implications is provided in Table 1, which highlights important differences in the theoretical schools.

SYMBOLIC PROCESSING THEORY

Before symbolic processing theory began to emerge in the 1960s, psychology was dominated by theories of behaviorism that treated human behavior as nothing more than direct response to environmental stimuli ($S \rightarrow R$). Symbolic processing theory rejected this assumption, concluding that human behavior could not be explained without positing an intermediate stratum of mental processes that occur *between* input (stimuli from the environment) and output (behavior). Human beings, it was argued, mentally represent information from the environment, process that information, then select behaviors accordingly. The mind, from this perspective, is an information processing system analogous to a computer: a physical symbol system. Input/output processes connect the symbol system with its environment, but it is between perception and action that 'thinking' (symbolic computation) occurs. Detailed computer models of 'in-the-head' processes have been constructed and successfully tested against specific forms of human performance, such as solving verbal analogies or algebra problems with two unknowns; however, they have been less successful in explaining complex, adaptive performance, such as expert medical practice.

This modeling approach to theory building is contingent, however, on a set of basic ontological assumptions. Such models assume cognition is a bounded, dependent but autonomous physical symbol system. The system is dependent in the sense that it is open to information from the environment, yet it is autonomous in the sense that its basic architecture is closed to reorganization. Information from the external world is the material the system operates on, but basic architectural changes are not determined by the outside; therefore, events 'in the head' can be factored from external events in the social and material environment and thereby accurately modeled by computer programs.

Behind this 'factoring assumption', in turn, is a fundamental division between the individual knower, knowledge, and the independent world based on the dualist ontological tradition of Kant and Descartes. From this perspective, the individual is a container with a sort of substance (albeit, symbol-based) called 'knowledge' inside. Learning is the acquisition, construction, and qualitative reorganization of this substance (knowledge), and the success of the learning process is measured by the transfer (application) of this substance from one place (the context in which the knowledge was acquired) to another (a different context in which that knowledge should be used). Therefore, useful knowledge is knowledge that is sufficiently abstract and general to allow for successful behavior across a wide range of relevant contexts (Anderson *et al*., 1996).

SITUATIVITY THEORY

If symbolic processing theory unpacked the black box of mental representation and procedures

Table 1. Situative and symbolic theories: alternative lenses for educational research and practice

Educational issue	*Situative emphases*	*Symbolic processing emphases*
Major epistemic categories	People acting in context Interwoven systems of activity Discourse structures Design and use of artifacts and tools Nonsymbolic processes	Minds in the environment Memory stores Information Attention Mental representations Symbolic processes
Learning and development	*Individual:* Internalization of practice Trajectories of participation Identity development Becoming a leader *Community:* Development of norms Development of artifacts Tool development and use Community knowledge growth	*Individual:* Comprehension Knowledge growth Knowledge restructuring Knowledge transfer Development of expertise
Transfer	Enhanced ability to participate in new, complex, community activities Enhanced ability to participate in new communities	Analogical (schema-based) reasoning Flexible situational construction (cognitive flexibility)
Learning environment characteristics	Discourse communities Classrooms and schools extend broader social community Authentic activities Tools of authentic practice Varied levels of participation Mentoring and apprenticeship	Cognitive objectives Mastery of prerequisites Explanation-based learning Group and individual work Problem-solving tasks Skill practice Memorization Use of representational tools and manipulatives
Teacher roles	Provide community leadership Design community infrastructure Promote development of social and discourse norms Share problem-solving Provide for mentoring, apprenticeship	Transmit and explain Set cognitive objectives Perform task analyses Design/select activities and materials Individualize instruction Provide feedback/guidance Lead discussions Challenge misconceptions Promote metacognitive reflection
Assessment	Evaluation of student-designed artifacts Portfolio assessments Evaluation of authentic performance in context Dynamic (formative) assessment	Measures of facts recall Comprehension tests Problem-solving tests Standardized summative assessments Standardized diagnostic assessments Performance-based assessments Transfer tasks

between environmental stimuli and individual behavior that behavioral theory refused to open, then 'situativity theory' (Greeno, 1997) is attempting to unpack the black box of activity structures (structures of interactions of individuals within their material and social contexts) de-emphasized by symbolic processing theory. Growing out of work in ecological psychology, ethnography, ethnomethodology, and philosophical situation theory (Greeno, 1997), situativity theory focuses

