

Towards a Theory of *Experience*

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Abstract

Experience is one of the most-used terms in (science) education, and it is recognized as being related to learning (education). Yet *what* experience is and *how* it is related to learning and change remains untheorized. In this paper, we mainly draw on the work of J. Dewey and L. S. Vygotsky but also on M. Bakhtin and more recent advances on the topic of experience from French philosophy to contribute to a theory of this important category. Accordingly, experience is not something that belongs to or is had by individuals but rather denotes *transactions* in and across space and time within irreducible person-in-setting units; and it is perfused with affect that is not (only) the result of mental constructions. An episode from an Australian physics classroom is used to exemplify what such a theory and its method-related implications has to accomplish in the analysis of concrete science lessons.

Keywords: experience; category; unit analysis; science learning; praxis; emotion; situated cognition; contradiction

Experience, in its fundamental sense, is that which, by putting us in play ourselves, modifies us profoundly in a way that *after* having crossed, endured, traversed it, we will *never* be the same again: undergo an illness, mourning, joy, loving, traveling, writing a book, painting are “experiences” in the first philosophical sense, surely simple, but nevertheless trivial. (Romano, 1998, p. 197)

Stating that we learn in and through *experience* is a truism. Thus, science educators can unproblematically state that “[a]dult learners learn from their experiences,” “for most people the ability to accurately define the concept of homeostasis was directly tied to their experiences at the Science Center” (Falk & Needham, 2011, p. 10), “developmentally appropriate engagement with quality science learning experiences can enhance children’s development of science skills” (Saçkes et al., 2011, p. 218), or “I use *my own* experience as a data source” (Wallace, 2012, p. 292, emphasis added). Yet the concept of experience remains troubling and under-theorized (Wong et al., 2001). As apparent in the quotations, a distinction is frequently made between experience and learning, where the former is said to precede or affect the latter. However, these accounts tend to focus “on the impact of experience on learning and have much less to say about the impact of learning on experience” (Pugh, 2011, p. 109). Rather, for experience to have analytical import in science education, there is a need to theorize what experience *is*.

The purpose of this paper is to contribute to re/theorizing experience by emphasizing critical moments of the category in the work of Dewey and Vygotsky and interpreting them with regard to more recent developments in phenomenological philosophy. We

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begin by providing an initial sketch of the category of experience and then move to present some case material and a reading thereof that focuses on experience from a pragmatic perspective. We then offer some theoretical discussion and development for the purpose of working towards a theory of the category of experience.

Experience: An Initial Sketch

Experience, as treated by Dewey and Vygotsky, is unlike the common use of the term as referring to participation in events or activities and, in the process, having certain feelings. Instead, experience is a *category* of thinking, a *minimal unit of analysis* that includes people (their intellectual, affective, and practical characteristics), their material and social environment, their transactional relations (mutual effects on each other), and affect. Thus, experience is not something concealed within individuals, but extends in space and time across individuals and setting in the course of temporally unfolding societal relations, which themselves are perfused with affect (Vygotskij, 1935/2001). Therefore, coming to grips with what it means to have an experience implies providing an account of how societal events—including school science lessons—are produced in ongoing society-specific interactional forms, and how in turn these events give rise to the social interaction itself. To this end, we need to theorize experience not as a synchronic category, an entity that can be named before its course has reached an end. It has to be considered as an unfolding unit that encompasses change itself, rather than change being an external factor causing or affecting experience.

Important groundwork has been laid by the American pragmatist philosopher Dewey, who emphasized the continuous nature of experience and distinguished experience in general from having *an* experience, that is, when an event that we have lived has run its course and comes to a determinate conclusion—a consummation (Dewey, 1934/2008a). Virtually unknown is the fact that Vygotskij (1935/2001), too, worked on a theory of experience that has the same essential characteristics. It is precisely this type of experience that science educators need to theorize to better understand learning in all of its dimensions (Lidar, Almqvist, & Östman, 2010). As such, *an* experience stands out against the stream of experiences generally as something special. However, there are only a few scholars who directly take up and emphasize the role of Dewey's work on pertinent issues in science education (e.g., Girod, Rau, & Schepige, 2003; Rudolph, 2005; Wickman, 2006; Wickman & Ostman, 2002). Notwithstanding these efforts, a critical analysis of the category of experience may be a timely and important task because it addresses the question of unit of analysis, a question that is central to recent socio-cultural and situative theories that strive to provide holistic accounts of the relations in which individual and environment *mutually determine each other*, and between the situational and continuous aspects of knowing and learning (e.g. Greeno, 2006; Hamza & Wickman, 2009; Lidar, Almqvist & Östman, 2010; Rogoff, 1995; Roth & Jornet, 2013).

Both Dewey and Vygotsky conceived of experience as a category for understanding learning and development, that is, as the minimum analytic unit that retains all the features of the whole (Dewey, 1938/2008b; Vygotskij, 1935/2001). For Dewey, experience denoted a functional transaction that both constituted and transformed subjects and their environments in the course of practical activity (Garrison, 2001). The term transaction means that participating terms—e.g., acting subject and environment—

cannot be independently specified because each is part of the other (Dewey & Bentley, 1949/1999). Similarly, in a cultural-historical *concrete human* psychological theory, experience constitutes the developmental unit that considers the inner (emotions, consciousness) and outer (material, social environment) within one irreducible unit (Vygotskij, 1935/2001). In fact, Vygotskij's Russian word *pereživanie*, besides experience, also has the English "emotion" or "feeling" as equivalents, so that the English translation of Vygotskij (1935/2001) uses "emotional experience" to translate the term (Vygotsky, 1994).¹ That is, experience—and even more so the Russian *pereživanie*—integrates the physical-practical, intellectual, and affective moments of the human life form that interpenetrate each other (Dewey, 1938/2008a; Vygotskij, 1984).

