

A Transactional Approach to Transfer Episodes

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There is no such thing as an instantaneous inquiry; and there is, in consequence, no such thing as a judgment . . . which is isolated from what goes before and comes after. The meaning of this thesis is not to be confused with the trivial, because external, fact that it takes time to form a judgment. What is affirmed is that inquiry, which yields judgment, is itself a process of temporal transition effected in existential materials. (Dewey, 1938, p. 246)

In this article we present an analytical framework for approaching *transfer episodes*—episodes of (e.g., school) tasks in which participants declare or can be declared to bring prior experience to bear on the current task organization. The framework is grounded in Dewey’s writings about the *continuity of experience* (Dewey, 1929, 1934/2008a, 1938, 1938/1997), but also draws on Vygotsky’s ideas about unit analysis (Vygotsky, 1986) and on more recent developments in continental philosophy (e.g. Romano, 2009). It involves a re-definition of the notion *experience* that rejects the “atomization of experiences” (Dewey, 1938, p. 245) that is implied in classical notions of transfer, and offers an expansion to current *ecological* (situative, sociocultural) reconceptualizations, where the notion of experience has received little attention. Following the opening quotation, we propose that experiencing, like knowing, *is* itself “a process of temporal transition.” Accordingly, a minimal *unit of analysis* must include whole-persons (including their intellectual, affective and bodily dimensions), their material and social environment, and their transactional relations (mutual effects on each other) *as these change over time*. This implies that during transfer episodes it is

not that some *known* thing is carried over—as cognitivist theories have it—but that the whole person-in-setting is transformed, a view that aligns well with but goes beyond recent situative sociocultural (e.g. Beach, 1999; Greeno, 2006; Packer, 2001) and phenomenological (e.g. Nemirovsky, 2011) approaches to transfer. It also implies that, during transfer episodes, not only knowing, but also *uncertainty* plays a central role. Thus, *receptive* and *affective* aspects of experience, often underemphasized in going theories, come to the fore as inherent moments in the unfolding of transfer episodes.

The article is divided in a theoretical part and an empirical part. We begin the theoretical part by outlining the fundamental premises of a transactional framework as it derives from Dewey’s theory of experience. Using an exemplary case of learning by a child, we then contrast the transactional approach with going theories of transfer and explore how different kinds of unit of analysis differently capture the relations between learners and settings over time. In the empirical part, we use the transactional lenses to analyze an episode of transfer from a technology-enhanced science education curriculum on energy in which students were presented with “analogous” models of scientific phenomena across different activities. In the analyses, we describe instances of *recognition*, *analogical reasoning*, and of how students *apply theoretical knowledge*—all central processes in transfer literature—as transactional processes, that is, as time-extending processes that imply changes in both persons and environments. The analyses not only provide empirical ground to the framework but also insight about the dynamic, affective, and embodied aspects involved in transfer episodes that may otherwise go unnoticed. In a final section, we discuss theoretical as well as practical (pedagogical) implications of a transactional approach.

Part I: Theory

Most often, the question of transfer is posed in terms of *something*—i.e. prior knowledge, a representation, a skill—which an individual had learned before and comes to apply into a new situation. However, as researchers have noted, this characterization is rather narrow compared to the range of ways in which people can be said to bring prior learning to bear in new situations (Bransford & Schwartz, 1999). Moreover, as Carraher and Schliemann (2002) note, when seen as the carrying over of prior knowledge, transfer is not a specific cognitive phenomenon, but a whole theory about how people learn and think. More broadly, the question of transfer refers to the question of *how past experiences relate to current experience*. Yet, and despite emerging re-conceptualizations of transfer during the last years (Engle, 2012; Goldstone & Day, 2012), discussions about *experience* and its relation to learning are absent in most prior and current literature about learning and transfer (Roth & Jornet, 2014).

In this part of the article, we elaborate on a transactional approach to transfer that has its roots in Dewey's category of experience, for whom the continuous nature of experience and the problem of how "rational operation grows out of organic activities" were central concerns (Dewey, 1938, p. 18). To better illustrate the nature of the phenomena that are of interest to a transactional approach, we begin with an exemplary case of learning by a young child. We then present the theory, which allows us to outline a *transactional unit of analysis*. Finally, we contrast this unit with other units of analysis that have been elaborated and applied in prior and current research on transfer.

An Exemplary Episode

At the time of the episode, Clara is two and a half years old and greatly enjoys drawing and painting. From an early age, her parents had encouraged her to color, scribble, and doodle on blank pages; and many of her paintings hang on her house's walls. Often, she asks her parents to draw figures for her, such as animals, landscapes, flowers, and the like—figures that she cannot yet draw on her own. Lately, her parents have begun to show her how to draw geometric shapes. They take her hand as she holds the crayon, and they guide her to draw circles and squares on the paper while they say “See, Clara, we draw circles!” or “Look there, that’s a square.” One afternoon, Clara is sitting with her dad, ready to draw some random lines on the paper, when she wonders aloud what they should paint. Without having made a decision, Clara spontaneously begins to draw what turns into an elliptical shape. She then looks at the shape and, suddenly and with an expression of great surprise, says, “Look, Daddy!! It’s a troll!” She then draws two circles that can now clearly be recognized as the troll’s eyes. Her dad then encourages her to continue drawing the troll’s nose, mouth, ears (in red color, Figure 1) and hair. Clara has just drawn her first (“troll”) face.



In the episode, a young child draws a face for the first time. Although the episode does not portray an archetypical case of transfer, it is useful to our discussion because it emphasizes relations between prior and current experience in situated action. Importantly, the episode is not an isolated event, disconnected from the child's history of development. The drawing in Figure 1 is the first of many different faces that Clara currently, two and a half years later, is producing. As Clara drew her first face, a new horizon of possibilities opened up for her and changed her *forever*—she would never again be the little girl who could not intentionally draw a face. But how did this event of development come about? How is this event connected with the child's prior learning and experience?

Most current approaches to learning and cognition explain episodes such as the one described above in terms of “prior knowledge,” which is most often described as an already existing intellectual or linguistic skill, such as an “idea.” Accordingly, learning something new “begins with the selection of ideas from everyday experience” (Roschelle, 1995, p. 41). Yet, some aspects of Clara's episode seem to be left unexplained by an account that takes “prior knowledge” as the primary ground of the developmental event. There is no clear evidence that Clara is intentionally “selecting” from prior “ideas” what she will end up drawing or how she will come to

recognize it later on. Rather, if anything, the episode suggests that Clara's drawing of a troll's face comes to her as an absolute surprise. She begins to move her hand over the blank sheet at the same time as she wonders aloud about what she should draw. She does not anticipate the outcome of her drawing. Indeed, she could not anticipate it because she did not yet know that she could draw a troll's face by herself. How could she intend what she did not yet know? Rather, Clara was able to do something before knowing (intellectually) that she could do it.

This episode highlights aspects that are unaccounted for by a theory of learning that reifies rational knowledge as the ground of lived-in experience. Instead, the episode suggests that aspects that are more often associated non-intellectual dimensions of life, such as the way we move and come into contact with our immediate material context, as well as the way we become overwhelmed and surprised, may be important for understanding how we come to relate prior and current experience. Even if intellectual aspects are important—obviously Clara needed to have some intellectual competences to think and to talk about faces and trolls—these cannot be thought of as having a determinate form that somehow structures action. If there are ideas—whether social or individual—underlying the event, they do not seem to be at the origin, but rather seem to be part of a larger unfolding process that cannot be reduced to either the initial idea or the final product. Instead, to understand how Clara's prior and current experience relate in the development of this episode, we need to investigate and theorize knowing not as determinate and formal, but as fluid and open-ended, extending in time, and as connected to actual engagement with others and with materials. This is precisely the way in which Dewey, as did Vygotsky, conceived of experience. Most importantly, and as we shall see in the following sections, their transactional conceptualization of

experience may offer transfer research analytical tools to disclose these otherwise unaccounted aspects of living and learning.

A Transactional Theory of Experience

Dewey is often cited in the literature on transfer because of his explicit positioning against grounding schooling on the idea of transfer as the acquisition of decontextualized skills (e.g. Beach, 1999; Engle, 2006; Packer, 2001). Dewey's ideas about experience have less often been taken up to develop analytical frameworks (cf. Hall, 1996; Clancey, 2011). However, the philosopher's theory had an eminently methodological character. Rather than appealing to "supernatural" forces, which are immaterial and external to an individual's lived-world, Dewey (1938) argued, "the method by which development takes place is something to be determined by a study of what actually occurs" (pp. 23–24).

For Dewey, there is continuity between the organization of actual experience and the constitution of the formal knowledge structures and rational operations that are said to *transfer* in the classical literature. Nonetheless, the philosopher emphasized, "rational operations grow out of organic activities, *without being identical with that from which they emerge*" (p. 19). That is, organic life cannot be accounted for in terms of the formal elements of logic that it leads to. Instead, a theory of how rational operations emerges from experience is needed.

In the following, we discuss how Dewey's theory considers experience to be (a) an analytical category that (b) always is related to a spatial-temporal situation, and (c) which is fundamentally a process of change that involves the whole person—including her attitudes and affects. In so doing, we not only read but also extend Dewey by highlighting points in common with cultural-historical (Vygotsky, 1986)

and phenomenological accounts of continuity as an irreducible dynamic phenomenon (Romano, 2009).

Experience as an analytical category

In most literature about learning and education, the notion of experience tends to be treated as an unproblematic aspect of the phenomena investigated (Roth & Jornet, 2014). In Dewey, however, experience is *an analytical category* that captures a process of living, of situated activity or inquiry. Dewey & Bentley (1999/1949) make this clear when they state that experience is “neither subjective nor objective but ... a *method* or system of organization” (p. 115, emphasis added). Experience is not a thing that individuals “have,” but is, as the quotation says, a *method*, a *system of organization*. Similarly, Vygotsky (1994) considers *perezhivanie*—the Russian equivalent term for *experience*—as one of “a few such units with which psychological research operates” (p. 342). Dewey further related his notion of experience to that of inquiry, which he defined as the situated, instrumental, and operational process of transforming “*an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole*” (p. 104, original emphasis).

Importantly, however, not every aspect of a person’s awareness has the unity that experience as a unit of analysis implies. In *Art as Experience* (Dewey, 1934/2008a), Dewey makes a distinction between the general stream of experience and *an experience*. He defines the latter as that experience which “is a whole and carries with it its own individualizing quality and self-sufficiency” (p. 42). After the fact, *an experience* “has a unity that gives it its name, *that* meal, *that* storm, *that* rupture of friendship” (p. 44). *An experience* is, therefore, that experience that can

subsequently, after it has already reached a determinate conclusion, be named. It is as long as we go through some event that has both temporal extension and a *determinate* terminus that we can jointly refer to it as *something* distinct from the flow of otherwise inchoate experience.