on interactive systems of activity of which the individual is only one part. Cognition, from this perspective, cannot be explained by computational models of structures and processes 'in the head'; rather, one must look to the intact activity systems in which the individual participates. Such systems always necessarily include social relationships, physical and temporal contexts, symbolic and material resources (such as tools), and historical change. From this perspective, cognition is 'a complex social phenomenon … distributed – stretched over, not divided among – mind, body, activity, and culturally organized settings (which include other actors)' (Lave, 1988, p. 1). The structures of interest, then, are the interactional structures of such social and material systems, not structures in the individual mind.

Thus, cognition is (inter)action in the social and material world. According to Lave (1988), the basic organizing structures of this world are the social, cultural, and professional groups, or the 'communities of practice', in which people choose to participate. Through participation in a community of practice, individuals come to understand the world (and themselves) from the perspective of that community. In contrast to symbolic processing theory, which takes the meaning of a symbol as given, situativity theory focuses on how meaning evolves through enculturation. Here, semantic interpretation is taken as part of what people do in the lived-in world; it arises through interaction with social and material resources in the context of a community with its own participant structures, values, and goals. An individual becomes attuned to a particular object's meanings and uses through the regular pattern of interaction that individual has with it, but this regular pattern of interaction is shaped by the individual's membership in a particular community for whom the object has meaning, usefulness, and relevance for accomplishing tasks associated with individual or collective goals.

Such activities have direct import for the identity of the individual. Who one *is* determines, and is reflexively determined by, one's participations in various communities (Greeno, 1997). A community delineates practices for its members, provides means of forging identities, of possible ways to apprehend and understand the environment through social and physical activity with tools and symbols. Thus, changes in knowing become changes in being: through participation in communities of practice, an individual does more than merely acquire and reorganize symbolic knowledge about the world; she or he is ontologically transformed by it.

This conception of cognition as a culturally mediated, historically developing, and activity-based process assumes a nondualist ontology in sharp contrast to the assumptions of symbolic processing theory. This nondualist tradition can be traced back through the work of theorists as diverse as Marx, Heidegger, Vygotsky, and Dewey, to the work of Hegel (1807/1967), who argued that 'the individual self is in no sense an immediately given element of consciousness (as Descartes claims of his *cognito*) but a socially created concept … we are wholly social products and social participants' (p. 514). The mind, the individual, and the world with which we interact are not natural entities but historical and cultural products determined by human practices; their meaning – what they 'are' – is constituted through human activity. As such, activities and contexts are mutually constitutive of each other rather than one nested inside the other.

While symbolic processing theory focuses on epistemological processes and the mental architecture and functions that sustain them, situative theory focuses on the genesis of participation in communities of practice. Accounts of how an individual interacts with her material and social contexts, and how these interactions change over time, replace accounts of individual knowledge construction occurring 'in the head'. Learning, from this perspective, is progress along 'trajectories of participation' and growth of identity within a given community of practice (Greeno, 1997). It is the gradual transformation of an individual from peripheral participant to central member of a community, through apprenticeship and increased acceptance of community values and increased participation in community practices. Thus, a new teacher (or lawyer, or doctor, or researcher) acquires professionally relevant knowledge and skill as she increases in prestige and power within a professional community. Importantly, learning also takes place at the aggregate level of the community, a process that involves emergent reorganization in the patterns of member activities, coupled with a growth of shared knowledge through changing practices and the creating of artifacts and tools that facilitate work.

ALTERNATIVE LENSES FOR EDUCATIONAL RESEARCH AND PRACTICE

The situativity and symbolic processing theory families represent fundamentally different lenses through which to analyze, design, and conduct research on educational environments. Some typical differences in points of view are highlighted

in Table 1 and discussed in the following paragraphs.

With respect to epistemic categories, situativity theory views knowledge, not as individual mental representation, but as something that resides within communities and manifests itself through what members of the community do and create. Thus, designers and researchers working from this perspective view learning environments in terms of their observable activity structures, including the systems of interaction and discourse among learners and teachers, and the development and use of tools and artifacts within those systems. An analytical problem for situativity researchers is decomposition of the environment for study, since activities are constituted by other activity structures as contexts. Thus, situativity researchers always study activity structures qualitatively and ethnographically *in situ*. Most studies place little emphasis on specifically describing internal cognitions. Rather, situativity researchers may postulate nonsymbolic 'cognitive' processes and structures that are external to the individual mind and can be inferred from classroom observations.