An important implication of the view on experience sketched here is that, if the physical-practical, intellectual and affective moments of experience cannot be considered as factors standing above or below each other, experience cannot be reduced to and therefore explained by (mental) construction and interpretation. The irreducibility of experience to mental constructions is central to more recent work in phenomenological philosophy, which emphasizes that we are not only subjects of experience but also subject and subjected to experience (e.g. Romano, 1998; Waldenfels, 2011). In this, experience always is in excess of cognitive construction. There is therefore a tremendous excess of experience over intellectual subject matter learning (Dewey calls it "collateral learning"). This excess may be even more important to learning than what is or is not learned in the subject matter (Marion, 2010; Roth, 2012a). It may also allow us to come to grips with the fact that so many students drop a science course or drop out of science altogether in the course of taking courses. This excess of actual over intended learning includes what Dewey refers to as "attitudes," and it is these "attitudes are fundamentally what count in the future" (Dewey, 1939/2008b, p. 29). There is therefore a need to theorize experience in terms that do not assume "control and rationality" as the "sine qua non" of learning (Wong, 2007, p. 192). It also implies a need to develop analytical accounts that retain the inherent uncertainty that is integral part of human experience.

From the Flux of Experience arises *an* Experience

Introduction

In this section, we present a brief classroom event that serves us to highlight some of the basic traits of the category of experience sketched above and to empirically ground further theoretical development in a subsequent section. The event presented is interesting because it will have turned out to have been *an* experience in Dewey's sense (1934/2008a). We use the future perfect tense, because as things were unfolding, neither teacher nor student knew that this instant of the physics course would eventually stand out as something significant. Whereas the category *experience* refers to the continuous transactions that are characteristic of "the very process of living" (p. 42), *an* experience stands out as a completed and complete whole that can be distinguished against "inchoate" flux of experience and named: "Then and then only is it integrated within and demarcated in the general stream of experience from other experiences" (p. 42). The

¹ We do not follow this practice, as Vygotsky clearly uses an adjective to qualify the noun "experience," that is, he writes "emotional experience [emocional'nyx pereživanie]" (Vygotskij, 1984, p. 45). Moreover, he uses phrases such as the "experience of feelings [pereživanie pereživani]" (Vygotskij, 2005, p. 30).

classroom event presented here can be counted as *an* experience, because the participants themselves marked it as something that had stood out for them in this particular lesson and because of its stated impact on both participants. During the interview following the lesson, the teacher (Carrie) said that it was salient because she “had to tell Jane (student) that we’ve changed her topic.” The researcher who was interviewing her, by using the demonstrative pronoun “that” in asking Jane whether “that is back to the drawing board for you,” referred to the event that he had just witnessed passing as some thing that can be referred to. Jane, in her response, also used a pronoun “it” to refer to the event: “*it* sucks” and “*it*’s annoying.” We therefore may legitimately qualify the event as “an experience,” because it “is a whole and carries with it its own individualizing quality and self-sufficiency” (Dewey, 1934/2008a, p. 42), something of “tremendous importance—a quarrel” or “something that stands out as an enduring memorial” (p. 43). Such experiences are of tremendous importance because “every successive part flows freely, without seam and without unfilled blanks, into what ensues” (p. 43). Such experiences constitute unities. As unities, we can name or denote them (“that meal, that storm, that rupture of friendship,” Dewey, 1934/2008a, p. 43).

Dewey emphasized the fact that young people in traditional schools do have experiences. However, he suggested that not all experiences lead to “growth” or become significant in some other way. For him, educators should “arrange for the kind of experiences which, while they do not repel the student, but rather engage his activities are, nevertheless, more than immediately enjoyable, since they promote having desirable future experiences” (Dewey, 1938/2008b, p. 13). Such kind of experiences are those that bear developmental continuity on a personal plane, and which, in a social relation, can be named and therefore referred to as common. As apparent in the participants’ later accounts, the episode here presented had a lasting impact in the way both student and teacher further engaged in the course of future science learning. Central to our effort of working toward a theory of experience is that the episode from the classroom constitutes an event arising from and irreducibly intertwined with the societal relation of the participants. Such relations are to be understood as category, “as [an] emotionally colored and experiencing collision, the contradiction between the two people” (Veresov, 2010, p. 273). The dramatic encounter “emotionally and mentally experienced as a social drama . . . later becomes [an] individual intra-psychological category” (p. 273). In the analyses that follow, therefore, we demonstrate how an understanding of both the agential and pathic dimensions of experience is possible once we, as analysts, acknowledge the primacy of the societal relation—which encompasses transaction—and describe the practices by which the relation is recognizably reproduced and accounted for by the participants while it is a relation-in-the-making.