Irreducibility of situation and experience

Dewey's philosophy of experience involves a rejection of Cartesian dualism and an elaboration of how organism and environment are intrinsically related as a unit of life. Central to such an elaboration is his notion of *situation*:

“What is designated by the word ‘situation’ is *not* a single object or event or set of objects and events. For we never experience nor form judgments about objects and events in isolation, but only in connection with a contextual whole” (p. 66).

A situation, therefore, is a contextual whole. It is only as part of such a contextual whole that any individual *experience* unfolds. As Dewey and Bentley (1999/1949) clearly remark,

“the word ‘experience’ should be dropped entirely from discussion unless held strictly to a single definite use: that, namely, of calling attention to the fact that *Existence* has organism and environment as its aspects, and cannot be identified with either as an independent isolate” (p. 193).

Situation and experience, therefore, form an irreducible unity of organism and environment. In this regard, Dewey's ideas are analogous to those sketched by Vygotsky (1994) about *perezhivanie* [experience], which the Russian psychologist considers as “a unity of environmental and personal features” (p. 343). Accordingly,

this unity extends both in time and in space Experience extends in space in the sense that it is not seen as internal to the individual; it “does not go on simply inside a person” (Dewey, 1938/1997, p. 39). There is an active side to every experience that changes the objective conditions in which further experiences take place and are had. Experience therefore involves both an internal side that goes on within the person, and an external one that belongs to ongoing practical, always-societal activity¹ (Vygotskij, 1935/2001). It therefore involves a *transaction*: An experience “is always what it is because of a transaction taking place between an individual and what, at the time, constitutes his environment” (Dewey, 1938/2008b, p. 25). Because experience extends along and in transaction with concrete situations, *experience* not only is distributed across tools and participants, but also *includes the temporal unfolding of action, and, therefore, needs to be seen as encompassing change*.

Experience is a Unit of Affect and Change

As a temporally extending unit, experience is not a thing that is had but, a “moving force” (Dewey, 1938/2008b, p. 21). This aspect, which Dewey took to be a fundamental principle, requires conceptualizing experience in terms of something that moves from itself to itself. This is precisely the dialectical articulation of a *force* that forms a non-self-identical unit (Hegel, 1807/1979). It is non-self-identical, because it encapsulates the difference *with* (rather than *from*) *itself* within the person-in-setting over time (Derrida, 1996). The person-in-setting, therefore, cannot be conceptualized in terms of identity, of things that repeat themselves, but needs to be thought in terms

¹ Throughout the paper, we use the modifier “societal ” used by Leont’ev (1983a) to refer to the theory he was developing together with Vygotsky . The adjective highlights the fact that social events do not only involve a single time-scale (the relation here-and-now between two or more participants), but form part of larger courses of activity (such as *doing* school science lessons), which in turn are aspects of society at large. Psychological functions and personality are the result of *societal* relations [obščestvennix otnošenij] (Leont’ev, 1983b; Vygotskij, 2005).

of change and transformation. Experience, as a moving force, involves a transaction by means of which the learner is *affected and thereby transformed*.

Within its temporal extension, going through *an* experience always involves a “doing” and an “undergoing” (Dewey, 1934/2008a). Accordingly, the learner cannot be considered only as being either intentional or unintentional; it is both, and both intention and receptivity are aspects or, more precisely, *moments* of a larger movement towards the coherence and unity that characterizes intelligible experiences. That is, in the unfolding of experience, the learner is as much agent as she subjected to the unfolding situation. This means that not just intentional agency, but also receptivity, is a crucial feature of experience. Thus, “the undergoing phase ... is receptive. It involves surrender” (Dewey, 1934/2008a, p. 59). Accordingly, the learner cannot be thought of only in terms of intellectual intentions or selves, but also in terms of affect and reception. At the end of an experience, there is not only change of ideas, knowledge, or skills, but also attitudes, dispositions, and orientations have changed (Dewey, 1938/1997).

Experience involves an element of “suffering in its large sense” (p. 47). In experience, learners undergo a process of *transformation*, the end of which they cannot foresee while experience is still in the making. Experiencing, therefore, is like going through an *adventure* that cannot be reduced to the intellectual but must also involve the affective. In the process of becoming, “the old self is put off and the new self is only forming, and the form it finally takes will depend upon the *unforeseeable* result of an *adventure*” (Dewey, 1929, p. 246, emphasis added). In the midst of experience, it is impossible to know precisely how things will turn out, and therefore escapes causal explanation (Roth, 2013a). It is only after it has come to an end, that an experience can be named, accounted for, and explained.

To account for such transformation, we cannot therefore take any two single instants of time as fixed referents in the course of development of an individual (Vygotsky, 1986), but must look at the process of becoming, the process by which the self *advenes* to herself (Romano, 2009). In this regard, the verb “to advene” has been proposed in philosophical discussions to account for the process of *becoming* as process *sui generis*, that is, without falling back into objectifying or transcendental formulations that describe two states as being formally related but without describing the process of transition from the one to the other. Accordingly, transfer episodes should be articulated in terms of processes of transformation, where both individuals and settings are changing. The minimum unit of transformation has to be transformation, a category of change.

Experience and Temporality in Transfer Literature: Self-action, Inter-action, and Transaction

The question of transfer has motivated research for over a century in the course of which different conceptualizations of the relation between learners and their environments have been proposed (Cox, 1997). Though rarely elaborated, these different conceptualizations entail more or less tacit views of *experience* and, consequently, of the question of whether and in what sense learners’ experience can be empirically approached as a *continuous* phenomenon. In particular, different theoretical frameworks imply diverse accounts of temporality as it relates to how people learn and develop across situations (Ludvigsen et al., 2011).

Dewey’s and Vygotsky’s transactional ideas about experience challenge classical assumptions that explain transfer episodes in terms of knowledge structures that are carried over across situations. Whereas their ideas align better with more

recent ecological (situative, socio-cultural) approaches, they also go beyond by articulating aspects of change and receptivity that have not yet been addressed in the literature. To better understand how, in this section we review and contrast the different kinds of unit of analysis that have been developed in the literature to address relations between prior and current experience, and elaborate We focus on unit of analysis rather than on theoretical principles—which very often are shared by many different studies—because, independently of theory, units of analysis determine how a phenomenon of interest is conceptualized and how it is made empirically available (Säljö, 2009).

To do so, we come back to Clara’s exemplary episode and re-visit it from the different perspectives. As described in Roth and Jornet (2013), we follow Dewey and Bentley (1949/1999) and distinguish three main models of unit of analysis: *self-actional*, *inter-actional*, and *transactional*. Self-actional models—largely adopted by classical cognitivist theories—explain continuity in terms of individual knowledge structures that are repeated across situations. In these models, context, and time, remain external to the unit of analysis. Both inter-actional and transactional models, on the other hand, propose *ecological* alternatives to the self-actional approach in that both take the unity of individual subjects and their social environments as the minimal phenomenon of interest. However, while inter-actional models attempt to articulate causal interconnections between subjects and environments, transactional models explicitly include time as an inherent aspect of their analytical units. Transactional models thus “deal with aspects and phases of action, without final attribution to ‘elements’ or other presumptively detachable ‘entities,’ ‘essences,’ or ‘realities,’ and without isolation of presumptively detachable ‘relations’ from such detachable ‘elements’” (Dewey & Bentley, 1949/1999, p. 133).

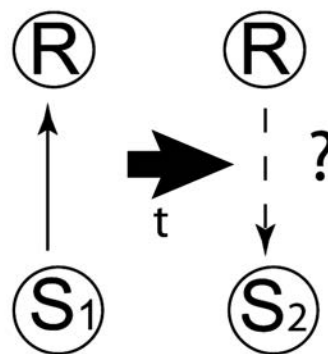
Self-Actional Models: The Mainstream Cognitive Perspective

Dewey and Bentley describe the self-actional mode of thinking as one that takes “independent ‘actors,’ ‘souls,’ ‘minds,’ ‘selves,’ ... as activating events” (p. 122). From this view, individuals are seen as intentional agents whose agency is independent from their surrounding social and material environment. In self-acting accounts, “things are viewed as acting under their own powers” (p. 132). Such an approach is best represented by the mainstream cognitive approaches (Reed, 2012), where peoples’ *experience* is accounted for in terms of *knowledge structures* that are “encoded” *from* experience (e.g. Anderson & Lebiere, 1998; Chi & VanLehn, 1991). Two situations or “problems” are related by means of structural alignments or *mappings* between mental representations of such problems or situations (e.g. Chi & VanLehn, 2012; Reed, Ernst, & Banerji, 1974). Continuity is a function of the level of abstraction in which knowledge structures are “encoded,” where precisely those structures that are more general are those that are less bound to the specifics of the initial experiences in which they emerged (Gentner, Loewenstein & Thompson, 2003; Gick & Holyoak, 1983).

The mainstream cognitive approach constitutes a self-actional model in that a learner’s actions and experience are accounted for by subjacent cognitive structures or representations that always *already* need to be in place for the given experience or action to happen for the learner: situated action always is the result of prior explicit symbolic representation (Vera & Simon, 1993). With regard to the episode, a self-actional approach accounts for Clara’s episode in terms of knowledge structures or representations. Clara was already learning to draw geometrical forms and had seen faces and trolls before, so she had knowledge representations of these aspects of the

world. There are structural similarities among these representations: they all share circular-like, elliptical shapes. It is by abstracting and applying this common structure that Clara comes to recognize her drawing as an instance of a troll's face. This structural mapping results in *inference projections* (Gentner & Markman, 1997) that lead to the formation of new knowledge structures: Clara has now acquired the knowledge representation necessary for drawing not only troll faces, but also faces in general.

The resulting unit of analysis may be illustrated in diagrammatic form as in Figure 2 (Roth & Jornet, 2013). In a situation (S_1), the person “extracts” some representation R from experience. In a later “structurally identical” situation (S_2), this representation R , may (or may not, as the interrogation mark points out) be applied.



The model offers an appealing account in that it relies on descriptions of structural aspects of the world that common sense tells us are important to our competence of enacting relevant skills across similar situations. However, the self-actional model involves an intellectualist stance in which bodily and situational aspects are either unaddressed or taken to be peripheral to the core phenomenon, which goes on inside the learner's head. It assumes a division of labor between body, whose acts are the result of prior knowledge structures, and the intellect, which

processes the information that results from moving our body in terms of formal descriptions. This division of labor implies also a particular view on the temporality of experience: at each step there must be a formal description of the ongoing situation. Experience is not continuous, but is atomistic, composed by descriptions of discrete forms and states. In this model, time, as theorized by Kant (1787/1956), is always external to and *condition of* experience: the learner is always accounted for as if she already has a representation of what has happened to her.