In contrast, the major analytical structures of the cognitive program are the unobservable symbols and processes within minds that are inferred from performance on tests and tasks designed to allow inferences about individuals' possession of facts, concepts and skills. For researchers, such inferences support theories about human learning, knowledge, and performance, and about the connection between learning and features of instructional design. These theories may be specified in detail and translated into computer models that are tested for matches against human performance. In such analyses, individual students or teachers, not activity structures in the environment, are the units for analysis. Moreover, because learning and performance can legitimately be examined separately from the broader social and physical contexts in which they take place, laboratories, as well as classrooms, may be sites for educational research.

Table 1 highlights the two theoretical families' differing conceptualizations of learning and development, and how these imply different ways of supporting the learning and assessment of students within educational environments. Situativity theorists see learning and development in terms of individuals' growing capabilities as participants in multiple authentic communities of practice, communities that can, themselves, learn and grow organically as knowledge-building entities. This viewpoint has implications for conceptualizing and designing learning environments, for the roles for teachers within those environments, and for assessing student performance. To the greatest extent possible, classrooms become extensions of authentic communities of practice found in broader society. For example, students of teacher education are not (conceptually speaking) taught or assessed on the skills and facts of teaching, but are apprenticed into a culture of professional practice. Mathematics students are likewise apprenticed into the culture of mathematicians (when appropriate) or (at other times) the culture of a mathematically informed citizenry. Teachers are viewed, not just as transmitters and challengers of knowledge and designers of instructional tasks that help students construct individual understandings of subject domains, but as founders of classroom learning communities that extend and connect to authentic cultures of practice, and as leaders and mentors and fellow learners within those communities. The emphasis of assessment in such communities is on production and critique of authentic, socially valued products and performances with concern for how individuals interact in social context while working.

In contrast, classrooms designed from the symbolic processing perspective tend to engage students in a variety of instructional activities that are designed to help them, as individuals, acquire specific cognitive objectives. While these objectives may be derived from an analysis of what knowledge is required for desired, complex performances in the real world, and while effort is made to connect classroom learning to real-world issues and problems, from the symbolic perspective, the classroom activity in which students participate need not replicate authentic, real-world practice in social context. Through various activities, some authentic and some nonauthentic, students are expected to acquire fundamental symbol structures that will later be recalled, combined, and used as analogies to guide thinking and behavior in the world outside of class. Understanding and transfer of knowledge is promoted through reflection (rather than enactment), and by teaching explicit symbolic knowledge about the conditions under which one will use what is learned. The teacher is expected to help students engage in thinking about their thinking (metacognition) during learning – asking themselves what they do and do not understand; how they will use it in future, etc. From the symbolic perspective, assessment focuses on design of reliable, repeatable tasks and instrumentation that can be used to measure use of specific ideas and skills across many individuals and different forms of tasks that require those ideas and skills.

A SUBSIDING DEBATE

Much debate continues between members of these two communities. Yet, many educational researchers, theorists, and practitioners today are successfully fusing both points of view within their work (e.g. Bransford *et al*., 1999). Researcher–designers and teachers working in school environments are likely to view classrooms as communities and to attend to activity and discourse structures and the authenticity of required activities and assessments but may also regard these as contexts or vehicles for individual learning viewed as symbolic processing. They may chart trajectories of participation for particular students, and simultaneously examine development of symbolic knowledge using a wide range of cognitive tasks and instruments. In larger studies, educational researchers may study classroom communities with varying activity and discourse structures, developing coding systems to capture these differences and statistically examining the impact of these variations on individual performance measured using standardized assessment tools.

Thus, although the symbolic and situative viewpoints have not yet merged to form a well-defined theory of educational practice, we see much evidence that a dialectic process is moving the field toward rapprochement between them. We believe the emerging result may be a complex systems theory of cognition understood in its broadest ecological sense, and that the resulting methodological approach will be superior to either theoretical viewpoint standing alone, capable of providing more complete understanding of learning and education.

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