Background to the Event

The event reported below was recorded during a physics curriculum unit in which 11th-grade students involving several classes conducted an extended experimental investigation in a private high school in an urban setting of Queensland, Australia. The students, working individually or in pairs, completed one from about six proposed investigations that would take them an entire term to complete. The problem statements were deliberately framed in general form to allow students a great degree of latitude in

just what they wanted to investigate and how they wanted to do it. One of the investigations involved a lantern, which, in the original problem framing, was to be made to rise using tea-light candles: “Design and make a [paper] lantern powered by a single tea-light that takes the shortest time (from lighting the candle) to float up a vertical height of 2.5 m. Investigate the influence of the relevant parameters. (Please take care not to create a risk of fire!)” The students were to write a report to be submitted at the end of the 10-week term and that would constitute the only form of assessment for this period of the course. The episode occurred in the second week of the term, when the head of the department had changed the problem definition (which students and teacher could access “on Moodle”). In the episode, the teacher Carrie (a former research engineer who, following a teacher education program, was in her first year) is informing Jane about the change. (Pseudonyms are used throughout.) In addition to the classroom video, which also features a brief interview with Jane about the event immediately thereafter, we also draw on three interviews in which Carrie talks about teaching physics by means of the state-mandated extended experimental investigations. In the following, we provide a narrative account of the episode that the participants themselves will be marking as *an* experience. As part of the narrative account, we include descriptions of both the prosodic and non-prosodic aspects of the conversation featured in the episode, as those constitute the empirical material on which our research draws.²

Getting a Student to Change her Topic in a Student-Centered Extended Experimental Investigation

What eventually will have been the event that stood out for the participants and observer began when Carrie walked towards one of the laboratory benches where Jane was sitting saying sufficiently loud for Jane and others to hear that she better talk to Jane first. After a brief pause, Carrie adds, “change of plans,” which is immediately taken up by what can be heard as disappointment. In fact, Carrie then acts as if she were reacting to disappointment by giving a reason for the change of plans: “to make life easier” because “it” “is too difficult.” In what can be heard as a plaintive voice, Jane responds that she has “just found a way to do it.” Carrie then suggests, beginning with the contrastive conjunction “but” that marks an objection that “it” “might still work for change of plans.” That is, although we can witness an apparent attempt on Carrie’s side to accommodate the student, she also reiterates the change of plan as a fact. Carrie then outlines that the new task definition can be found on Moodle.³ The two then enact an IRE ritual, whereby the teacher initiates a query concerning an alternative way of making the Chinese lantern rise (“can you think of something,” “like we get hot air from?”), repeatedly responded to by the student (no response, “breath into it,” “I would say fire”),

² The full episode and the transcripts of the interviews with Carrie and Jane are provided in Roth, 2013b, pp. 163–170. The ethnomethodological analyses provided in that book only draw on what the interaction participants, here Jane and Carrie, make available to each other and act upon. No special methods were required other than those “ethnomethods” that Jane and Carrie used to make sense, as stated in the subtitle of the book. The analyses provided there show how every aspect of the episode is collaboratively achieved, including such aspects as Jane’s plea, change of plans, bringing an end to the experience, etc.

³ Moodle is the acronym for Modular Object-Oriented Dynamic Learning Environment that was used in Jane and Carrie’s school as a common platform for managing courses, such as physics, taught by multiple teachers and to bring all assignment (specifications) into alignment.

which is evaluated on the part of the teacher (“easier than that”). Despite having first invited Jane to “think of something,” it is the teacher who finally names the alternative heat source to be used: a hair dryer.

Although there were signs of disappointment initially, addressed in the way Carrie responded, Jane then participated in the exchange without obvious signs of negatively tinged affect. But this changed as soon as Jane stated the realization that using the suggested hairdryer meant that she could not do the experiment with the waxes she had designed. Carrie assertively repeated the statement that Jane “can’t experiment with different waxes.” Carrie quite apparently hears the disappointment in Jane’s interjection, as she states what Jane can actually do (“investigate how you can have a lantern rise in the least amount of time for two meters”), which the latter accepts in a subdued voice. Although the definition of an extended experimental investigation states that the students themselves design the experiment, here it is Carrie who outlines the details about how to heat the air in the lantern. There are subdued acknowledgments on the part of the student (“kay,” head nod), and a final comment that re-asserts the fact that Jane “won’t be able to test different types of waxes.”

Jane apparently did not give in, as she began to describe the preparations she has completed at home and to explain what she was going to do. Carrie, in a subsequent debriefing interview, articulated this “not giving in” as “balking at it all,” that is, as providing resistance to the suggestions she made. In the exchange with Carrie, Jane articulated that she would use candle bases and different waxes she had ordered, how she would use lightweight tinsel to support the candles and a paper ring, and how she would use baking paper. All this would make the lantern “go up really easily,” which in fact addressed the principle issue that had led to the change in task definition.