However, as we discussed above, there is no clear evidence that Clara's actions are the result of prior explicit representation of either ellipses or of faces. At least no more than reasons to assume that the recognition of a connection between her drawing and the possibility of drawing faces comes to her as an absolute surprise. Rather than the applying of some form of which Clara already had a representation, is one of *form-generating* (Ingold, 2013). It involves many transitional moments that seem important in the mapping between the initial drawing and the possibility of drawing faces in general. Rather than applying existing knowledge in a new situation, she found herself knowing to do something after having done it for a first time.

Ecological Perspectives: Interactional and Transactional models

Problems and limitations of the cognitivist view have been the focus of extensive discussions during the last decades (e.g. Beach, 1999; Cox, 1997; Lobato, 2006; Tuomi-Gröhn & Engeström, 2003). A central argument has been that it implies a decontextualized and normative stance towards human activity, a view where “the only ‘good’ experience [is] distanced and generalized, removed from the debilitating influence of immediate time and place” (Lave, 1988, p. 182).

To address these limitations, a growing number of studies have developed what we refer to as *ecological* units of analysis, where a categorical division between individuals' intellect and their material contexts is no longer held. In groundbreaking work, Greeno, Smith & Moore (1993) explain transfer episodes in terms of learners' attunements to *invariant* affordances across situations. Here, the notion of affordance refers to actions that the context offers up to the individual (e.g., like a door knob affords turning, and a door handle affords pushing down). Prior and current situations are connected when invariant sets of affordances are perceived across them (e.g., a door knob, a knob on a thermostat, and an oven temperature knob all afford turning). Engle (2006) further addressed the question of how the social environment is inherently involved in transfer episodes. She developed the notion of *framing interactions* to account for the observation that what students bring to bear as relevant across (school) situations is not only dependent upon the "content's structure," but also, and more importantly, upon the ways in which situations are socially framed as relevant contexts for the use of such content. Similarly, built upon Lobato's (2003) *actor-oriented* framework, a *focusing framework* has been proposed as a "complex systems" approach for the analysis of how individuals' noticing of relevant features across situations is shaped by discursive practices (Lobato, Rhodehamel, & Hohensee, 2012).

In ecological approaches, the appropriate unit for understanding cognition is not the individual, but the mutual constitution of individual and environment. However, among ecological approaches, it is possible to distinguish between inter-actional and trans-actional models. Irrespective of their common theoretical premises, and as we shall see, the difference lies in the extent to which *time*—considered external in the self-actional account—is included as internal to the unit of analysis.

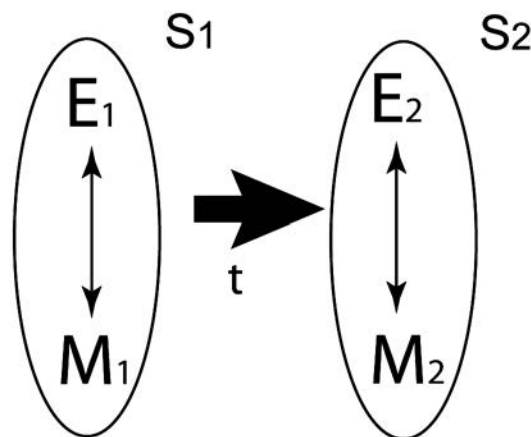
Inter-action. With the emergence of ecological approaches, the notion of (social) *interaction* has gained much attention in the transfer literature and is routinely used to mark an interest on situated practices rather than on individual private minds. Yet, for Dewey and Bentley (1949/1999), the notion—particularly when they presented it hyphenated—was problematic because, in most uses, it still did not “stress system” emphatically enough (p. 133). They saw examples of problematic uses in the following cases:

“when selves are said to inter-act with each other or with environmental objects; when small portions of organisms are said to inter-at with environmental objects as in the traditional theories of sensation; when minds and portions of matter in separate realms are brought by the epistemologies into pseudo-interactional forms; or probably worst of all, when a word’s meaning is severed from the word’s actual presence in man’s behavior, like a sort of word-soul from a word-body” (p. 133).

Proponents of the ecological approach often acknowledge that the phenomenon under study is inherently dynamic and that neither subjects nor environments can be considered as being static or constant. Yet, the analytical focus often traces the person-in-setting at different points in time, whereas the process of transition itself is not problematized, thus remaining at the inter-actional level described by Dewey and Bentley. Thus, for example, whereas Lave (1988) does account for the situated nature of mathematical actions of the same persons in the supermarket, in front of the supermarket, and during paper-and-pencil tests, but she does not provide an explanation of how the different performances are related to or inform each other. More recent studies account for how social contexts are organized so as to facilitate that participants draw particular conceptual connections across situations. They show that certain ways of attending to mathematical graphs or of

elaborating causal explanations across situations are associated to certain ways of organizing the classroom interactions—e.g., through framing (Engle, 2006) or focusing interactions (Lobato et al., 2012). But the analyses themselves do not address transformation and movement of the kind the notion of transaction is about.

Returning to the episode, it is not that Clara projects a prior explicit representation into another representation of the current situation. Instead, she will discover after the fact that her immediately preceding embodied actions share aspects with earlier experiences related to forms such as faces. We may say that what has transferred is not abstract knowledge, but a particular individual-environment configuration. In diagrammatic form, an experience (E_1) manifests itself in a particular way (M_1 , see Figure 3). The whole constitutes a situation (S_1). In another situation, we find a different but structurally analog person-in-setting configuration and, therefore, a different experience E_2 and manifestation M_2 . The unit of analysis assumes the mutual constitution of experience and manifestations thereof, where experience is not an abstraction, but an integral aspect of the person-in-setting unit.



However, this unit of analysis—of which there is a structurally equivalent diagram in Greeno et al. (1993)—does not include the unfolding of time as an internal aspect. Thus, studies applying this type of unit do not account for how subjects and contexts mutually constitute each other in the moment-to-moment of lived-in action.

We do not therefore know how E_1 and E_2 in Figure 2 are connected but by reference to social structures or organizations that are shown, after-the-fact, to have influenced experience. What is missing in the inter-actional unit of analysis is the internal movement that, in the transactional theory outlined above, provides learning experiences with unity in and across occasions.

Failure to consider this temporal aspect may have important consequences (Rogoff, 1995). For one thing, in characterizing what fundamentally is a temporally unfolding phenomenon in terms of a discrete system of elements and their relations (e.g. “knowledge about” experience), a gap is created between every synchronic instance of experience that theory must somehow close. As a result, “the links between these separate time segments are bridged in mysterious ways to bring information or skills stored at one point in time to use in another” (p. 155).

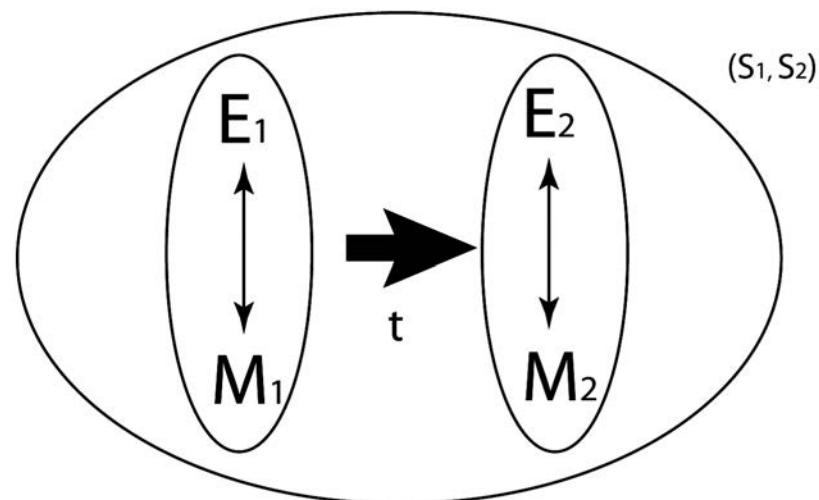
Transaction. A transactional unit of analysis derives from the theory of experience described above, where individuals and settings are seen as continuously moving and changing in mutually constitutive relation. In addition to considering the unity of subjects and settings, it includes time as an internal aspect. Some contributions from ecologically oriented studies, particularly those taking cultural-historical stance, do indeed include change and development (i.e. time) as an internal aspect to their unit of analysis. A case in point is Beach’s (1999) consequential transitions framework, where “continuity and transformation in learning” are accounted for as “an ongoing relation between changing individuals and changing social contexts” (p. 103). Yet, Beach’s and other similar frameworks (e.g., Konkola et al., 2007) look at transitions across contexts and developmental stages, but do not discuss development at the more basic micro-genetic, moment-by-moment level of analysis. Hence, whereas such studies provide accounts of mutually transforming

relations between subjects and environments, an account of *experience* alternative to the classical self-actional notion is still missing. There is a re-conceptualization of transfer without a reconceptualization of the individual selves and how they come to form part of the larger transition. Thus, it has been argued, a challenge for the emerging ecological models is to address how the person also *changes* in the person-in-setting dialectical relation (Packer, 2001; Stetsenko & Arievidt, 2004).

Another transactional account can be found in Nemirovsky (2011), who accounts for a transfer episode in terms of embodied *episodic feelings*—feelings that entail “living discrete kinds of time constitutions from within which a subjective sense of before/after emerges” (p. 311). Accordingly, “feelings” involve “living bodies in the act of *constituting time*” (p. 314, emphasis added). Time becomes an inherent aspect of lived-in experience that not only focuses on intellectual or rational dimensions of knowledge, but which unites “cognition, emotion, and bodily experience” (p. 335). Nemirovsky explores the intricate ways in which affect, body, and mind are tightly wound up in the fabric of experience. As a result, transfer episodes are not described from a normative or intellectualist approach, but are revealed to involve a spontaneous and involuntary “arousal.” However, Nemirovsky’s study leaves unaddressed the question of how this view of the learner as receptively involved in her bodily experience further unfolds as a moment of the larger social organization. Its notion of experience spreads across time but remains within the individual subject.

With regard to our exemplary episode, a transactional approach, which addresses experience as a moving force, aims to account for Clara’s transition from her initial trace on the paper to her achievement of drawing a face as a unitary, continuous event. Clara’s prior uncertainty about what she is doing and her

subsequent pursuit towards drawing a specific form (a troll’s face) must be accounted for as a unitary but fluid phenomenon in which both individual and environment *are changing*. There is no “Clara” as a stable and identifiable subject of activity; instead, there is a line of flight (Ingold, 2011) to which the name is pinned. And this line is to be seen as entangled with the other lines that her father’s actions and the way materials co-respond to their actions form. There is not just Clara’s intellectual and formal idea of a troll, but also an affective relation that is in formation. Doing and undergoing come to form part of a unitary transactional phenomenon. What other models capture in terms of before and after is here *internal* to the analytic unit, which, as a consequence, embodies an inner contradiction because its parts continuously change. The resulting unit of flow captures continuity as an irreducible phenomenon (Figure 4).



