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Situativity theory: A perspective on how participants and the environment can interact: AMEE Guide no. 52

STEVEN J. DURNING & ANTHONY R. ARTINO
Uniformed Services University of the Health Sciences, USA

Abstract

Situativity theory refers to theoretical frameworks which argue that knowledge, thinking, and learning are situated (or located) in experience. The importance of context to these theories is paramount, including the unique contribution of the environment to knowledge, thinking, and learning; indeed, they argue that knowledge, thinking, and learning cannot be separated from (they are dependent upon) context. Situativity theory includes situated cognition, situated learning, ecological psychology, and distributed cognition. In this Guide, we first outline key tenets of situativity theory and then compare situativity theory to information processing theory; we suspect that the reader may be quite familiar with the latter, which has prevailed in medical education research. Contrasting situativity theory with information processing theory also serves to highlight some unique potential contributions of situativity theory to work in medical education. Further, we discuss each of these situativity theories and then relate the theories to the clinical context. Examples and illustrations for each of the theories are used throughout. We will conclude with some potential considerations for future exploration. Some implications of situativity theory include: a new way of approaching knowledge and how experience and the environment impact knowledge, thinking, and learning; recognizing that the situativity framework can be a useful tool to "diagnose" the teaching or clinical event; the notion that increasing individual responsibility and participation in a community (i.e., increasing "belonging") is essential to learning; understanding that the teaching and clinical environment can be complex (i.e., non-linear and multi-level); recognizing that explicit attention to how participants in a group interact with each other (not only with the teacher) and how the associated learning artifacts, such as computers, can meaningfully impact learning.

Introduction

A number of theories can be broadly classified into situativity theory. Situated cognition or "SitCog" is perhaps the best example, but others include ecological psychology or "Ecopsych" and distributed cognition. In this Guide, we will cover these theories with an emphasis on situated cognition and ecological psychology.

Situativity theory proposes a number of important implications as outlined in the abstract. This Guide will provide a brief historical perspective and then discuss specific situativity theories (situated cognition, situated learning, ecological psychology, and distributed cognition). We will then discuss the theories applied to the practice of medical education and will follow up with a discussion of potential future directions and implications. We use a number of illustrative examples throughout. Because the typical medical educator is familiar with (and often embraces) information processing theory, we will begin with briefly comparing and contrasting situativity theory with information processing theory.

Situativity theory versus information processing theory

Situativity theory evolved from cognitive psychology. The prominent tenet of situativity theory is the perspective that knowledge and thinking (cognition; i.e., situated cognition), as well as learning (i.e., situated learning), are situated in experience. Experience includes the participants (i.e., students, teachers, and patients), the culture, and the physical environment where thinking and learning occur. Stated another way, situativity theory stresses the social nature of cognition, meaning, and learning, with emphasis on the importance of the participants and the environment, as well as the *evolving interaction* between the participants and the environment within which thinking and learning occur.

Situativity theory proposes a model for dealing with knowledge, thinking, and learning that is fundamentally social and cultural (i.e., it is "situated"). Examples to illustrate situativity include playing Scrabble™ or writing a manuscript with a colleague. Knowledge, thinking (cognition), and

Correspondence: S.J. Durning, Department of Medicine and Pathology, Uniformed Services University of the Health Sciences, Bethesda, MD 20814, USA. Tel: 1 301-295-3602; fax: 1 301-295-3557; email: sdurning@usuhs.mil

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Practice points

- Knowledge, thinking (cognition), and learning are situated in experience; experience comprises the participants, the culture, and the physical environment.
- Outcomes can be non-linear because of complex interactions between the participants, the culture, and the physical environment that evolve with the encounter.
- Transfer theory supports a situativity approach as little evidence exists that a participant can effectively apply what is learned in one context to another, novel context.
- Situated cognition, situated learning, ecological psychology, and distributed cognition are examples of situativity theory.
- Situated cognition and situated learning put *equal* emphasis on the importance of participants and the environment.
- Ecological psychology focuses on the agent (participant)-environment interaction. Learning and cognition emerge as a result of an *intentionally driven* (goal-driven) participant interacting with a rich information-containing environment.
- Ecological psychology adds to situated cognition by providing an explanation for how individual participants interact with other participants and their environment – through goal-directed activity.
- Distributed cognition puts a *special emphasis* on the social setting and how social interactions facilitate thinking and learning.
- Situativity theory proposes implications that include potentially unique ways to "diagnose" and meaningfully impact ("treat") how we educate physicians.

learning are social and interactive in these settings. In Scrabble, the words that participants place on the board, as well as the tiles chosen, influence the thoughts and actions of other players. Also, the act of moving the tiles (environmental artifacts) around augments thinking. This may not be planned in advance, nor can one argue that thinking and action are solely based on what is inside a single participant's head. Similarly, when writing a manuscript with a colleague, the authors write and revise the text together, and the written document is based on the interplay between the individuals, the words on the page, and the environment (to include artifacts, such as the computer and books or articles on the subject). Likewise, situativity theory would argue that a patient encounter with a physician is situated – what occurs in an encounter is fundamentally based on the environment which has, for example, social and cultural aspects.

Situativity theory differs from information processing theory, which can be thought of as a prototypical example of a cognitive psychology theory. In information processing theory, knowledge is something transferred from the teacher to the learner and becomes stored in the learner's memory for later use. Proponents of situativity theory do not see knowledge in this fashion. Knowledge is not an inert, self-sufficient, abstract, self-contained, symbolic "substance" independent of the *situations* in which it is learned and used. Instead, proponents of situativity theory view knowledge more like a tool (Whitehead 1929; Brown et al. 1989). One can own a tool without being able to use it (in this sense, one might say the tool is "inert"). Using the tool helps build an increasingly rich understanding of both the world and the tool, both of which change as a result of the tool's use. Further, different groups of individuals, or communities, can use the same tool in different ways – compare, for example, how a carpenter and an archeologist might use a hammer. In other words, the tool, the participant(s) using the tool, the environment, the specific context, and the culture are all *interdependent* – you cannot meaningfully understand one of these components without understanding the others; they are situated. Thus, situativity theorists view "when and how" to use knowledge (the situations in which knowledge is applied) as the key issue – knowledge is a tool applied in certain circumstances or situations. As such, a key take-home message from a situativity theory perspective is that in teaching and learning situations, instead of focusing primarily on content (information given from the teacher to the learner), teachers *must also* pay close attention to demonstrating when and how (or, the *situations* in which) this information could and should be used. This is a key distinction between proponents of situativity and information processing theories and will be described in more detail later in this Guide.