Carrie suggested that the baking paper above the candle would burn, which is followed by an exchange over its anticipated interaction with the flame. Jane countered in saying that it would not burn, but Carrie, who first asked whether the paper would burn then asserted that it would burn and char, creating holes in it. In using the contrastive conjunction “but” before stating what she could investigate also marks to be insisting on doing the investigation that she designed rather than what Carrie was in the process of suggesting she ought to do. Carrie then asks whether it is possible to use the set up that Jane proposes with the configuration (hair dryer) that she had been suggesting. As the contrastive conjunction “but” indicates, Jane was hearing Carrie to be suggesting she abandon her experiment and then Jane expounded that the lantern would go up no matter what the conditions. Rather than engaging with Jane’s argument, Carrie then asked Jane to “think about that” and “what she can do with that” and continued by articulating the mediating conditions that interfered with making “it” “work.”

Jane, however, was not giving up. She now pleaded for continuing with her plan under the condition that she could get it to work; but Carrie objected by stating that in this way Jane would be spending more time trying to make it work, and eventually would be running out of time. Again, Jane articulated a plea and a promise to do the alternate hairdryer experiment if she could not get her investigation to work. Carrie did not engage with this idea but reasserted her suggestion that Jane work on elaborating ideas under the new task condition and to work at home on the wax experiment. Jane apparently assented, but in a very subdued manner.

Carrie then offers up a change of topic: the theory (behind the experiment). Asked “how is your theory writing going,” Jane stated not to have had the time, and Carrie suggested that the student could add the theory, if there was one, concerning the “wax bit” and to treat it as an experiment, but one that she “did not do.” Jane however insisted that she needed to do the experiment and explained that there is no theory “because there’s nobody who has done an experiment like that.” Again, Carrie objected (marked by the contrastive conjunction “but”) by insisting that there had to be a reason for doing the experiment. Although Jane did list a couple of reasons, the discussion of this topic ended with Carrie’s assertive query “kay?” followed by Jane’s subdued, low-volume “yeap.” Carrie then apparently restated what is to happen: Jane has to look up the edited assignment, and then provided reasons for following the change of plans: it “makes life easier” for Jane and she could “get a good mark” for her analysis.

Jane provided signs that she was giving in and thinking about the new task condition. She articulated a query about the amount of heat to be added, which would be made difficult because of the hairdryer, but which might affect the speed with which the lantern would rise. Carrie replied first by stating that the amount of air was determined by the size of the lantern, and then articulating that the lantern had to be held in place until the hot air was added, at which point it would be released. There was an exchange over when to turn off the hairdryer, and then Carrie, as if she had heard Jane asking about the process, stated two ways of understanding what would be happening: adding hot air or heating the air that is there. Jane, initially providing signs of assent (head nod, “kay”) then articulated a possible problem: Would the hairdryer not heat the air surrounding the lantern? Carrie stated that this was an interesting point that Jane could comment on.

The episode came to an end with an exchange of an assent-seeking query “kay?” and the subdued giving of assent “yup,” upon which Carrie got up moving to another group, leaving Jane by herself. It was at this point that the researcher present approached Jane asking “is that back to the drawing board for you, Jane?”

Coda to the Episode

Episodes and experiences as the one featured here have not received much attention in science education, though they may lastingly change what a student does and how she does it in her further education. Such encounters lastingly change individuals because an “emotionally experienced collision brings radical changes to the individual’s mind, and therefore it is a sort of act of development of mental functions” (Veresov, 2010, p. 274). The lack of attention might be partly due to the “superficial treatment” Dewey’s philosophy has received despite its general acceptance on the parts of educational theorists and practitioners (Wong et al., 2001). Even when, and perhaps precisely because some science educators read Dewey very closely regarding the continuity of experience, they tend to heed the intellectually mediated aspects of (aesthetic) experience rather than the pathic (affective, emotional) dimensions (e.g., Hamza & Wickman, 2009; Wickman, 2006). The theory of experience towards which we are working, however, takes the individual-in-setting as an *irreducible* whole, including those affective features that are *integral* to the Vygotskian notion *pereživanie* (e.g., Veresov, 2010). In the following, we analyze the episode just described focusing on two central aspects that arise with the category of experience: (a) the open-endedness (indeterminacy) of experience that arises

from its transactional nature and (b) the affective dimension of experience transcends the individual.

Transactions Lead to the Open-Ended Nature of Experience

Experience (*pereživanie*) in the way Dewey and Vygotsky define the category refers to the transactional relation in which the subject and environment mutually constitute each other. Dewey formulated the principle of continuity as follows: “every experience enacted and undergone modifies the one who acts and undergoes, while this modification affects, whether we wish it or not, the quality of subsequent experiences” (Dewey, 1938/2008b, p. 18). That is, in experience, both the one who “enacts and undergoes” and “the quality of subsequent experiences” are transformed independently of any intention. Experience understood in this way leads to the fact that teachers “cannot ever anticipate the unforeseeable and flowing, continuous plenitude of possibilities that [even] a strongly Socratic conversation brings to light in a wake, self-coordinating group” (Wagenschein, 1999, p. 98). In the course of events, prior to closure, the two participants *cannot comprehend* (i.e., grasp) *what* is happening to them while it is happening (Romano, 1998; Roth, 2013a). Because episodes such as the one in which Carrie and Jane are involved are unpredictable, an appropriate theory requires categories that “capture” the indeterminate nature of experience. It is for this reason that Dewey and Vygotsky suggest approaching such events through the analytical category of experience (*pereživanie*). This category (minimal unit of analysis) includes all individuals, their social/material setting, and the transactional relations that bind them into an irreducible whole (Roth & Jornet, 2013). Affect is neither something separate from the unit nor a factor that influences or characterizes a part of this unit: it *perfuses* the unit. We cannot therefore understand the *dynamic* of the happening from the perspective or through the contributions of the individual actors as if these were to *determine* its unitary character (in this case, we would be looking at *interactions* of independent entities and not at *transactions* [Dewey & Bentley, 1949/1999]). As the German physics educator Wagenschein (1999) recognized, even in a strongly Socratic classroom conversation, “the teacher cannot know ahead of time what he will say at which turns of the road” (p. 98) because s/he cannot know ahead of time what students will say; and students cannot anticipate what they will say even seconds hence because they do not know what the teacher will have said when s/he has ended.