Coda to the Theoretical Part

The transactional view articulated here differs in important ways from the cognitivist approaches, and, although building upon extant ecological approaches, it also expands them. According to the transactional view, the problem of continuity is to explain how present experience *changes* in the course of ongoing activity despite the fact that, and precisely because experience always *already embodies a particular*

history of development (Rogoff, 1995). Therefore, we should consider “students’ struggle to reconcile old knowledge with new phenomena” (Carraher & Schliemann, 2002, p. 20) as a process in which students are *becoming*, “advening” to themselves in the course of changing situations that, despite of, and precisely because of this change, can be regarded as connected with a particular history of activity. This involves that the constitution of continuity cannot be attributed to individual minds, but to whole fields of action, of which the acting human body and its emotions are fundamental aspects. Rather than the result of an individual or social construction, we must analyze learning as the result of an emergent “constitutive order” (Lave, 1988) that exceeds any individual intention (Roth, 2011).

In the exemplary case, Clara is not a learner because she decides to learn something, but because she discovers herself as having learned something after her situated actions. Clara has not mobilized previously constructed representations in a new context but has discovered relations between familiar forms and forms that have resulted from her present doings. Her new competencies are not the result of a prior (learning) intention but have occurred to her, a fact that she recognizes after the fact, and which only once it has run its course become a namable event, *an* experience. In this instance, what was happening to Clara has become for us (authors) the “troll episode,” where the mere mention of the name suffices to invoke all its aspects discussed here. But in its real-time unfolding, Clara, as well as any aspect in her experience, was not like a self-contained essence that moved from point to point without transformation. She was what Ingold (2011) refers to as a “line of flight,” a becoming into that both is and is not yet. In that situation, Clara’s drawing *was* rather than produced change and learning, and involved not just her thinking, but she as a whole person.

PART II: THE EMPIRICAL CASE

In Part I of this article, we build upon Dewey's notions of experience to elaborate on a transactional unit of analysis that aims to capture learners and settings in their mutual becoming. In Part II of the article, we further elaborate on the frameworks' methodological import for transfer research by analyzing an episode of transfer from a technology-enhanced science education curriculum in which students are presented with "analogous" models of scientific phenomena across different tasks. We begin by describing the empirical setting. We detail how we selected the particular episode, which we categorize as *an* experience, and present a brief digest of it, which allow us to draw from the actual materials to illustrate analytical techniques involved in the subsequent section. Under the heading *Capturing Unfolding Experience Through Micro-Genetic Analyses of Talk-in-Transaction*, our purpose is to demonstrate, through an exemplary analysis of actual empirical materials, how interaction analysis techniques constitute a praxis structurally equivalent to the transactional unit of analysis (Figure 4).

The actual analyses are presented in, *A Transactional Account of a Transfer Episode in a Science Classroom*, where we explore how applying a transactional framework leads to new insights about transfer. Through the analyses, we elaborate on how a transactional approach provides alternative accounts of three cognitive processes important in the literature on transfer, namely *recognition*, *analogical reasoning*, and *applying theoretical knowledge*. In a concluding section, we discuss how a transactional framework overcomes remaining dualisms associated to the exclusion of temporality from the unit of analysis. We also discuss specific

educational implications that emphasize the centrality of receptive and affective (rather than just the intentional and intellectual) aspects of learning.

Setting, Participants, and Data Selection

Research Setting

Data for this study was collected as part of a larger project (MIRACLE) that designs and investigates technology-rich science learning environments for bridging learning experiences across tasks in different contexts (Jahreie et al., 2011). The project employs the method of design experiments (Krange & Ludvigsen, 2009), and implements an inquiry-based instructional approach in which tasks where students jointly explore and examine energy phenomena under minimal instructional guidance are combined with teacher-led plenary lectures and discussions where exploration tasks are summarized and reflected upon. Across the tasks, the students are presented with multiple instantiations of similar scientific phenomena in the form of textual and graphical inscriptions, video-recorded explanations, material manifestations, and interactive digital visualizations of phenomena. The project is thus particularly well-suited for exploring whether and how students build coherence and continuity across tasks.

A class of 24 students from a public, combined lower/upper secondary school in Oslo (Norway) participated in the study. The 16–17-year-old students attended the first year of upper secondary education. The curriculum was part of the regular science course during a unit on “energy for the future.” The 20-hour unit was implemented in 7 days spread over a four-week period. The diverse tasks and settings for the unit are described in Table 1. Sessions where the teacher offers lectures or

leads plenary discussions were combined with tasks where students solve problems in groups. There were hands-on tasks, visits to a science center, problem solving with a set of digital simulations, and the development and presentation of a power-point presentation. Students worked in six groups of four. The teacher assembled student groups following two criteria: gender and achievement balance (high, moderate, and low achievers). Students used hand-held devices and laptops to capture pictures and videos of their tasks, as well as for formulating their ideas and answers to tasks by producing text.

[INSERT TABLE 1 ABOUT HERE]

Data and Analyses

Up to four high-definition digital video cameras were used to record the tasks along the entire unit, varying the number of cameras depending on the kind of task. Two focal groups were selected for closer follow-up study during group tasks. For all participants in these two groups, pre- and post-interviews were conducted. Otherwise, video-recordings were taken of the whole classroom setting, focusing on teacher and student relations during plenary sessions. Recordings resulted in a total of 37 hours of videotape. Pictures were taken of the different settings, artifacts, and inscriptions that students and teacher produced (such as notes on whiteboards or drawings in notebooks). Digital products that the students delivered were collected along with other deliverables, such as handmade diagrams and handwritten documents that were produced during the tasks.

The analysis of the videos was conducted in different phases. In general, we followed the principles of interaction analysis (Jordan & Henderson, 1995), which included approaching the recordings without preconceived coding schemes to better

understand orderliness the participants were generating and building upon in their relations. The analytical process involved several rounds of visioning the data material, and of refined identification of relevant episodes. In the process, we arranged collective data session where members of our immediate research community were invited to participate. Dedicated software was used for facilitating detailed transcription of prosody, lapses, and gestures of selected episodes. We use Jeffersonian transcription conventions, as detailed in the appendix. The transcripts included here are translated from Norwegian.

Selection of the Transfer Episode and Brief Digest

Central to this study is the selection of a particular episode of transfer, in which formal aspects of prior experience were made relevant to make sense of ongoing tasks. However, we do not presume that the occurrence of the episode rests upon the existence of mental knowledge structures that individuals transfer from one situation into another. Instead, our aim is to examine how the episode, as a phenomenon that extends in time, achieves its integrity through concrete performances and transactions. This does not only involve highlighting the socially situated and distributed nature of the episode—as extant ecological studies do—but also describing how individual subjects and their societal and material environments are themselves in a process of becoming.

Preliminary analyses of the recordings revealed an instance in which one of the participants (Andreas), spontaneously identified (a) a dynamic figure in a digital model depicting the inner workings of a heat pump (Table 1, Task 5b) as connected to (b) a scientific principle about pressure, temperature, and boiling point of a liquid (saturation temperature) that was elaborated during a previous teacher-led plenary

session (Task 3, Table 1), and (c) a previous task where the students had experimented with a syringe filled with lukewarm water and been challenged to make interpretations of their observations manipulating the level of pressure inside the syringe (illustrating the relation between low pressure and low boiling point) (Task 2b, Table 1). The episode, taped on Day 5 in the curricular trajectory (Task 5b, Table 1), stood out in our analyses because it offered a typical instance of transfer, where a common aspect of knowledge, in this case a scientific principle, was identified as underlying two different problems or situations.

The situation was salient to Andreas himself, who in a post-test interview marked it as an “aha” or “eureka experience.” In that interview, asked about whether he had realized of possible existing conceptual connections across the different tasks, the student spontaneously referred to the episode, where he “saw like all the relationships, in a way. In the room [referring to digital model 3 (Figure 5)] there was low temperature in the water and it was the same as in the syringe, and it boiled too” (Andreas, post-test interview). These preliminary findings, together with Andreas’ performance record—which the teacher evaluated as “outstanding”—and with observations of the inquiry tasks and post-test interviews with the remaining participants of the group, allowed us to trace how a scientific principle had been used in different instances across the group’s participation trajectory.

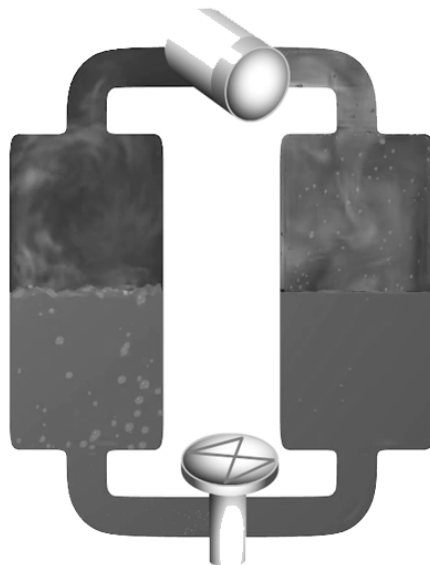
The selected episode can be categorized both as an episode of transfer, and as constituting *an* experience—one that, after it had run its course, could then be pointed in the interview as *that* particular experience in which Andreas claimed to have seen “like all the relations.” However, and as the analyses below show, the episode is not one in which a student sees a simulation and immediately transfers his knowledge and recognizes all the connections—between the scientific principle or

“boiling point law,” the simulation, and the prior experiment with a syringe—at once. Rather, between the first moment in which Andreas claims to have recognized the connection, and until the moment in which the students formally elaborate on just how the three aspects are connected, there go over 60 turns of conversation. During that time, there is evidence of Andreas and his peers not knowing whether there actually is a connection, or how to articulate it in a way that formal structures may be mapped across. As we elaborate in the analyses below, the episode raises questions about the intellectual and formal nature of the episode. It also shows how the episode does not consist of immediate mental processes, but movement between a first recognition and a full account of the connections involves not just an individual, but the whole group and the immediate material environment change.



During the episode, the four students in the focus group—Andreas, Andy, Isaac and Rachel—are sitting around a computer in which an application makes it possible to engage with 3 different digital models of a heat pump (Figure 5). The

application is accessed through the project’s online platform, which in turn makes it possible for the students to access other resources, including stored digital annotations that they have produced along the curricular trajectory. As the episode begins, the students have just started to look at the different digital animations and Isaac, who controls the touch-pad of the laptop, is switching between them rather quickly. During the sequence, Animation 3 (Figure 6)—an animation intended to illustrate the inner workings of a heat pump—features prominently. Prior to the episode, the students have just read aloud part of the task’s formulation: “in Animations 2 and 3, you will learn more about heat pumps. Explore the animations to find out how a heat pump works.” In the case of Animation 3, a semi-transparent window that displays “pressure,” “temperature,” and “phase state” appears at each position as the students move the mouse pointer over the left and right chambers.