Norman (1993) posed the following question: *Does symbolic cognition (or information processing theory) accommodate situativity, or does situativity accommodate symbolic (abstract) cognition?* We will argue the latter in this section, as we believe situativity theory can serve as an integrating framework. Information processing theory emphasizes individual participants (memory and symbolic representation of knowledge in an individual's head), while minimizing the potential contributions of other participants, the environment, and artifacts in the environment, such as computers and other tools. Indeed, these other components are often considered to be "noise" from the standpoint of information processing theory. In contrast, situativity theory argues that meaning is socially and culturally constructed, thereby giving significant weight to the potential contributions from social interactions, including the context in which learning and cognition occur. Therefore instead of the information processing view of the "the world inside the head", situativity theory places an emphasis on "the head inside the world". When something is situated, as Lave (1991) points out, it implies that a given social practice, such as teaching or learning, is intricately *interconnected* with other aspects of ongoing social processes (and that the teacher needs to be attentive to these processes to maximize effectiveness); parentheses added by authors of this Guide and we will return to this key implication later in this Guide.

Moving from a theory of symbolic representation inside an individual's head to a theory that stresses individuals and the environment in which knowledge, thinking, and learning occur does have broad implications for instructional design; implications that will be discussed in this Guide. For example, by assuming that instruction, cognition, and learning occur in complex social environments (as opposed to inside one's

Table 1. Comparison between information processing and situativity theory.

	How does learning occur?	Which factors influence learning (environment or learner)?	What is the role of memory?	How does transfer occur?	What are implications for instruction?
Information processing theory	Acquisition of mental models (i.e., schemas) in long-term memory (LTM)	Organizing environment to facilitate storage of new material Learners' mental activities dictate, in large part, what is and is not learned	Learning results from changes in LTM (i.e., schema construction)	Is a function of how information is stored in LTM Occurs when learners understand how to apply knowledge in different situations	Emphasize active learner involvement Emphasize structuring of information, organization, and sequencing
Situated cognition	Creating a unique reality Creating personal meaning, not ''acquiring'' it	Interaction between learners, teachers, and the environment is key All meaning is situated in specific contexts Authentic learning activities should result in better learning	Less emphasis on memory and more emphasis on direct perception and action To the extent that memory might be important, it is always ''under construction'' and is context specific	Is facilitated by authentic tasks anchored in meaningful contexts Learning is always tied to context	Promote learning in authentic contexts Emphasize active learner involvement Present information in a variety of ways Recognize the contributions of other learners, teachers, and the environment by encouraging social interactions

Notes: Comparison of selected tenets (learning, memory, transfer) – classic information processing theory and situativity theory. Transfer can be defined as using material learned in one context to solve a novel problem encountered elsewhere.

head alone), we necessarily introduce a broad array of interactions that can impact learning; these are interactions that the teacher must attend to and which go beyond conveying "static" content. When considering these interactions as potential "signal" instead of "noise" we introduce the notion that cognition and learning for an individual (or group) can be non-linear (or more than the sum of the component parts). For example, a somewhat tired student interacting with a less dynamic teacher could result in no learning (i.e., because the learner falls asleep). If either one of these factors were absent, significant learning could occur – the lack of learning is not merely additive, it is non-linear and multiplicative in this case. Further, such a stance implies that we should pay closer attention to authenticity (i.e., approximation to "real life" or out-of-classroom experience with the content being discussed) of the teaching environment. This is not only an overall consideration, but also applies to each of these interacting factors (participants, environment, and culture). Table 1 provides a brief comparison of information processing theory and situativity theory and Box 1 provides a practical example comparing the two approaches.

Historical perspectives

Two positions on the origin of knowledge (and, by extension, the origin of thinking and learning) find their roots in Plato and Aristotle. These two positions are *rationalism* and *empiricism*. Rationalism (Plato) refers to the idea that knowledge derives from the mind alone and not from the senses (experiences); its counterpart, empiricism (Aristotle), argues the opposite – experience is the only source of knowledge. Cognitive theories are typically rationalist and behaviorist theories are prototypically empiricist. Situativity theory arguably represents a blend of these two classic positions.

Some readers may wonder how situativity theory differs from constructivism, which emerged largely in the 1980s. Although a complete discussion of constructivism goes well beyond the scope of this Guide, suffice it to say that situativity theory extends on the social constructivist theory of Vygotsky (1962, 1978), the social cognitive theory of Bandura (1986), and educational theory of Dewey (1938, 1981). Situativity also has roots in dynamic (complex) systems theory (termed *chaos* by Prigogine 1984). For example, Vygotsky's zone of proximal development (ZPD) is defined as the "distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky 1978, p. 86). The ZPD represents the amount of learning possible by a student given the proper instructional conditions (Puntambekar & Hubscher 2005), which implies the importance of environment (in particular, capable others) – a key tenet of situativity theory as described here. Likewise, Bandura's (1986) social cognitive theory highlights the reciprocal relations between learners and social environmental features and, as such, is also consistent with situativity theory. Dewey's theory of inquiry has situated cognition roots. Also, artificial intelligence's knowledge acquisition model, consistent with situated cognition (and important implications of situated cognition in and of themselves) that break from information processing theory tenets, argues that (Robbins & Aydede 2009):

(1) learning is an active, willful, process not a passive comprehension and storage of facts and procedures (i.e., symbols) to be later applied,

Box 1. Teaching – information processing versus situated approaches.