Most learning theories privilege the intentional and rational aspects of experience, where individual agents are in control of what they experience (Lave, 1988; Wong, 2007). In contrast, Dewey emphasizes that the control of individual actions resides in the *situation* and that it “is not the will or desire of any one person which establishes order but the moving spirit of the whole group” (Dewey, 1938/2008b, p. 33). In addition, “the authority in question when exercised in a well-regulated household or other community group is not a manifestation of merely personal will; the parent or teacher exercises it as the representative and agent of the interests of the group as a whole” (p. 33). The teacher does not exercise in an arbitrary way: “When it is necessary . . . to speak and act firmly, it is done in behalf of the interest of the group, not as an exhibition of personal power” (p. 34). The category of experience, therefore, covers this dimension in which events are not (completely) under the control of the individual subjects. Teachers and students, as Carrie

and Jane in the episode, not only are agential speakers but also *subject to* and *subjected to* the speech of others—i.e., they are patients as much as agents. As a result, the happening carries Carrie and Jane away, makes them undergo and go through something that never is under the control of either. They fully comprehend what has happened only after the fact. It is from the condition of being subject and subjected to something that much of the emotional coloring arises—even though and precisely because neither participant has control over what is happening. The grade that issues at the end, therefore, needs to be understood as the result of the experience as a whole, involving Carrie and Jane, the social/material setting, and the transactional relations that not only bind them into an irreducible whole but also constitute them as the particular actors that they are (e.g., Roth, 2013b). Jane merely gets stuck with the failing grade and the lack of competencies that are associated with it. She also gets stuck with “a loss of interest,” which, as we show here, in part arises from a situation that makes it impossible for her to continue with her experiment and to take on board another one designed by someone else.

In the episode, although the teacher initiated the exchange with the idea of communicating to Jane a change of plans, she could not anticipate what would happen, how the exchange would unfold, or when precisely it would end. Jane, too, could not know what would be happening when Carrie approached her. Both, therefore, though active contributors to the event also were subject and subjected to it. They were undergoing the event as much as producing it. As a result, the course the exchange was taking and what was said (i.e., the results of the talk) *emerged*. This is precisely how Bakhtin (1994) characterizes dialogical relations, such that even the authors of dialogical novel—such as F. Dostoyevsky—do not know beforehand the destinations of their characters until the dialogue has ended.

Throughout the episode there are affective signs that the two protagonists made available to each other and that they took up in their replies. There is indeed evidence that Jane had engaged considerably in efforts to design and prepare for a scientific experiment; yet subsequent interviews with the teacher, including one at the end of the term, revealed that Jane turned off during this lesson and lost interest for the extended experimental investigation for the remainder of the term. In the end, Jane was the only student who did not receive a passing grade. Though the example does not lend itself to make causal claims, *this* experience—consistent with Dewey’s (1938/2008b) conceptualization—was *an* experience that appears to have shaped how Jane subsequently engaged with the investigation (i.e., subsequent experience) and, therefore, the experience of the entire school term as a whole. Certainly, the teacher had not intended for Jane to lose interest; she asserted repeatedly wanting to make the task manageable for Jane so that she could succeed. Despite these intentions, the outcomes of the transactional experience were different.

The indeterminacy of events that arise from transactions also shows itself in the fact that despite good intentions, classroom episodes initiated by a teacher to bring about something positive—making a task easier—the actual outcomes might include dispute and negative affect. Carrie summarized and characterized the event as one of objections: “So and Jenny did balk at it all. As much as it’s making life easier for her, she wants to do her own thing so hopefully it doesn’t put her off too much and she does get on with it. She’s also not working with anyone. . . . She said she wanted to do it by herself because she wants to be proud of her own work I think.” As described in our narrative account,

Jane did in fact provide reasons to support her request—which turned into plea—to continue with the experiment as originally planned. The event, following the announcement of a change of plans, therefore did involve discussion, opposing arguments, and debate—by definition, a dispute. In *Education and Experience*, Dewey does indeed talk about how disputes arise in and from experience. When disputes arise, “it is usually on the alleged ground that the umpire or some person on the other side is being unfair; in other words that in such cases some individual is trying to impose his individual will on someone else” (Dewey, 1938/2008b, p. 33).