Capturing Unfolding Experience Through Micro-Genetic trans-action

Analysis

A transactional framework involves considering how intelligible, coherent *experiences* unfold and achieve their unity in and through situated action from the perspective of the participants, who are themselves implicated in the experience. In this section, we discuss and illustrate how a turn-taking interaction-analysis framework (Jordan & Henderson, 1995), itself informed by ethnomethodology (Garfinkel, 1967) and conversation analysis (e.g. Schegloff, 2007), offers a valid approach to get an empirical grasp of transactional phenomena.

Interaction analysis—which in this paper would be most properly labeled as *trans-action* analysis—focuses on how the participants organize their joint actions and talk with each other as they are addressing practical concerns. People’s joint organization of action and materials is what Dewey referred to as *inquiry*, and may be seen as the social “constitutive order” that Lave (1988) pointed out as fundamental to understand transfer from an ecological perspective. To find out how inquiry moves forward and transforms people and environments, we do not therefore need to look inside people’s minds. As Dewey reminds us, experience spreads across space and time. Accordingly, instead of accounting for situated action in terms of individual intentions, ideas, or meanings—which would constitute a self-actional explanation—we need to look at *consequences* of actual action, which both transform the persons who experience them and the objective conditions of their further experiences.

Two-parts units and trans-action: a reading forward analytical procedure.

A distinctive feature of interaction analysis is the practice of taking two-part units (Schegloff, 2007) as the minimal unit of analysis. Two-part units are sequences

of conversation that include at least two turns, and which accomplish a particular social action. Examples of such actions include a telling, an agreeing, or an invitation. These actions, in turn, may come to form part of larger social actions (e.g., a telling as part of a solving-a-classroom-task). What is fundamental is that the two or more turns that constitute the minimal social action are *an irreducible unit*, and that their meaning and function can only be given with regard to the larger unfolding of activity within which they take place

An analytical implication is that it makes no sense to talk about one turn of conversation in the two-parts unit as having an intention, idea, or meaning in itself. Whatever the turn is doing is not determined by the turn in itself (self-action), but by its relation to the whole *social* action that is being accomplished, always by more than one individual (e.g. in telling there need to be a teller and a listener; in agreeing, there need to be two parts to agree). This is the principle of next-turn-proof-procedure (Sacks, Schegloff, Jefferson, 1974, p. 729), by means of which analysts focus on how a next-turn displays how the prior turn becomes relevant and consequential for the unfolding episode of transaction.

Just as a transactional unit of analysis requires, a two-parts unit always extends beyond the individual and, most importantly, it includes time as part of the minimal unit of signification. Indeed, although instances of overlapping talk are often allowed and may even be normative in some practices (e.g. liturgy), conversation, by its very definition, implies a temporal unfolding sequence where people take turns. Accordingly, *analysis does not proceed backwards*, identifying the social action as a whole and then set the gloss of the social action to explain the actual sequence of conversation, as if the final outcome was a cause determining each individual turn. Instead the analyst must *read the episode forward*, questioning how each turn relates

to the sequence of turns as it unfolds. This involves taking the first-time through perspective of the learner whom, just as Clara in the exemplary case, cannot know in advance what her experience will turn her into prior to its completion. The (time-unfolding) experience of, let us say, “coming to draw a face for the first time,” cannot be accounted for by its final outcome: the drawn face, or a representation thereof.

To better understand how interaction analysis procedures constitute a transactional form of analysis, consider the following fragment, which is taken from the selected transfer episode that we digest above, and which we analyze further in a subsequent section:

- 01 Andreas: look here. >look.< it’s the boiling point law thing.
- 02 Isaac: oh ye::a:::
- 03 Andreas: here the temperature starts to be higher...

The three turns together, as moments of a single social action, may be glossed as accomplishing [recognizing a simulation as the boiling point law]. Turn 1 is showing where to look and articulates what is to be seen, whereas turn two may be heard as displaying that whatever is to be seen is acknowledged. Each turn is designed to be heard by someone else, and therefore would make sense without each other’s presence in the sequence. Indeed, without the context that each turn provides to each other, it is rather difficult to say what each turn is doing. This mutually constitutive relation between turns and the larger social event or *situation* that they are in the midst of becomes more evident if we move further in the sequence and include the turns that actually followed:

- 04 Rachel: okay. can someone explain that figure to me.
- 05 Isaac: Andreas. you explain it. I didn’t get it.

Whereas up to this point turns 01 to 03 may be thought as constituting a demonstration/acceptance pair, as time and action unfold, their significance for the ongoing transaction is transformed. Instead of a reification of acknowledging what there is to be seen, in turn 04 we find a request for an explanation. Most importantly, we also find a deferral by part of Isaac, who, without this context, and reading only turn 02, we might have taken as “meaning” that he had “got” what Andreas was showing in turn 01 and which he now states not having “got it” (turn 05). The social situation is now transformed into one where *recognition*—as we shall elaborate in more detail in the analyses below—is no longer granted. What is it that turns 01 to 03 mean is yet not known, because their significance is constituted by the unfolding situation, which both is shaped and shapes the relevance of each turn.

As the analyses above show, a turn-taking analytical procedure that takes a two-parts minimal unit and considers the sequential nesting of social actions, as developed in interaction and conversation analysis, offers a means to achieve a transactional account of empirical materials collected through video. When performed without ascribing intentions or meanings to individual actions, this form of analysis allows an empirical hold on the question of how subjects and environments mutually transform each other in the unfolding of (transfer) experiences. This procedure differs from other existing analyses in that it treats transfer episodes as time extending phenomena that have coherence and exhibit an endogenous form of organization. By taking the episode as a unitary phenomenon of experience, reading it forward from the first-time through perspective of those implicated in its unfolding, a trans-actional analysis provides an alternative account to transfer that does not consider prior knowledge as the most fundamental source of action.

A Transactional Account of a Transfer Episode in a Science Classroom

Throughout the prior sections of this article, we lay down a transactional analytical framework, both in theory (Part I), and in praxis (as elaborated in the previous section). In this section we draw from fragments of the entire episode in order to provide a transactional account of cognitive processes considered to underlie transfer.

As advanced above, the episode analyzed may be considered as the unfolding of *a* transfer experience. Between the first moment in which the connection between “boiling point law,” simulation, and prior experiment is suggested, and the final moment in which such a connection is grounded and established as fact, there is inquiry in the course of which both setting and participants become transformed. To examine this process of transformation, we divide the episode into three sections, each corresponding to a cognitive aspect associated with transfer: *recognition* of structure, *analogical reasoning*, and the *application* of theoretical knowledge.

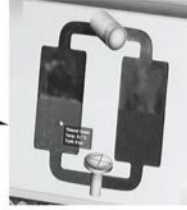
Recognizing the “Boiling Point Law Thing”

The idea that transfer episodes involve the “recognition” of an underlying structure that is common across several situations is central to classical definitions of transfer. This view underlies many learner-centered instructional designs such as the one presented here, which often involve learning materials and tasks that, from the point of view of the designers, bear structural (conceptual) correspondences.

However, whether and the sense in which students come to recognize any such correspondence is always an empirical matter (Lobato, 2003). As prior research has shown, seeing two aspects as connected is not automatic but involves *structuring work* (Jornet & Roth, 2015; Roth & Bowen, 2001).

In the sequence analyzed here, the students notice an aspect in Animation 3 as bearing correspondence with another, “the boiling point law thing” (see Excerpt 1). Parts of fragment 1 have been analyzed in the prior section, where we show how what initially seems to be a conclusive two-part bearing a recognition/acceptance pair becomes expanded and transformed as time and action unfold. In this section, we further examine how such process of expansion unfolds. Our analyses lead to a re-definition of recognition not as a process of transfer in itself, but as the beginning of an act of perception.

Fragment 1



01 **Andreas:** look here. >look.< it's the boiling point law thing.



02 **Isaac:** [oh ye::a:::]

03 **Andreas:** [here the temperature starts to be higher.



pressure is higher. (1.5) and here, (1.7)
((shifts cursor over to right-side chamber))



the temperature:::goes(.)higher up.

(3.4) ((students stare silent at the screen while the cursor moves up to the top of the right-side chamber))

04 **Rachel:** okay. can someone explain that figure to me,

05 **Isaac:** Andreas. you explain it.

06 (2.4) ((Andreas is shifting to model 1, then back to model 2))

07 **Isaac:** I didn't [get it.

08 **Andreas:** [just look at it. I think it was easy. ((Andreas orients the laptop towards his peers))

09 **Rachel:** okay. >can someone explain it to me?<

10 **Andreas:** what is the law again?

Fragment 1 begins as Andreas moves the cursor over the figure in the screen, where information about pressure and temperature is being displayed. Andreas invites his peers to “look here,” and offers a description of the simulation as “the

boiling point law thing.” First apparently taken up with an acceptance token (turn 02), the intelligibility of the description offered becomes challenged by Rachel, who asks whether “someone” can explain “that figure” to her (turn 04). Here, in the place of a possible acceptance to Andreas’ offer, there is a query for an explanation. The two-part unit is thereby expanded, not yet closed, and none of the participants know at this part how the situation will unfold and whether agreement will be reached so that simulation and law emerge as a recognizable feature of their task.

The request for an explanation is reified in the next turn, where Isaac defers an answer to Andreas because he “didn’t get it.” In this way, turn 02, where there was an acknowledgement token, does not become a conclusive turn whereby a recognition of *something* is reached as an aspect of the social transaction. Rather, Isaac’s acknowledgement token becomes a *continuer*, which embodies “the understanding that extended talk by another is going on by declining to produce a fuller turn in that position” (Schegloff, 1982, p. 81). There is, therefore, no evidence of a substantive understanding of either simulation or of “boiling point law” so far.

Addressing the requests for explanation, Andreas then invites the others to “just look at it,” as he slightly moves the laptop towards his peers, and adds the evaluative claim that “it was easy.” Without noticeable delay, Rachel again utters “okay,” but then repeats in an almost exact manner the same question that she had uttered in turn 04. Structurally, Rachel turn is almost the same—it just changes the pronoun “it” for the noun “figure,” is uttered more quickly, and exhibits a more pronounced increase in the pitch towards the end (turn 09). Sequentially, it repeats a request for a repair as if nothing of what had been said or done since had yet addressed her previous request.

In response to Rachel's reiterated request, and instead of providing an explanation, Andreas articulates a question, "what is the law again?" That is, the query concerns the very law that initially was "recognized" in the figure. Whatever there is to be seen is not yet apparent to everyone in the group. Not only that but, if that what is to be seen is the "boiling law thing", that thing is not yet known, at least not in a way that would respond to Andreas' question of "what is the law."