All teachers make certain assumptions, often times subconsciously, that guide their instructional decisions. For example, when organizing instruction, teachers who identify with an information processing approach are likely to consider their students' cognitive processes, such as the storage and retrieval of information from memory. As such, they might structure their classroom to facilitate such processes by presenting a lecture that simplifies ideas to be learned, clearly organizes and categories information, and provides both concrete and abstract examples of important concepts. Their goal is usually the transfer of facts, whereas specific learner features (especially non-cognitive features, such as well-being, fatigue, and prior experience) and environmental characteristics (such as authentic demonstrations; see Table 1 for more details) are less of a priority. These learner and environmental features are typically viewed as ''noise''. Further, learners who do not know how to answer a question in a lecture should ''read more'' from an information processing theory viewpoint. That is, they should acquire more knowledge so that symbolic memory can be created and/or strengthened.

On the other hand, instructors who identify with a situated approach worry less about their learners' mental representations of the world and the nature of input/output transformations, and instead prefer to focus on *situations* and the parts that people play. For these instructors, human knowledge is about interactions with the world and the mutual accommodation of individuals and the environment. As such, instructors who identify with a situated approach are likely to teach from a single, overarching imperative – create learning environments that situate virtually *all* learning in *authentic* contexts, using a variety of teaching formats which may take the form of small-group, large-group (i.e., lectures), and one-on-one instruction. Authentic contexts are truly ''authentic'' if they share some of the important aspects of real-life problems, including being ill-defined, having complex goals and multiple solutions, and containing collaborative activities among learners and with practitioners in society (Young 1993; Jonassen 1997). By situating learning in authentic contexts, students are expected to construct extensive, flexible knowledge through the integration of information across multiple domains, instead of learning non-contextualized (facts that have been organized for them).

In short, situated approaches to teaching employ authentic contexts to help students develop extensive, flexible knowledge that may be more easily retrieved and applied under varying conditions (Bransford et al. 2000). Teachers who use situated approaches to instruction are mindful of the factors in Figure 1 and how they interact with each other. They tend to monitor for and adjust their teaching based on how these factors evolve. Furthermore, instructors who identify with a situated approach will use these factors (Figure 1) to help ''diagnose'' situations where learning appears to be less than optimal. Situated approaches to teaching embrace the importance of communities of practice and legitimate peripheral participation. That is, these approaches model good practice and allow for the progressive independence of learners, with increasing responsibility and membership in the community. Finally, teachers who work from a situated perspective would be less likely to use lecturing as their sole teaching modality because the typical lecture is much less authentic than other instructional formats, such as small-group learning.

(2) understanding requires experience, whether physical or in the imagination (often termed vicarious),
(3) conceptual understanding relies on perceptual-motor experience and simpler ideas, such that learning can be viewed and usefully guided in stages, which themselves require time and exploration to develop.

Though there are many similarities, a key distinction is that constructivists view learning and thinking as being ''constructed'' in an individual participant's head. As such, many constructivists, like most information processing theorists, still emphasize what goes on in the head; whereas situativity theorists place knowledge and understanding at the intersection of the individual and the environment.

Situativity theory (also known in some circles as grounded cognition) represented a significant shift in cognitive science theory, occurring largely in the 1980s and 1990s. Information processing theory (also known as cognitivism in some circles) was the pervading cognitive science theory at the time. Within information processing theory, community and culture enter into the equation only as they can be broken down into discrete elements that the *participant* can manipulate in their head in the stable, objective realm of experience. Therefore, for practical purposes, community and culture are largely considered noise by cognitivists (Kirshner & Whitson 1997). Accordingly, the notion of exploring learning and thinking as processes that occur in a local and socially constructed world is not readily apparent with the information processing approach.

Groundbreaking studies leading to the emergence of situativity theory involved the work of Lave (1988) and her exploration of learning (i.e., situated learning) in everyday activities. In particular, her work revealed the distinct (and immense) differences between learning in schools and learning in everyday activities. She focused on the behavior of students and non-students (typical persons in a community) and found that the way a typical person learns (and thinks) is quite distinct from the way a student is asked to learn (and think) in school. The typical workers' activities are situated in the culture of their working environment, and within this environment individuals negotiate meaning and construct understanding with other participants and artifacts, or tools, in the environment. Compare this approach to typical learning in school, where formal definitions, well-defined problems, and symbol manipulation often encompass the bulk of scholastic activity. Thus the situativity perspective offers a different view than more traditional classroom instruction with attendant implications.

Lave's work also led to three other principles often considered to be common components of situativity – *cognitive apprenticeships* (learning by working with mentors within a social and cultural context), *communities of practice* (the social and cultural group or ''community'' involved in the activity; e.g., a practice), and *legitimate peripheral participation* (or how ''newcomers'' and ''old timers'' in a community relate to one another, which includes activities, identities, and knowledge). For example, physicians are a community of practice involved in the activity of providing medical care to patients. From a situativity theory perspective, for a trainee (medical student or resident/registrar) to become a board certified physician, legitimate peripheral participation is needed – the trainee must care for patients under conditions allowing progressively higher levels of autonomy and under the direction of one or more mentors (cognitive apprenticeship). Thus, increased learning is tied to increased self and community identity, i.e., ''belonging'' to the community. Cognitive apprenticeships, communities of practice, and legitimate peripheral participation epitomize the situated nature of knowledge, thinking, and learning in everyday practice.

In terms of specific situativity theories, Situated Cognition or "SitCog" is a perspective that has been embraced by many (Brown et al. 1989; Resnick et al. 1991; Greeno 1993; Salomon 1993). Another related perspective, Ecological Psychology or "Ecopsych" considers cognition as the interaction of learners and the properties of their environment, particularly the *affordances* (or potential) and *effectivities* (abilities) for action that individuals possess. For example, a person opens a closed door provided the individual recognizes the affordance (a door knob, which is turnable) and has the effectivity (ability to act on the affordance, can turn the door knob) for action. Importantly, like situated cognition, ecological psychology argues that if learning occurs at all, it occurs within a social context – with learner goals and intentions (prioritization of goals) largely determining how learners perceive and act (and thus learn) in a given situation. From an ecological psychology perspective, it therefore becomes impossible to separate the learner from the context in which learning occurs (Lave 1988). Ecological psychology is likewise embraced by many (Gibson 1977; Young 1993; Heft 2001). Finally, distributed cognition, as perhaps first described by Hutchins (1995) and Hutchins and Klausen (1996), emphasizes the notion that an individual participant's thinking and ability to solve problems is complemented by (and often dependent upon) other participants' cognition.