Dewey already knew about the more difficult task for the progressive educator, who “must be aware of the potentialities for leading students into new fields which belong to experiences already had, and must use this knowledge as his criterion for selection and arrangement of the conditions that influence their present experience” (Dewey, 1938/2008b, p. 50). In the episode, and despite the teacher’s stated intentions, the conditions for learning appeared “to be settled upon outside the present life-experience of the learner” (p. 51). Carrie “always thought that that topic wasn’t the best for [Jane] because it’s not as straight forward. They’re meant to be making a lantern rise through tea-light candles. We have simplified the problem and adding hot air to the lantern, seeing how quickly it can rise.” However, what for the teacher was anticipated as a simplification, it turned out to be a disconnection for the student. From a purely intellectual point of view on the subject matter, an educator may assume an isomorphism between tea-light candles and hairdryers in their function of warming up the air, so that a lantern will rise in either case. With regard to the “science behind,” the two may be analog to the same scientific principle, and function equally well in a science (learning) experiment, save that the hairdryer solution may “make life easier.” However, as Dewey insisted and this study suggests, relations within the curriculum do not necessarily bear connections within lived-in experience:

Thinking goes on in trains of ideas, but the ideas form a train only because they are much more than what an analytic psychology calls ideas. They are phases, emotionally and practically distinguished, of a developing underlying quality . . . subtle shadings of a pervading and developing hue. (Dewey, 1934/2008a, p. 44)

For Jane, the hue of the unfolding experience was constituted by a series of irreducible emotional, practical, and intellectual shadings that, according to her actions and statements, did not seem to make up the expected connection between candles and hair-dryers despite their coherence within the curriculum.

Throughout the episode, we get a good sense of the indeterminacy that is characteristic of life as an open-ended phenomenon and that makes actual outcomes differ from intended ones. Observers, witnesses, and the participants do not know what precisely is happening, which they could name and point to; they can do so until after everything has come to an end, when everything will have been said and done, and until of *an* event has emerged. As a category, experience is designed to capture how the continuing, open-ended flow of a happening is reflected in the consciousness and affect of the participants. We observe the Deweyan intellectual, practical (gestural), and affective “intakings and outgivings” without ever being able to gauge the quality of this

experience *as* (namable) experience or the ways in which it would modify (mediate) future experiences in the continuity of experience.

Affective Dimensions of Experience Transcend the Individual

Stating that the affective dimensions of experience cannot be reduced to the individual amounts to saying that they cannot be explained by focusing on individuals, their interpretations, constructions, physiological and hormonal make-up, and so on. Because the category of experience/ *pereživanie* covers the entirety of individual-acting/being-affected-in-setting, affect, which is a manifestation of experience *as a whole*, cannot be explained by considering individuals alone. Scholars working with the category of experience all point to the role of the pathic dimension: in experience affect, intellect, and practical action are woven into one cloth (Bakhtin, 1993; Dewey, 1934/2008a; Vygotskij, 1984; Waldenfels, 2002). But this dimension does not mean that affect is the result of interpretations. Instead, as recent research in science and in mathematics education shows, affect is continuously produced and transformed such that from negative affective qualities, both positive and even more negative affect may result without the actors being conscious of this (Roth & Radford, 2011; Roth & Tobin, 2010). Activity—which is the smallest unit that retains the societal characteristics that explain consciousness and personality—*inherently* and *irreducibly* is perfused with affect (Leont’ev, 1983). We know from both Jane and her teacher Carrie that the event has had affective dimensions: Carrie having to do what she did not really want to do (i.e., tell Jane that she had to change her investigation), and Jane having an experience that “suck[ed].” Carrie also stated feeling that she had to attend more to Jane’s needs. Clearly, this is the kind of situation and associations we might anticipate to be able to witness if Dewey is right in asserting that “there is some kind of continuity in any case since every experience affects for better or worse the attitudes which help decide the quality of further experiences” (Dewey, 1938/2008b, p. 20). This is so whether one is a teacher or a student, and Dewey’s framework about educational experiences—though he did not explicitly frame it as such—is as valid for the teacher who gains experience in and through experience as it is for the student.

The most important among the attitudes to be developed in and through experience is “the desire to go on learning” (Dewey, 1939/2008b, p. 29). In Jane’s case, this desire, though it was initially apparent to Carrie, later disappeared. When asked about the extended experimental inquiry, Carrie noted at the end of the term: “some girls in some groups didn’t sort of take that struggle on and that challenge on and do anything with it.” Asked to elaborate, she used the example of Jane, about whom Carrie said that she “never really engaged in any of it much,” and that “she was quite enthusiastic to begin with but it didn’t carry her very far. She didn’t take any of that enthusiasm and apply it to anything.” Carrie also stated to “know that during that lesson [Jane] switched off. At the end she was over chatting with Rita, not doing anything. I had another little discussion. There are things that she can be doing but I think she’ll get back on track.” Although experience is said to build on and to be constrained by previous experience, the principle of continuity does not inherently mean growth or development. It may in fact “operate so as to leave a person arrested on a low plane of development, in a way which limits later capacity for growth” (Dewey, 1938/2008b, p. 20).

The category of experience includes an affective coloring that cannot be separated out from its practical and intellectual colorings (Dewey, 1934/2008a). In fact, there is a continuous interplay of the practical, intellectual, and affective: even the emergence of an intellectual understanding is affectively colored (Vygotskij, 1984). This interplay does not take place in the private sphere of thought, but is a public phenomenon, empirically available in and through embodied transactions. Throughout the episode, we can see and hear how the participants produce and make available to each other the affective, cognitive and practical aspects of the unfolding activity, without these existing in any exclusive modality or parcel of materiality. Thus, for example, in taking up the announcement of change of plans and the following reasons for it, Jane utters a plaintive “I just found a way to do it,” which cannot be said to involve separable intellectual and affective aspects. Rather, in one and the same conversational turn, Jane’s voice articulates (a) an affective evaluation (intonation), (b) a negation (having found a solution in contrast to the teacher’s provided reasons for the change of plans), and (c) a reason for continuing with the desing (“I found a way...”).