Recognition as the starting point of *an* experience. In our reading forward of the transfer episode, we leave the sequence in the midst of its making in order to reflect about some of the initial implications relevant to transfer literature. A transactional account of fragment 1 raises questions about whether and in which sense the notion of *recognition* can be said to be involved in the episode. Rather than there being structures that the students refer to and connect across, there seems to be the beginning of a *structuring* process.

First, the fragment exhibits the material and dynamic means by which the situation begins to be structured as a particular field of semiotic resources in and for intelligible action (Goodwin, 2000). This field of intelligible action begins with the spatial distribution of the bodies and artifacts that constitute the ongoing situation. Hence, whereas Andreas instructs to "look here," what is there to be looked at is not specified verbally, but is given by bodily aspects: the students' bodies (e.g., hands, gazes) orientating towards the laptop display screen, and the fact that Andreas is at the same time moving the pointer upwards over the left chamber provides the context within which this statement can possibly be intelligible to other participants in the setting. From this perspective, one of the elements articulated in the connection is itself an action that extends in space/time and not just an object or entity that can be

grasped or re-cognized at once. The *what* of what is there to be seen indeed includes all the material aspects of the situation and their movement (i.e. change).

Accordingly, to understand what the talk is about, and consequently what—if any *thing*—is being identified as “the boiling point law thing,” it does not appear helpful to look for a given structure that is to be found standing independently of the students’ action. There are no fixed structures; instead, the action and the referents thereof have a material, multimodal, and spatial-temporal character through and through.

What may be considered the contents of experience, the *objects* that are theorized in the classical model (e.g. Gentner & Markman, 1997) here are functions of the organizing embodied, sequential, social relations that is situationally produced. It is therefore difficult to explain the ongoing situation in terms of *representations* of either the “figure” or the “boiling point law thing” that may be said to precede the identification of the one as an instance of the other. Whereas an initial connection with the “boiling point law thing” has been suggested, neither the formal nor the structural terms in which this connection exists are spelled out in the transaction. In the place of what could have been an explanation, there is a recurrent *presentation* of the figure itself, which turns out *not* to repair a misunderstanding claimed in the relation. There are presentations, but not re-presentation over and above of what is to be explained. There is reference to a “law,” which may indeed be taken as a means to represent the figure. Yet, this reference does not seem to point to a given “prior knowledge.” Rather, it prospectively indexes to further actions, to inquiry in Dewey’s sense; in particular to find out “what is the law again.” In this way, the structures that emerge and are grounded through social relations gradually become accountable phenomena that may later on be taken up and constitute elements of continuity in the situation.

As the sequence unfolds, a relational dimension emerges and unfolds, transforming the participants' position with respect to the larger situation. Thus, whereas at the beginning one particular student may have been said to "know" the connection, at the end of the fragment this same student is the one being held accountable but exhibiting not knowing the law. The participants are both subjects of and are subjected to the relations that they are producing there and then: making the mapping between Animation 3 and the boiling point law *noticeable* becomes a social achievement that cannot be reduced to any one single participant, nor which can be accounted by any one's prior intentions. Knowing and not knowing do not belong to any single individual but depend upon the unfolding of the societal relation: they are cognitive features of the collective. As Andreas notices, he is made accountable for making his noticing visible, that is, *noticeable*. As Rachel keeps on requesting an explanation, she sets the conversational conditions for what needs to be done for making the connection noticeable. Both the knowing subjects and the objects to be known in this situation are in the process of becoming.

Rather than the result of a completely formed thought, the connection between model and law seems to be in a vague nuclear state that still requires development, articulation, and completion in verbal formulation (Vygotskij, 2005). Rather than the end of a cognizing act that has gone privately in someone's head, it is its beginning. This evidence is consistent with Dewey's suggestion that perceiving a situation does not consist in "merely tak[ing] in what is there in finished form" (Dewey, 1934/2008b, p. 58). Instead, "In recognition there is a beginning of an act of perception" (p. 58). When considered an *act*, as Dewey suggests, perceiving the connection between Animation 3 and the boiling point law takes place in and as the *concrete* of the unfolding practical action. as two sides of the same unitary

phenomenon. Recognition is not a self-contained process, but a moment of a larger cognitive phenomenon that encompasses both the perceiving learners and the perceived objects as they mutually change each other.

Emergence of an Inference

Analogies are widely regarded as a cornerstone aspect of human cognition and learning, and are assumed to underlie the occurrence of transfer episodes (e.g. Gentner, 2010). In this regard, a key component is *inference*, the process by which new aspects of a target phenomenon are revealed as the result of aligning correspondences between two analogues, thus “bootstrapping” learners beyond what they already know (Gentner, 2010). Whereas mainstream cognitive approaches situate the occurrence of inferences in mental processes going on inside a learner, ecological models have not yet described inference processes as social phenomena of material and personal transformation. There is at least one study showing how analogical reasoning processes were distributed across several actors in interdisciplinary work teams, showing how analogical reasoning may be a process extending over periods as long as longer weeks of collaborative work (e.g. Hall, Wieckert, & Wright, 2010).

In this section, we provide a transactional account of a fragment in which an inference emerges. In the fragment, a relation of correspondence between the figure and a prior task, the “syringe” task, is identified. In that task (Task 2b, Table 1), the students experimented with a syringe filled with lukewarm water that boiled when the syringe’s plunger was drawn back (i.e., when pressure was reduced). The students filmed the experiment, which was subsequently displayed and discussed in a later teacher-led plenary session (Task 3, Table 1). In the plenary session, the phenomena

observed were explained in terms of three scientific laws relating pressure and temperature.

Following the articulation of the analogy, the students come to notice new aspects of the model, which we regard as an instance of inference. The noticing, however, does not emerge immediately, but is achieved through a particular course of actions. Importantly, the new understandings that emerge involve not just joint actions but also the undergoing of the actual situation as it is transformed through action. Our analyses show how inference (a) is distributed across participants and their environment, (b) is pregnant with receptivity and affectivity, and (c) involves historicity rather than causality.

11 **Isaac:** =in any case, ((positioning cursor over lowest part of the left-side chamber)) if you look down, there, ((pointing with the finger over the screen where the semi-transparent screen displays info)) the temperature is quite low.

12 **Rachel:** aha,=

13 **Isaac:** =it goes up up up up ((moving the cursor upwards on left-side chamber))

14 **Andreas:** it's exactly like the:: syringe.

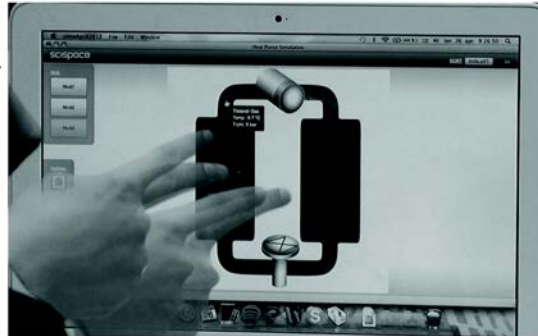
15 **Isaac:** the same as the syringe.

16 **Andreas:** but pressure increases, right?[in this animation.

17 **Isaac:** [pressure increases, (.) yes, it must be something [like that.

18 **Andreas:** [>wait<. look at the pressure here.= ((points with finger on left-side chamber, then on right-side))

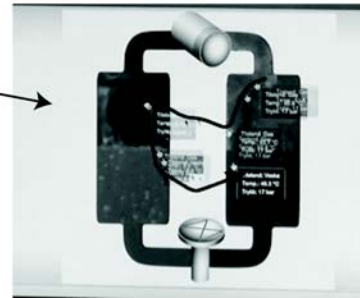
19 **Isaac:** ((moves cursor following the path marked by Andreas pointing)) =as you see- ((releases touch-pad)) >yes because< there- ((points with finger over compressor)).

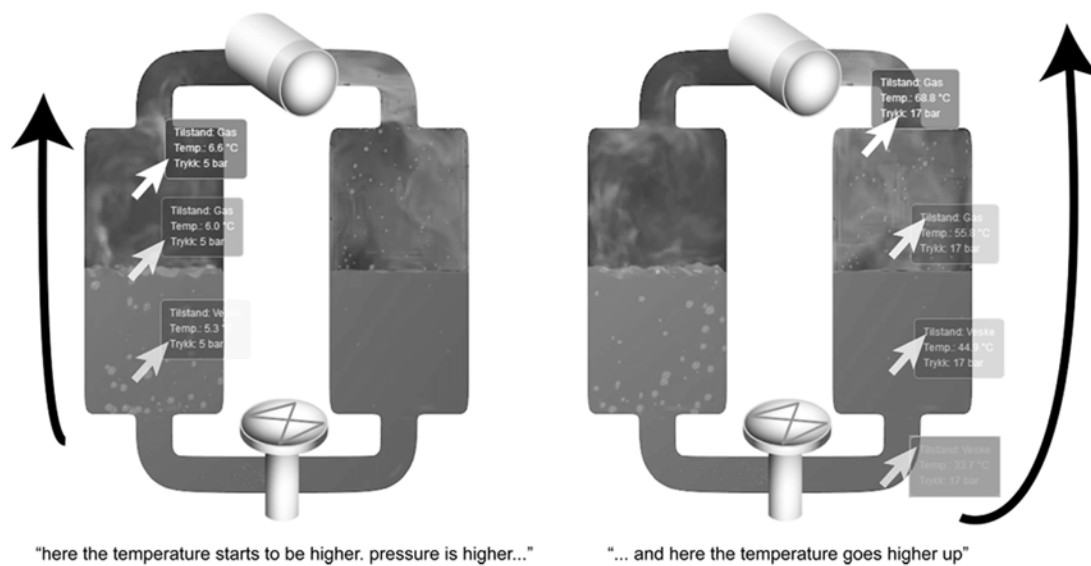


20 **Andreas:** ((takes over touch-pad, moves cursor over right-side chamber)) here the pressure is much greater then?

21 **Andreas:** (2.0) ((moves cursor over the left-side chamber, then back to the right))

22 **Andreas:** find that about the laws, Andy;





In the sequence, and following Isaac’s performance that again presents how pressure and temperature change as they students move the cursor over the screen (turns 11–13), Andreas states that “it’s exactly like the syringe” (turn 14). Followed by another acknowledgement token (turn 17), the sequence is further expanded as Andreas abruptly interrupts Isaac, quickly uttering “wait” (turn 18), and articulating a particular way of structuring the figure.

In the fragment, thus, the students formulate an analogy, which further motivates the articulation of structural aspects of Model 3 that had not been noticed before. Whereas before pressure was said to increase throughout chambers, as glossed in Figure 6, a contrast between the chambers is now made salient gesturally and verbally. Although the numbers appearing beside the “pressure” label in the semi-transparent window have been constant—5 bars in the left chamber, 17 bars in the right chamber—it is only now that the contrast between them is noticed. In this regard, the episode confirms prior research showing the central role of analogies in fostering the emergence of new understandings. Yet, the classical model (Figure 1), because it remains at the level of internal representations, does not explain how the

same aspects of the material environment are represented differently in spite of having been explicitly attended to and not having “physically” changed (Wagner, 2010). Constructivist accounts, which explain the phenomenon in terms of learners reconstructing their internal representations over time, treat the social and material aspects as external to the cognitive phenomenon. A challenge to ecological approaches is to describe inference processes as social phenomena of transformation.