The theories explained

Situated cognition:

As noted above, situated cognition argues that thinking and learning must be viewed as "situated" (or located) within the larger physical and social context of the environment. Situated cognition therefore shifts the focus from the individual participant as the unit of analysis (traditional information processing theory) to the social and cultural setting within which all activity (the processes, the participants, and the practices) occur. This theory argues for a complex interplay between the participants (social context) and their environment (physical context). It is important to point out at this juncture that some theorists consider cognition to solely involve thinking, while others consider cognition to include the processes of thinking *and* learning. The former have created a separate perspective for a situated cognition approach to learning – Situated Learning – while the latter would consider Situated Learning to fall under the umbrella of Situated Cognition. As one of our goals with this Guide is to acquaint the reader with the theories and terms that relate to situativity theory, we will discuss Situated Learning as a separate section.

As Lave (1988) contends, traditional cognitive psychology has found precious little evidence that learners can apply knowledge gained in one context to problems encountered in another. This problem of transfer argues for the need to consider the effects of the other participants as well as the environment on learning – a situated approach. This notion returns us to the tool example – the need to emphasize when and how to use a tool as opposed to just providing a tool with little to no attention to the context (i.e., treating the tool as an inert object). Therefore, it is not just what a teacher says, but how and when that information is provided (to include the physical and social context) that affect how and when that information may be used in the future; this is a key implication of situativity theory that we will return to later in this Guide. Accordingly, these issues need to be explicitly considered in instructional design.

A related term to situated cognition is *embodied cognition* (Robbins & Aydede 2009), which refers to how the body shapes thinking. Without the cooperation of the body, there can be no sensory inputs from the environment and no motor outputs from the individual, hence no sensing or acting, which makes thought essentially empty. From this perspective, the mind is not a storehouse of abstract representations; instead, we receive specific sensory inputs. Further, as the above cooperation example illustrates, perception, thought, and action are co-constituted or interdependent. This is why situated cognition theorists talk about the importance of environment to thinking as discussed below.

Situated cognition does not only argue for the *embodied mind* as described above. It also argues for the *embedded mind* and the *extended mind*. The embedded mind argues that thinking is not only dependent upon what goes on in the individual participant; we need to also consider the complex transactions that occur between our embodied minds and the embedded world. An example here could be what is referred to as *cognitive off-loading* – or putting cognitive work onto the environment. Consider how a skilled grocery packer will sort items into heavy, light, and fragile areas as groceries come off the conveyer belt. This rearrangement significantly decreases the load on working memory relative to the alternative of trying to place each item into its optimal position of the grocery bag as it comes down the conveyer belt. The extended mind argues that the "boundaries" of cognition lie outside the envelope of the individual organism, encompassing features of the physical and social environment.

Situated cognition not only *recognizes* a complex interplay between participants and environment, it puts *equal emphasis* on these two components (Young 1993). This perspective actually builds upon the cognitivist approach of a participant *in* environment to participant *and* environment (Bredo 1994). Further, all participants (and the environment) are potentially changed by this complex interplay, which can necessitate non-linear and/or multi-level approaches to analyzing what occurs. This latter point returns to the notion of the ZPD – an interactive system within which people work on a problem which at least one of them could not, alone, work on effectively (Kirshner & Whitson 1997). An example of a ZPD in medicine could be a debilitated patient with multiple medical problems who presents with an upper gastrointestinal hemorrhage to the general internal medicine service. The radiologist provides interpretation of the studies, consultants provide opinions (i.e., gastroenterologist can provide endoscopy results and interpretation, physical therapist recommendations regarding ambulatory assistance needs) related to their specific specialty, and the general internist puts the pieces together to arrive at the best care plans for a complicated patient. Ultimately, when functioning properly, the care rendered is improved by this interactive system, and no individual

participant can provide the quality of care that the group can render. Another example could be disease management teams caring for a patient with heart failure or diabetes. The notion of the ZPD is a key feature of distributed cognition, as discussed below.

Situated learning

Situated learning embraces the above tenants of situated cognition and, as previously mentioned, many consider situated learning as one component of situated cognition (cognition as thinking and learning). Key tenets of situated learning are legitimate peripheral participation and communities of practice. The term legitimate peripheral participation involves meaningful ("legitimate") involvement in an activity ("peripheral participation") that is led by a coach/mentor or teacher, who is a member of a community (a "community of practice"). This approach to learning highlights the evolution of becoming a member in a community (self and social identity) as foundational to learning; learning actually involves a change in self (and community). It is "peripheral" as the learner does not initially drive the curriculum. Importantly, a near peer (someone close in training, and therefore knowledge, to another – i.e., a fourth-year medical student instructing a second-year medical student) can serve as the mentor/coach – learning does not require a "master" within a profession for learning to occur. For example, situated learning argues that a resident can (and should) teach medical students. Increasing responsibility, which facilitates evolution of self and community, is also essential for learning. The emphasis on the social nature of learning and transformation of self and community with learning (i.e., a learner becomes increasingly involved, ultimately becoming a member of a practice) are distinctive features of situated learning.

Ecological psychology

Ecological psychology also argues that thinking and learning must be viewed as "situated" within the larger physical and social context of the environment. Ecological psychology does so, however, from a slightly different perspective than situated cognition. In ecological psychology, the unit of analysis is the agent (participant)-environment interaction. In this view, learning and problem solving are not the product of learners' internal cognitions (information processing) but emerge as a result of an *intentionally driven* (goal-driven) participant interacting with a very rich information-containing environment. From an ecological psychology perspective, it is impossible to separate the learner, the content to be learned, and the environment in which learning takes place. In other words, *if* learning occurs, it occurs within a particular context, and the participant's goals and intentions *direct* the participant's perception and action (and thus the participant's learning). Accordingly, analyzing cognition requires an understanding of these and other complex interactions, which results in the need to consider non-linear and/or multi-level approaches, as discussed above. As opposed to information processing theory, ecological psychology contends that learning and cognition are not (and cannot) to be driven by static states, such as the symbolic representation of memories, which are devoid of physical and social context at a particular point in time.