Because of the irreducibility of the practical, intellectual, and affective, emotions featuring in this episode—such as disappointment or empathy—should not be taken to be the result of interpretation. Rather, from a cultural-historical perspective, there are stark warnings of the grave error we commit if we understood the affective evaluation as a result of the *intellectual* dimensions and *interpretation* of what someone else has said (Vygotskij, 1984). Emotion is not a reaction apart from the “reasoning” or the experience, but is integral to the passing “*from* somewhere . . . *toward* an end” (Dewey, 1934/2008a, p. 46). In the episode, intellectually and practically, there is a change of plans; this change is associated with affective qualities, as there had been emotional investments toward a goal that now is in the process of disappearing. As Jane noted, going with her mother shopping to buy “all this stuff” “was fun,” that is, was colored by and produced positive affect. The practical aspects of preparing for the experiments were colored by and mediated further affective investment. But this is not all. The experience of the exchange itself puts the subject at and exposes it to risk, and such risk, however small, inherently has an affective coloring. Indeed, after the fact, Jane referred to the change of plan as “really annoying because I had everything planned and I knew what exactly I wanted to do.” If it turned out that the described event contributed to the loss of interest and abandonment and the “switch[ing] off,” this might not come as a surprise, for “the principle of continuity of experience means that every experience both takes up something from those which have gone before and modifies in some way the quality of those which come after” (Dewey, 1938/2008b, p. 19).

There is an extended aspect of experience that exceeds the single individual. In the episode, disappointment and empathy are better described as qualities of a category that unfolds in time and which includes both participants and their transactions, than as the external expression of “internal” experiences. In Carrie’s uptake of Jane’s first signs of disappointment, we find expressions of acknowledgment of Jane’s position and a lowering of the pitch that has the effect of decreasing the conflictual nature of different ideas generally and between students and science teachers specifically (Roth & Tobin, 2010). That is, in Carrie’s turn we observe an acknowledgment of Jane’s intellectual-affective expressions just described. There is a coordination (transaction) of the melodic move between Jane’s and Carrie’s turns in conversation, where tonalities sound in a

“coherent” (in that they are continuous and responsive to each other, again transactional) symphony that is not over or below experience, and which do not fully pertain to any single participant. Emotional qualities are written all over this experience, not because the researcher interprets it as such but because the participants themselves respond to each other’s affective expressions. Emotions, coloring and being colored by events, as they do, “are not, save in pathological instances, private” (Dewey, 1934/2008a, p. 48).

All experience has affective qualities that shade the experience, transform it, and are, in turn, transformed by the unfolding experience (Bakhtin, 1993; Dewey, 1934/2008a; Vygotskij, 1935/2001). Affect is not just associated with, garnish of events and experience: “Emotion is the *moving and cementing force*” (p. 49, emphasis added). Dewey thereby highlights precisely the same aspect that is also central to idea of the motive forces underlying thought (Vygotskij, 2005). Throughout, affective quality of the event as a whole is apparent. It not only was a driving force of what was happening but also was its product. After the fact, Carrie talked about the intentions that she has had for the conversation with Jane. In this description, addressing the anticipated effect that the announcement of a change of plans might have stands out: “I think I was, I sort of knew that she wouldn’t be particularly happy with it and I guess I approached her with the idea that I wanted her to feel that it was a good thing rather than meaning she’d done all this work and it was wasted etc. etc.” That is, Carrie’s after-the-fact description suggests the presence of a certain degree of sympathy and empathy with the anticipated affective impact that the news would have on Jane—and, therefore, the affective coloring of her own (speech) action. The ultimate “aim of the conversation [was] to let [Jane] know that this was what was happening but have her feel that it was okay.” But there is no evidence that Carrie could have anticipated the *precise* effect that the announcement would have, how it would affect Jane, and how Jane would respond to it practically, intellectually, and emotionally. In fact, she came to be confronted with and affected by Jane’s “balking,” and the perhaps unanticipated degree to which the news affected Jane. And that Jane was indeed affected was endogenously available to Carrie through a variety of means including intellectual content, prosody, body positions, and facial expressions. Afterwards, Carrie acknowledged her understanding that the experience was more upsetting for Jane than anticipated: “Jane, I guess I feel, I feel a bit more aware of making sure I say things that won’t, I guess, upset her in a way, whether it’s how I say it or how I try and put things to make sure she doesn’t get off track. . . . Not so much upset Jane but not have Jane upset.” Here, Carrie described her intended concerns for Jane’s emotional wellbeing, and refers to the upset that the event has ostensibly caused in Jane.