The new structure emerges in transaction and is undergone in experience (not the other way around). Examining the sequence in terms of the participant–environment transactions, an aspect of uncertainty seems fundamental to the inference. In the sequence, a sense of surprise and sudden realization is constituted not only as an aspect of Andreas’ private experience, but also and at the same time as part of a larger unitary phenomenon of sequential organization. There is nothing in the preceding exchanges that makes the quickly uttered “wait” in turn 18 a statement conditionally relevant as a next turn. That is, there is no element that could anticipate it in the relation. It makes sense precisely because there is a set of expectations about sequential ordering of talk at play, and work needs to be done to introduce turns such as this one, which otherwise are not conditionally relevant or expected.

Most importantly, noticing both syringe and model as analogues does not bring about the new knowledge immediately. After the analogy is offered, two expansions follow: one introducing a nuance about how the model is not “exactly like the syringe,” and another one laying down the prospects for “look[ing] at the pressure” (turn 18). What the outcome of this latter action will be, however, is revealed only by actually performing the action, and not before. There is a question, “pressure increases, right?” that is responded to only when certain actions reveal

particular phenomena.. Rather, noticing the analogy becomes the premise for further exploring and transforming (structuring) the figure in extended time.

The new structure is perceived after it already exists as an objective aspect of the situation. As such, the possibility of observing the contrast in pressure between the two chambers is not inscribed in the analogy itself. It is also not inscribed in the prospects for action that it motivates, but in the animation, which will show this relation to exist or not depending on how observers *move* the pointer—and their eyes—over it. Whereas some prior knowledge of the “syringe” has to be accounted for—it is a premise in the participants’ conversation—such prior knowledge mediates the realization of the new structure only as part of the larger transactional phenomenon, and only under the condition of being “effected” in the materials that make up the situation. The inference is thoroughly distributed between participants and across the unfolding sequence of transactions. And it does not end as the constitution of new “knowledge”, but as a means towards continuing inquiry. Thus, even if new formal aspects have been structured, the fragment closes with the prospect of finding “that about the laws” (turn 22).

In addition to this distributed character, there is also a fundamental receptive aspect into the process of inference that is not accounted for by adopting other analytical approaches. Thus, establishing the newly emerged structure as an objective aspect does not only involve doing, but also *undergoing* the new situation. As the result of the sudden realization, the participants come to find themselves in the midst of a transforming semiotic field that, by its very suddenness, could not have been anticipated. Rather than the result of mental construction or processing, the new structure may be seen as the result of having gone through *an* experience; it is not constructed but is *given in experience and taken in*.

Just as Nemirovsky (2011) describes *episodic feeling* as one by means of which a “new realm of possibilities for [the learner’s] body motion” emerged (p. 321), we may speak here of a new realm of possibilities opening up *in* and *as* a moving space of intelligible action. There is a possibility for action, an *affordance*, that is perceived. But there is no perception of the outcome of taking the afforded course of action before such course is actually taken. It is here where some ecological models remain at an inter-actional level. Whereas transfer is theorized as the invariance of perceived affordances across situations (Greeno, Smith, & Moore, 1993), there is no elaboration of the temporal and transactional extension that the event of perceiving and effecting affordances involves. Yet, we could hardly talk of the inference as having bootstrapped the learners beyond what they already know if the event had stopped before the students’ actions actually brought the new structure forth as a concrete aspect. It is only by putting themselves to the risk of *actually experiencing* the difference that is implied in the analogy, of letting themselves undergo the results of their own actions, that the inference comes to an end and brings about a new structure.

Applying Theoretical Knowledge

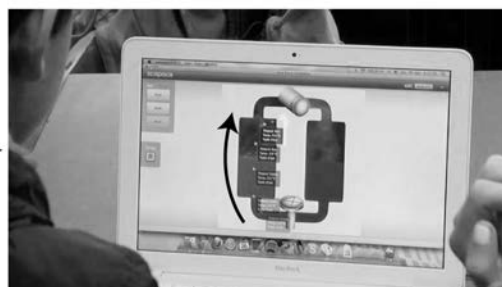
Transfer literature is particularly concerned with how learners come to apply formal knowledge across a variety of situations. From a transactional perspective, rational and formal aspects of practical action are properties of the larger social and organic constitutive order, which is in excess of any individual intention. In this section, we offer a transactional account of the coordinating practices that the students perform to map a propositional law that they read from their notes—the “pressure and temperature law”—into their interpretation of the digital model.

Fragment 3

38 **Andreas:** so when pressure (0.5) ((Isaac begins moving cursor over left-side chamber)) increases, (0.8) it goes higher heat;

39 **Isaac:** yes. (0.8) is it- ((continues moving cursor over left-side chamber)) it's heat.

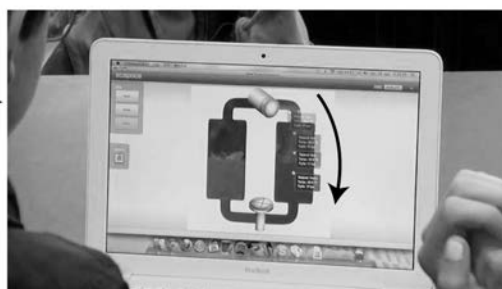
40 **Andy:** mmm,



41 **Isaac:** while here, =

42 **Rachel:** =and when pressure decreases,

43 **Isaac:** ((moves cursor downwards over right-side chamber)) here it decreases.



44 **Andreas:** ((pointing to left-side chamber)) high pressure decreases, right?

45 **Isaac:** the one there is high pressure, yes.

The fragment begins several turns after Andreas had requested Andy to “find that with the laws.” Andy claims to have found “something” and begins reading aloud from the students’ notes: “*when pressure in a gas increases, temperature increases. When pressure in a gas decreases, temperature decreases.*” This is “the pressure and temperature law.” The students then begin to contrast the law’s formulation with what they observe in the digital model. Through turns 38–45, the students re-visit the simulation in a sort of concerted performance, where the reading of the law is implemented as a particular way of moving throughout the figure.

Mapping law and world, and the development of new perceptual orientations. During the sequence, the students literally “apply” the “pressure and temperature law” from their notes. As a prescriptive device for reading the figure, however, the law does not specify a straightforward course of actions, a mapping from theory to world. Rather, the continuity between the law and the world comes to be established in and through the organization of joint action and builds on competences that belong to the transactional domain.

As the result of the prior transactions in the episode, the mapping between law and materials comes to build upon an evolving way to perceptually and conceptually structure the students’ field of action. Therefore, the mapping is subject to the history and contingencies of the unfolding transaction, not upon prior formal descriptions or representations. Structures that have emerged and which have been grounded through the students’ trajectory go here without saying. There is no work to initiate the coordination that goes on in the sequence: as Andreas repeats the law, Isaac moves the pointer. As Isaac moves the pointer, Andreas modulates the pace of speech. Such coordination between Andreas and Isaac shows the participants’ orientation towards a common field of action that is presumed in the relation.

A sort of grammar becomes enacted in coordinating the law’s propositions and the actions over the screen. Contingences implied in the already vernacular, embodied competence to move the pointer over the figure’s contour, become translated into contingencies that are implied in the propositional form of the law by means of language. The formulation “when pressure increases, temperature increases” appears to be read as a course of action that takes a particular path in the space: moving the pointer first upwards over the left-side chamber, then downward over the right-side chamber (see figure in Excerpt 4).

Rational (logical) arguments emerge and become part of the work performed to manage progressivity in conversation. Thus, there is a conversational repair in turn 44 that marks a possible ambiguity in the conversation, where it is not clear whether the utterance “decreases” (turns 43–44) refers to “heat” or to “pressure.” As the turn-pair concludes, there seems to be agreement among the participants that (a) pressure decreases in the left-side chamber and (b) pressure increases in the right chamber. During the sequence it has also been established that temperature increases in the left and decreases in the right chamber. According to the law, however, temperature should increase with increased pressure and vice-versa. Yet such contradiction does not become the object of the verbal exchange. Rather than thematizing a lack of conceptual consistence between the law and the students’ observation, the repair seems to address progressivity and shared understanding in ongoing conversation with regard to previously made observations. This practical grammar, where concerns are the management of consequentiality in transaction, is at work before the students adopt a formal, propositional grammar.

In reading the law and moving the pointer, the students enact affordances that already are familiar to them. Yet, the work of exploring the model, of actually disclosing the figure and experiencing what is thereby being disclosed, is a condition for the mapping between law and world to be drawn. In fact, a premise implied in the fragment is that whether the model is indeed an instance of the pressure and temperature law is not yet known. In reading the law, words that are not the students’ own become appropriated into a way of moving in the world that is only, uniquely and irreplaceably, their own. It is at this intersection between the students’ lived world and the use of categories that belong to practices that exist in larger historical systems of organization (Lemke, 2000). In reading the law, the students indeed “say more than

they actually know” (Wertsch & Kazak, 2011), which allows them to go through an *adventure*, the outcome of which they cannot anticipate and which potentially will transform them.

Closing the Episode: Receptivity and Enriched Experience as Fundamental Aspect in Transfer

A sociocultural premise in ecological approaches to learning is that the competences that we observe at the individual level have their origin in relations that exist before at the relational level. More so, the relation *is* what eventually is attributed to the individual as a higher psychological function (Vygotskij, 2005).

In fragment 4, analyzed here, the different moments of a possible connection between the “boiling point law” and Animation 3 have been laid out in transaction before the participants come to apprehend the connection in formal terms. Several turns after the sequence described in the prior section, Andreas finally articulates the “boiling point law” that he had identified at the beginning of the episode. The student does not read the law from any notes, but rather seems to recall its propositional form “by heart.” The articulation takes place again in an unexpected manner (see Excerpt 5). This time, however, once the law is articulated, “the lower the pressure, the lower the boiling point” (turn 50), he immediately offers an account that indexes a logical implication to specific aspects of the digital model that already have a recognizable structure for the students (turn 58). That is, the mapping between theory and world appears ready-to-hand, and work goes on to further explore the simulations as Andreas’ assertion is accepted (turns 59–60).