Like the situated cognition perspective, the environment is a key component in the ecological psychology viewpoint. The environment provides functional value or "opportunities" to participants. These opportunities, referred to as *affordances*, are what the environment offers to participants, what it provides or furnishes, either for good or ill (Gibson 1986). As previously mentioned affordances are possibilities for action and, importantly, they are *not* stable for all participants at all times. A participant's ability to act in ecological psychology is termed *effectivities*. This environment-participant dynamic dyad (affordances and effectivities) are codetermined (i.e., neither stands alone) – affordances (and their effectivities) only exist for certain classes of participants and vice versa. For example, a television provides the affordance of being "watchable" and a car the affordance of being "drivable". These affordances are only available to participants with appropriate effectivities – a blind person does not have the effectivity to watch a television and an infant does not have the effectivity to drive a car. Furthermore, an affordance is only important when a potential need (or *intention*) arises based on the agent's goals and objectives.

Another key dyad in the ecological psychology perspective is intention and attention. An individual's intention is driven by his or her goals and objectives, while an individual's attention is his or her ability to perceive an affordance. Importantly, one's intention drives one's attention. Stated another way, intention and attention depend upon each other just like affordances and effectivities. As a participant's goals and objectives evolve (intent is a dynamic construct), his/her attention, or focus, likewise evolves (another dynamic construct). For example, consider a patient who presents to the Emergency Department with acute retro-sternal chest pain. The Emergency Department physician first considers cardiac disorders (goals and objectives) which drives the focus (or attention) of the initial physical exam. The physician then hears a rub on cardiac examination (affordance) pointing to the possible diagnosis of pericarditis (redirecting goals and objectives and intent to other diagnostic and therapeutic possibilities). The physician then orders an ECG revealing electrical alternans and diffuse convex ST elevations and T-wave inversion (effectivity).

As illustrated in the above example, a participant's goals, objectives, and attention impact detection and selection of affordances (or opportunities), which are intricately tied to effectivities (or abilities to act). The complexities both within each dyadic component as well as in the dynamic interactions between these dyads result in the need to consider non-linear and/or multi-level approaches for analysis.

Finally, ecological psychology views intelligence as the interaction of a participant with his/her environment; it is not a property inherent to an individual – the emphasis is on perception (and interaction with an environment) as opposed to the static notion of memory. Indeed, learning is seen as a *tuning* of the agent within the environment (i.e., when and how to use the "tool" as discussed above) as opposed to putting knowledge into symbolic memory. This progressive

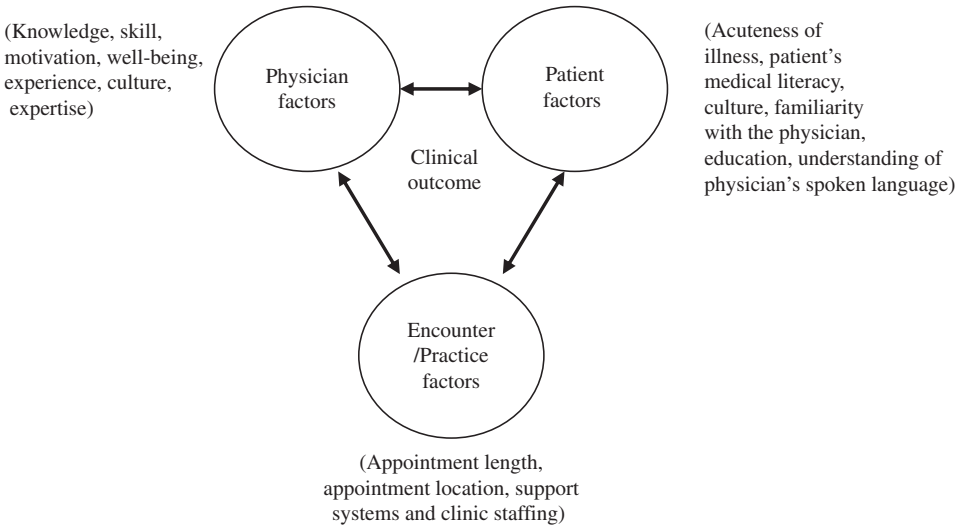

Figure 1. Situated cognition and the clinical encounter.

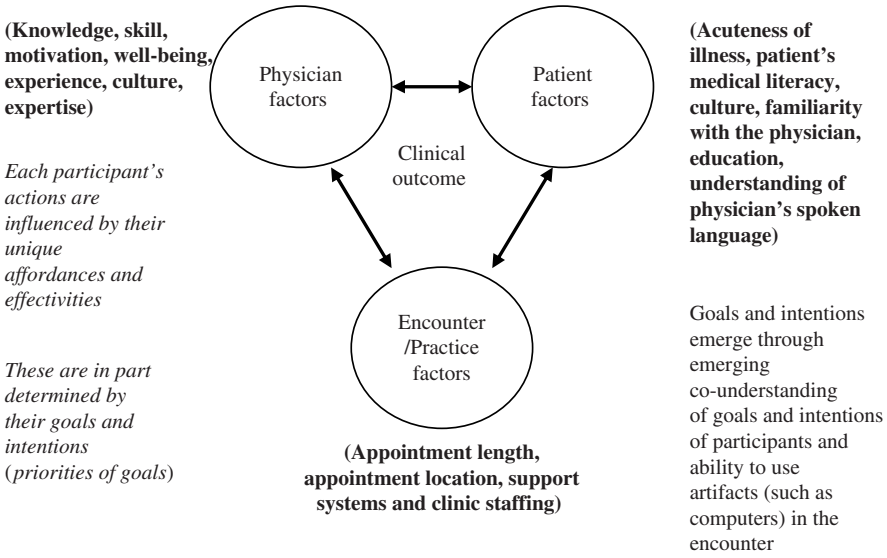

Figure 2. Situated cognition (bold), ecological psychology (italics), distributed cognitions, and the clinical encounter.

tuning of the agent leads to *automaticity* – the ability to complete a task with little conscious effort. Furthermore, tuning can be accentuated by the instruction of a coach and/or mentor. An example of tuning could be repetitive auscultation of a type of heart murmur. As the learner listens to the murmur (an activity that is often guided by a mentor), the distinct characteristics and nuances of the murmur (or the "environment") become more apparent to the learner; that is, the learner's perception and attention are tuned.