50 **Andreas:** >wait.< (1.2) the lower the pressure, the lower
the boiling point, right?
51 **Isaac:** that i::s-
52 **Andreas:** ((*pointing over left-side chamber*)) that one there
is cold, right?
53 **Andy:** is it cold water?
54 **Andreas:** it's blue, isn't it?
55 **Isaac:** it's high pressure then,
56 **Andreas:** low,
57 **Isaac:** is it low pressure?
58 **Andreas:** as you can see, ((*points over left-side chamber*))
it boils with low temperature. then it must be low
pressure.
59 **Isaac:** yeah.
60 **Andy:** ok.

A question arises as to why the formulation that was accomplished in the end was not offered when an explanation of the model was explicitly and repeatedly requested throughout the episode. Why would Andreas ask, “what was the law again,” and request his peers to “find that with the laws,” if he already knew the law prior to the occurrence of the episode? Proponents of the mainstream cognitive account may reply arguing that this is “the problem of accessing appropriate knowledge at appropriate times” (Kolodner, 1997, p. 60). Certainly, the episode may be described in terms of knowledge encoding and retrieval: At the beginning of the episode, there are some aspects of the knowledge that are retrieved; towards the end, the situation has changed so as to match the way in which the original situation was encoded, therefore facilitating full retrieval. However, such an explanation would obviate many of the arguments in the literature and the empirical evidence presented here that suggest that what people do and what they know are not just a stable set of structures that relate to each other, but are integral part of the unfolding situation with which they transact, and with which they constantly change.

An alternative explanation is that Andreas and his peers have indeed changed throughout the episode. Change here needs to be understood from the holistic perspective that both Dewey and Vygotsky intended when they laid down their

analytical notions of *experience* as involving not just the intellect, but the whole person-in-setting, including the body and the affects. We may then say that, through the episode, the students change not only their way of *thinking about* the law and the animation, *but also their own embodied relation to the unfolding situation, which involves changing how they become affectively and receptively attuned to a changing environment*. Thus, although the objective conditions for drawing the connection had already been laid down, they had to become part of the students' "organic activity," to use Dewey's own terms; the connections had to be both done and undergone. If one of Dewey's (1938/1997) main concerns was to develop an education that would "promote the enriched growth of further experience" (p. 73), Andreas may be said to have developed a way that Andreas and his peers may be said to have developed a way to orient to the current situation that is *richer*—as opposed to saying that they have developed more complex knowledge structures about the world and its connections.

Throughout the analyses, we emphasize the importance of the receptive and affective aspects in the development of an intellectual grasp of the connection between prior and current experiences. As it was the case in prior instances throughout the episode, the specification of the law and its relation to Animation 3 came all of a sudden, as if having been given in perception rather than anticipated in thought. Different from prior instances, however, Andreas and his peers had at that moment gone through a history of transactions in which particular ways of structuring and accounting for the figure have been developed. Rather than first intellectually apprehending and then enacting them, these ways of structuring evolved in and through embodied and affectively laden joint engagement. Were it not for there having been an unfolding social relation where assertions about prior and current experience were met with uncertainty and requests for clarification, recognizing the

animation as an instance of the boiling point law could not have evolved beyond merely being an initial feeling devoid of cognitive valence. Had this engagement not had any affective character, there would have not been a force to move this feeling towards a more definite and cognitively relevant completion.

Discussion and Concluding Remarks

The aim of this study is to (a) contribute to the scholarship on transfer by articulating a theoretical and analytical framework for the study of transfer episodes that does not only include learners and their environments but also their changing relations, and (b) concretize the approach in a detailed analysis of a group of students who came to experience new (curricular) situations as related to prior ones. We begin elaborating on Dewey's notion of experience and its affinities with Vygotsky and with phenomenological studies on the primacy of movement, and articulate a view of experience not as *something* that individuals have, but as a phenomenon that extends across space and time, and which inherently involves movement and change. We review literature on transfer and contrast self-actional and inter-actional units of analysis. Despite there being conceptual tools such as Beach's *consequential transitions* (1999), which are explicitly developed to address transformation through transfer, the challenge of accounting for the individual *subject* as a transforming aspect of the person-in-setting relation has remained a slippery task in the exostomg literature (Packer, 2001; Stetsenko, 2005). We further elaborate on transactional analysis, which build upon interaction analysis techniques, and which involve (a) abandoning presuppositions about structures pre-existing the unfolding of experience and (b) taking the learners' perspective from which an event is in the process of becoming.

In this section, we conclude emphasizing two interconnected ways in which this study contributes to extant ecological literature on transfer. First, the framework presented here offers conceptual resources to *overcome remaining dualisms* in extant ecological approaches. It makes visible performative, bodily, and affective aspects that often remain peripheral in accounts of transfer. Second, the framework implies the need to *bring pedagogical awareness to such performative, bodily, and affective aspects* as being central assets in the development of intellectual competence.

Overcoming Remaining Dualisms

The transactional approach presented here emphasizes the primacy of movement and of bodily and receptive aspects of engagement in the development of intellectual understandings during transfer episodes. Thus, it involves a reading forward of interaction. Although starting from the premise that individual subjects and social settings are irreducibly related to each other, extant ecological studies tend to conduct backward reading, often maintain an analytical division between the social and interactional on the one hand, and the cognitive and informational on the other (Macbeth, 2011). Whereas analyses of transfer as *framing interactions* (Engle, 2006) provide descriptions of transfer as being a social achievement, they do not show *how*, as a situated course of concrete action, context and content become mutually constitutive aspects of one and the same phenomenon. Similarly, Lobato et al. (2012), in their exemplary analyses of how *noticing* is socially organized and key to what is conceptually transferred from one learning situation to another, examine “individual cognition, as well as the structuring resources of socially situated activity” (p. 434). For the authors, noticing is not just socially distributed but is also an individual cognitive process that is “not directly accessible” (p. 439). Accordingly, their analyses

focus on the “products” (but not processes) of individual noticing, which only latter are related to the *focusing interactions*.

Despite their irrefutable contributions, studies such as those described above retain some of the dualism characteristic of the mainstream cognitive approach that has been extensively problematized during the last decades. As we argue throughout this article, a way to overcome this dualism is to move beyond an interactional level of description and include the unfolding of time as part of the minimal unit of analysis (Figure 4). From this view, both the contents of experience and the social interactions that bring them about are conceived of as moments within an integral phenomenon of social transaction. By defining experience as a category that extends beyond the individual, social phenomena that are considered to be external (though associated) to cognition can be regarded as being cognitive through and through.

In our empirical analyses, we examine processes that are associated to transfer, and which usually are regarded as mental from cognitivist perspectives, but seldom explicitly articulated from an ecological perspective. We show how such processes and their associated outcomes—i.e., recognizing something as an instance of something else, projecting inferences that reveal new aspects of an ongoing situation, and applying theoretical knowledge to interpret the everyday world—involve movement and transformation both at the individual and the collective levels. The moving body—i.e., hands that move pointers that move over the laptop’s screen, eyes that follow pointers, and whole body orientations that define possible fields of action—has been shown to be the first materiality by means of which structures come to emerge as accountable aspects of experience. The emerging structures have been shown to be themselves actions that extend in time rather than objects or entities that

could be grasped at once. It is only by means of extended transactional work that those actions become stable aspects of discourse and become subject to be accounted for and explained in formal and disciplinary (scientific) terms.

When including time in the minimal unit of analysis, intellectual and performative aspects of experience can be elaborated as moments of the same *developmental* process. In this regard, we fully agree with Engle's (2006) assertion that "transfer involves not just knowing but doing" (p. 455), but we wish to extend the statement by bringing Dewey's insights about experience to bear. In our analyses we have shown how recognizing an animation as connected to prior learning tasks did not happen immediately, but involved a process of development in which both doing and undergoing were necessary moments. More so than a formed thought, at first there was an *episodic feeling* (Nemirovsky, 2011) where a sense of "having been there" (p. 311) appears to be all that the participants had in the situation. It was when this sense came to form part of an ongoing social situation, however, that the initial feeling was put into motion and became something with more definite form through inquiry. In this, *prior knowledge* was not of intellectual form, but involved an affective situation. Most importantly, *knowing* was not something that was given by either feelings or intellect, but was achieved as both affective and intellectual aspects evolved in dialectical relation.

Transfer, education, and the Enriching of Experiences

Finally, some educational implications may be drawn from a transactional perspective. As Packer (2001) points out, "the debate over transfer rests on but obscures divergent views of the goals and aims of schooling." (p. 493). Most often, and against Dewey's vision, education's goals relate to the learners' acquisition of

(conceptual, procedural, inquiry, meta-cognitive) knowledge. Yet, if one takes seriously Dewey's theory of experience, as Packer suggests, the goal of school should be *to change the person*.

The view of experience advanced here emphasizes not only rationality and control but also receptivity and affectivity as fundamental to the achievement of intellectual competences. Accordingly, accounts of transfer should not only emphasize rational and intentional dispositions, but also the receptive undergoing that is always in excess of any rational control. Notions such as agency, choices, and purpose—important in current approaches to instruction informed by ecological frameworks (e.g., Greeno, 2006)—should be explored in their relate to personal rather than (only) intellectual development. The individual subject is not just an agent, but “the one to whom events happen in that he is himself implicated in what happens to him” (Romano, 2009, p. 52). To be implicated in what happens to us means “to be capable of *experience* in the most fundamental sense, which does not refer to a modality of theoretical knowledge understood as the way a subject and object face each other, but rather an undergoing and passage from self to self” (p. 52).

In focusing on such “passage from self to self,” our empirical analyses have shown how the particular positioning that individuals took in the relation *emerged* as a function of the larger sequential organization of tasks. Thus, even when the purpose and prospective course of actions was articulated in advance, the outcomes of such actions were unforeseeable and came to be comprehended only after minimal units of transactional signification had come to an end and had thereby been undergone. That is, whereas *authoritative* and *accountable* positioning (Greeno, 2006) indeed are important for facilitating the emergence of transfer episodes, it is only by virtue of the emerging constitutive order—which transforms both the learner and the objective

conditions in which she comes to find herself—that new understandings come to be comprehended.

Our study suggests the need of developing educational assets that build upon the recognition of the importance of receptive dimensions of engagement. Some researchers have proposed fostering competences such as *anticipation*—considered as “the imaginative sensing of possibility” (Wong, 2007, p. 192)—and *responsibility* (Roth, 2013b; Wong, 2007)—considered as the competence of being not just thoughtful but also sensible and receptive to one’s own and to others’ acts. These competences do not build upon the assumption of the primacy of rationality but emphasize the importance of fostering an affective orientation toward being implicated in what happens to us as learners, and how our actions affect others. Perhaps most importantly, what is here argued is not to change our view of the learners without changing our view of what should they be learning. Our analyses show that, despite the initial intentions of the designers, what learners actually learn are forms of relating to their immediate environment and to others; of developing attitudes and dispositions that will lead to further action. Studies such as these one should therefore not just raise a change in the way we conceptualize transfer, but also a shift of what we expect education to achieve, which for Dewey involved promoting “the enriched growth of further experience.”

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