We believe that ecological psychology adds to situated cognition by providing an explanation for how participants interact with other individuals and their environment – through *goal-directed activity*. Figure 1 shows situated cognition in a clinical encounter and Figure 2 shows how ecological psychology and situated cognition can be unified in the clinical encounter.

Distributed cognition

The theory of distributed cognition also falls under situativity theory and, like situated cognition, it argues that thinking and learning must be viewed as "situated" within the larger physical and social context of the environment. Distributed cognition, however, puts a *special emphasis* on the social setting and how social interactions lead to thinking and learning. The unit of analysis is individuals engaged in cognitive activities within social and material contexts (Salomon 1995). Like situated cognition and ecological psychology, distributed cognition considers a "person plus" unit of analysis, whereby artifacts (non-humans, such as computers) can, and do, augment participants' cognitive capabilities. Within the literature, distributed cognition has also been referred to as *distributed learning* and *distributed*

intelligence (Bell & Winn 2000). All of these terms imply the socially shared nature of thinking and learning.

Like situated cognition and ecological psychology, distributed cognition theorists see the learning environment as a highly complex system in that there are multiple components (teachers, learners, and settings) and, more importantly, there are opportunities for multiple interactions between and among these components. In this theory, which accounts for social, cultural, and physical components, communication *between and among components* is the *sine qua non*. Importantly, components can be either people or objects; the latter are often referred to as artifacts. An example of an artifact is a computer, and theories of distributed cognition explore how such artifacts can extend human capabilities in learning settings, such as our prior example of a grocery handler.

There are two other core characteristics of the distributed cognition approach. First is the concept that information is shared by all. This sharing allows the best-equipped person (or artifact) in the environment to use the information for the benefit of the group. The second core characteristic is that the components of the distributed system must rely on each other to get the job done. For example, consider how these characteristics are germane to the proper navigation of an aircraft carrier or serving as the primary care physician for a patient with multiple medical problems.

The theories in practice

Since medical education involves instructing learners and taking care of patients, we will emphasize how situativity theories can be applied to these clinical settings. As in other sections, we will describe each theory independently and then compare and contrast the theoretical viewpoints.

Situated cognition and situated learning. Viewing a classroom in medical school through the lens of situated cognition and situated learning leads to some important insights. As a student prepares for a small-group discussion, she cannot predict precisely what will happen in the classroom. The outcome of the discussion is dependent upon the student, the conversations and thoughts of his/her peers, the instructor, the setting, and their dynamic interactions. This likewise holds true in the clinical setting. Even if a physician is quite familiar with a patient ahead of time, s/he does not enter that patient encounter knowing exactly how things will end – the "success" of the encounter is determined by the dynamic interactions between the doctor, the patient, and the physical environment. This situated viewpoint of the classroom and the clinical setting does more than just acknowledge the environment as a passive component or "noise"; it places the environment on equal footing with the people in that environment and their unique interactions. Figure 1 shows a situated cognition approach to the medical encounter. However, while situated cognition theory does provide a model for viewing the component parts of the classroom interaction or medical encounter and their inter-relations, it does not fully illuminate the question of participant goals and available resources in the complex system. We believe that this important additional information emerges when one turns to ecological psychology, which focuses on co-determined dynamic interplay between humans and the environment.

Ecological psychology. Like situated cognition, ecological psychology argues that educators need to be aware of participants, their environment, and their inter-relations. Taking our small-group teaching example above, a learner's goal (intent) could be to outperform their peers. As such, s/he reads multiple textbooks and articles in preparation (affordances) and then is able to answer questions raised by participants during the session (effectivities) due to his/her extensive preparation. Considering the dynamic dyads that ecological psychology endorses – agent–environment, affordance–effectivity, intent–attention – has implications for instructional design as discussed in the following section.

Moving to the patient care environment; suppose a patient presents to the internal medicine clinic with a hot swollen knee but has no scheduled appointment. The receptionist at the check-in desk pages the physician on call because s/he lacks the effectivity to arrive at the diagnosis. The physician contemplates how to diagnose the knee effusion. She calls for an arthrocentesis (knee aspiration) kit (affordance). Because she understands the differential diagnosis and the next step needed to establish the diagnosis (effectivity), she inserts the needle into the knee (intention), removing fluid which is subsequently found to contain crystals consistent with a diagnosis of gout. In this example, the starting point is known as well as the desired outcome; however, the various aspects of the encounter – affordance, attention, intention, and effectivity – emerge dynamically. Various features in the specific context can evoke different reasoning processes to arrive at the correct diagnosis. Indeed, in order to transfer the necessary knowledge to different settings, the knowledge (chunks or patterns) must be connected to a variety of retrieval cues (Shell et al. 2010); arguably some, if not the majority, of these cues are likely to be bound to the social and/or cultural context.

Distributed cognition. Consistent with situated cognition and ecological psychology, distributed cognition considers both the participants and the artifacts (tools in the environment) in constructing meaning. For example, returning to our small-group exercise discussion, participant components in the distributed cognition system include the discussant, the discussant's peers, and the teacher. The artifacts could include a whiteboard and/or a computer. The discussion that emerges from the presentation represents a distributed cognition system. In this example, when cognition is distributed with a view to helping students learn something, students' conceptions (both of the discussant and the peer group) would be expected to converge toward an agreement with the expert (teacher). In distributed learning systems, one needs to be able to deal with unexpected events that increase the uncertainty (entropy) in the system as opposed to reducing uncertainty. Take, for example, the problems that could occur if the discussant was totally wrong with an answer to a peer or teacher question and/or if the teacher could not answer an insightful question from a student. Also, the artifacts, such as computer or whiteboard, must be capable of changing as part

of the distributed cognition system. Imagine, for example, the difficulties that could emerge, in terms of outcomes for the learners, if the computer looses power or if the whiteboard marker runs out of ink. This example, as well as the clinical example below, is an illustration of productive dynamic systems which are *self-organizing*. That is to say, the amount of uncertainty (or variation in performance) within the system would be expected to *decrease* over time as student's conceptions converge toward agreement with the teacher's.

Using our clinical encounter example of the patient who presents to the clinic with a hot swollen knee, participants would include the receptionist, the patient, and the physician. Artifacts would include the arthrocentesis kit and the microscope used to analyze the synovial fluid. This productive dynamic system should be self-organizing; that is, the amount of uncertainty in the diagnosis would be expected to decrease as the patient's understanding of what is wrong converges toward agreement with the physician's diagnosis. Consider the problems that can emerge if the physician cannot answer important patient questions, if the physician cannot explain shortcomings to the proposed action plans of care, and/or if the arthrocentesis needle kit is missing essential parts for performing the procedure. In such a distributed cognition system, participants must be able to deal with unexpected events that can increase uncertainty (patient questions), and the artifacts must be capable of change (arthrocentesis kit "malfunction"); that is to say, the artifacts need to be capable of providing information to other components of the distributed cognitions system. Figure 2 shows a situated cognition, ecological psychology, and distributed cognition approach to the clinical encounter.

These three different theories take into account the various components (people and the environment) and their interactions. And while the terms, representations of interactions, and emphasis of the theories vary to a degree, through dynamic interactions of multiple components, all of these theories would argue for non-linear outcomes in some circumstances and/or outcomes which are dependent not only upon individual person characteristics, but also upon characteristics of the various groups of persons who experience a common phenomena. Such assumptions are consistent with deterministic chaos theory (Guastello, Koepmans & Pincus, 2009). We hope the reader can also appreciate that given the different views that each of these three situativity theories provide, it may be beneficial, at times, to combine the theories. For example, combining situated cognition and ecological psychology in the clinical encounter (see Figure 2) provides a descriptive, situated representation of the encounter that would not be permitted with either theory alone.

Instructional implications and future developments

The implications of these theories for instructional design are numerous, and we have outlined some examples in the above section on theories in practice. We believe these implications can be broadly characterized into three major themes: (1) the importance of more than just content in teaching and learning; (2) the implications of a potentially nonlinear, even chaotic system; and (3) a way to diagnose (and propose solutions to "treat") a less than ideal teaching or clinical situation.

The importance of more than content

Situativity emphasizes the importance of the participants, the environment, and their interactions. This is not to say that teaching content is not essential – it is, but it is simply not sufficient. This is a point of significant departure from information processing theory, which considers much of the effect of environment and interactions between factors (Figure 2) as error variance or noise. When viewed from a situativity perspective, the instructional designer must consider the environment, learner dynamics and perspectives, teaching modalities, and their interactions – they all matter. The teacher should not only spend time on drafting discussion points for the session, he should consider, for example, learner perspectives and preparation, potential group dynamics, tools available in the teaching environment (artifacts) to assist the learner and how to best optimize them, and authenticity of the instructional format (how close to actual practice are the materials). Situativity theory would argue that it all matters and though the instructional designer cannot control how the different factors interact, explicitly paying attention to (and adjusting, as much as is possible for the teacher) the components of the factors and their interactions can optimize learning. This model also provides a scaffold for changing instruction by encouraging teachers to focus on not only the content, but also on these other factors and how they play out in the session.

We will return to our examples to illustrate some of the practice implications for teachers and designers. The teacher in the small-group setting who approaches things from a situativity perspective would endorse the relative ineffectiveness of mini-lectures (which usually lack social and physical context), as well as the need for authentic cases (to assist transfer to clinical situations), attention to the purposes and potential value of computers and other artifacts of instruction, and the potential use of facilitating discussion versus lecturing. The teacher would also be mindful of the well-being of the trainees and the need to provide them with opportunities to demonstrate regulation of their own learning activities. Attention to authenticity in the participant and environment factors is also a priority to facilitate learning and transfer. Further, the environment (other participants and artifacts) all play an important role in learning. These items should not be seen as "noise" since attention to these facets would be predicted to impact both learning and transfer (knowledge as a "tool"). The teacher would craft the lesson with these factors in mind, not just solely focusing on transferring inert/symbolic knowledge.

More specifically, in relation to individual situativity theories, we might ask questions such as: How does the small group facilitator augment or scaffold student attention and intention to fine tune their perceptions (learning)? What affordances are instructors aware of and how can they convey these to the students? How can intent (goals) be augmented for learning? Are all teachers prepared to avoid the distributed cognition negative implications of a question that is

not addressed or answered correctly by the teacher? Has attention been paid to small group student dynamics? These are just a few of the many questions to consider when designing instruction from a situativity perspective – effective teaching (and learning) involves far more than just the inert transfer of knowledge.

Moving to the clinical encounter, the above implications for learner interactions also apply. Additional considerations include helping the learner understand the patient's perspective (see the examples in Figure 2) and appreciating the system strengths and weaknesses (e.g., practice factors; Figure 2). Situativity encourages the teacher (and instructional designer) to consider a host of contextual factors that can impact teaching and learning besides the content being delivered. An emphasis on the various features of the context and how they can impact teaching and learning is where situativity diverges from other instructional design theories.

Potentially non-linear system. The recognition that the outcome (be it teaching, learning, or patient care) is based on these context-specific, interacting parts that evolve over time raises the possibility for a non-linear or even a chaotic system (Durning et al. 2010). As the outcome is more than the sum of the parts in a chaotic system (the outcome has sensitive dependence on the initial conditions), focusing on factors (Figure 2) that are often overlooked could lead to non-linear gains in the desired result. This represents a *major shift in instructional design* – considering the outcome of design as potentially more than the sum of the parts (as non-linear). For example, in a non-linear system, improving one of the factors in Figure 2 could result in very large differences in the desired outcome; likewise failure to attune to one or more of the factors could lead to dramatic underperformance. To illustrate this point further, consider the act of pouring a cup of sand onto a table. One can predict the general shape of the pile of sand, but predicting the location of a specific grain of sand defies mathematical calculation as the individual grains of sand bump into so many other grains, which ultimately affect its destination. The learner is like a grain of sand and the items listed as factors "bump into" each other and can lead to a more than additive outcome. The teacher who is attuned to the desired outcome can make important changes or "course corrections"; although it is fair to say that no individual factor can be completely "controlled" by the teacher. This is akin to the pile of sand example, where the person pouring the sand (the teacher) can direct the location of the overall pile (the outcome) but cannot control how individual grains of sand interact.

Teachers and designers seeking to investigate the effectiveness of their teaching approaches should consider the use of hierarchical linear modeling (HLM), structural equation modeling (SEM), and chaos theory mathematical approaches, which can address how these components can (and do) interact. For example, a medical educator who is interested in understanding the effectiveness of collaborative learning methods across various medical contexts would do well to apply multi-level modeling techniques, such as HLM. Doing so could potentially highlight differences in the relationships among person-level variables that exist *between* the contexts themselves; that is, the effectiveness of collaborative learning techniques may vary considerably across contexts. These between-group differences represent an additional source of variability above and beyond that which is present at the individual level (and that which can be modeled by traditional statistical methods, such as analysis of variance and multiple regression). Thus, the use of multi-level modeling effectively captures and models this variability across multiple contexts, thereby allowing the medical educator to better understand the influence that contexts – such as groups, classrooms, or schools – may have on individual outcomes (O'Connell & McCoach 2008).

Future empirical work is needed, however, to provide additional evidence for the various situativity theories. For example, does changing one or more of the factors listed in Figure 2 (while leaving the other factors constant) impact the clinical outcome? Does performing one or more of the methods mentioned (i.e., HLM or SEM and/or deterministic chaos) in the clinical encounter shed light on what is occurring with teaching and/or learning? One could also study the effect of adding one or more design implications above on teaching and/or learning. And finally, where do traditional information processing and situativity theories overlap (and diverge) in instructional settings? More empirical work is needed to begin answering these fundamental questions that have important implications for the theory, research, and practice of medical education.

Diagnosis and treatment of situations. As medical educators, we often think that we teach in an ideal situation and encourage students to learn in the "ideal" situation. Practice tells us otherwise in that few (if any) teaching or clinical situations are truly ideal. Situativity theory can help these real-world settings in a couple of ways. First, it provides a potential method to *diagnose* what is potentially going wrong with the teaching or clinical setting. Returning to Figure 1, a less than optimal clinical encounter can be dissected (and sub-dissected) using the rubric of patient, physician, and encounter or practice factors (some, of the many more possible components of these factors are shown). Furthermore, these factors could be prospectively studied to see if they impact the clinical (or teaching encounter). Second, situativity theory proposes a potential way to "treat" a less than optimal teaching or clinical situation. Returning to our prior examples in this Guide, situativity theory can help with "treating" a number of "what if" situations. What if the microscope did not show gout crystals or what if the patient refused to have the procedure? By approaching the situation as patient, physician, and encounter factors, a number of potential interventions come to mind. Further, what if the teacher was unable to address a thoughtful student question in a small group setting? Situativity theory proposes other potential means, such as asking a fellow student (trainee), use of the internet (artifact), or other solutions.

Making situativity theory and its implications explicit to the teacher and the student could lead both to considering how the environment impacts performance and how the

environment can be potentially altered to effect a more positive outcome. Understanding the potential non-linear interactions can also encourage the teacher and the learner in that a small change in one component of one factor (i.e., encouraging student self-efficacy or belief in one's ability to complete a task) could lead to disproportionate positive gains – the trainee becomes more motivated, asks more questions of peers and teacher(s), and may even enjoy the material more (leading to additional learning gains).

Summary

Situativity theory takes the perspective that knowledge, thinking (cognition), and learning are situated in experience; that is, they are situated within the participants, the culture, and the physical environment of an activity. Situativity theorists embrace the notion of non-linearity (or the outcome can equal more than the sum of the parts) as these components (participants, culture, and environment) interact in dynamic and evolving ways. Further, situativity theory addresses the problem of transfer, or the notion that a participant's ability to apply knowledge gained in one context to problems encountered in another is very limited. By considering the effects of the other participants and the environment on learning, a situated approach provides possible options for improving transfer.

In this Guide, four situativity theories were discussed: situated cognition, situated learning, ecological psychology, and distributed cognition. Situated cognition not only recognizes a complex interplay between participants and environment, it puts *equal* emphasis on these two components. Ecological psychology focuses on the agent (participant)–environment interaction. In this view, learning and cognition emerge as a result of an *intentionally driven* (goal-driven) participant interacting with a very rich information-containing environment. Ecological psychology adds to situated cognition by providing an explanation for how individual participants interact with other participants and their environment – through goal-directed activity. Distributed cognition puts a *special emphasis* on the social setting and how social interactions lead to thinking and learning. Implications primarily involve considering these components and their interactions as true signal as opposed to noise or error in construction of knowledge, thinking, and learning. Considering these implications, which suggest far more than content-knowledge expertise to effectively educate others and the need for the teacher to explicitly attune to more than just the content of the lesson, can potentially assist the medical teacher as well as the medical learner.

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Notes on contributors

STEVEN J. DURNING, MD, is a Professor of Medicine and Pathology at the Uniformed Services University (USU). He directs the Introduction to Clinical Reasoning Course and is a general internist.

ANTHONY R. ARTINO, JR., PhD, is an Assistant Professor of Preventive Medicine and Biometrics as well as Medicine. He co-directs the Long-Term Career Outcome Study of Uniformed Services University (USU) students and graduates with Dr Durning. He has a PhD in educational psychology with an emphasis in cognition and instruction.

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