Carrie’s talk did in fact embody a concern for Jane in the future, as she articulated for Jane that a change of plans would make things easier, give her a set of data to work with, and get a good mark on this part of her course. She acted as the “educator [who] by the very nature of his work is obliged to see his present work in terms of what it accomplishes, or fails to accomplish, for a future whose objects are linked with those of the present” (Dewey, 1938/2008b, p. 50). The educator looks ahead, concerned with experiences that live on to influence further experiences. “The educator, by the very nature of his work is obliged to see his present work in terms of what it accomplishes, or fails to accomplish, for a future whose objects are linked with those of the present” (p. 50). Thus, intervening prior to the negative experiences and emotions that might come from the failure of continued effort to make the experiment “work” count among those

that educators often attempt to accomplish. However, this is a sword with two edges, as the situation is more complicated than it might appear from the philosopher's comments. This is so because a change of plans intervenes precisely with going through a situation that Jane has chosen for herself. The situation conflicts with another condition of experience the philosopher specifies: the one concerning control over the conditions.

Toward a Theory of Experience

In the preceding section, we present an episode from a classroom, where students learn physics by doing extended experimental investigations. The episode might be considered mundane and reduced to a one-sentence statement: "The teacher, Carrie, told the student (Jane) that she had to change what she wanted to investigate." The episode, however, as Carrie said during an interview after the term, had lasting impact in that Jane, who had been very eager initially, had lost interest and ended up being the only student in the school with a failing physics grade for this term. Vygotsky and Dewey suggest that to theorize such events, we require the category experience that is spread over individuals and the settings in which they both act and are subject/ed to social/material environment. Out of the continuous stream of experience, consciousness and affect mark some in a way that they become remarkable, stand out as *an* experience. In the following, we highlight dimensions of a theory of experience that leads us to an appropriate understanding of what happened to Carrie and Jane. In the following we articulate four aspects that a theory of experience has to contain: (a) experience manifests itself in/has passions; (b) experience integrates over space and time; (c) experience is a moving force; and (d) experience is transformation.

Experience Manifests itself in/as Passions (Affect, Emotion)

The subject is that which suffers, is subjected and which endures resistance and frustration; it is also that which attempts subjection of hostile conditions. (Dewey, 1929, p. 239)

In our episode, Carrie and Jane affected each other and the situation as a whole. Carrie's subsequently stated intent was to tell Jane that she had to change her experiment; and Jane, in and through her "balking," did not allow rapid closure. Neither knew what the other would be saying, and, therefore, what they would be saying even seconds hence from where they were at any given instant in time. Experience is an appropriate category for capturing these dimensions, for they are part of its etymological heritage. *Experience* (*pereživanie*) in its original sense—in English and Russian as well as in the French *expérience* or the German equivalent *Erfahrung*—suggests that in contrast to the repetition of something, experience is related to travel, traversal, peril, risk, and change. The Proto-Indo-European root *per(e)-* denotes the verbs to try, dare, and risk, put oneself in danger; as such, it also made it into such words as *experiment* (Greek *peírama*, experiment) and *perilous*. That is, the category of experience includes risk and putting oneself in danger, and, therefore, our continued exposure to the world that is beyond our intentions and control. A second sense has made it into many modern languages: to carry over, bring, to go over, fare. As such, the root refers to transition, going through and

undergoing something. We are affected, which also means that we cannot anticipate all that comes with subjecting oneself to experience. There is a third sense in which the root has made it to the modern day: to go over, leading towards (e.g., “far,” “afar”), further, later, forward (prone, pronate) towards the end, a limit (perimeter). That is, *experience is both a process and that which, at its limit, the process gives rise to*: That of which the experience is an experience is an event. We do not control events: we live through and undergo them (as witnesses, patients, advenants) *as much as* we are agential subjects therein (Romano, 1998).

The etymological roots of the term *experience* show that there is more to experience than what we can intend. This more therefore exceeds what we know. Experience affects us in ways that we can come to understand only after the event has come to an end; and it affects us before we can understand what has happened (Roth, 2013a). Research in science education has recently turned attention towards these more receptive, aesthetic dimensions of experience (Pugh & Girod, 2007). A study of students’ development exhibited the perceptual and discursive differentiations of “what does belong and what does not belong in science class” (Jakobson & Wickman, 2008, p. 62). However, “the idea that human experience involves elements beyond our intentional control” (Wong, 2007, p. 203) has been underestimated and under-theorized.

Having *an* experience—one that is “integrated within and demarcated in the general stream of experience from other experiences” (Dewey, 1934/2008a, p. 43) as opposed to mere “automatic reflexes” of no significant contribution to further development—involves a “balance,” a “proportion” of *doing* and *undergoing*: “Unbalance on either side blurs the perception of relations and leaves the experience partial and distorted” (p. 51). Lust for completion (an excess of agency) results in an experience “so dispersed and miscellaneous as hardly to deserve the name” (p. 51). An excess of receptivity leads to an equally distorted experience “because nothing takes root in mind when there is no balance between doing and receiving” (p. 51–52). Reception means that we are given a gift; and gifts, as recent phenomenological analyses show, lie beyond our intentions (Marion, 1997). In this dialectic between doing and receiving, agency and reception are set in co-constitutive motion.

As Dewey, cultural-historical psychologists emphasize that activity cannot be “reduced to volitional processes and volitional experiences” (Vygotskij, 2005, p. 652). The passions—what we are subject and subjected to, including suffering and pain—are an integral and *irreducible* part of experience generally (Vygotskij, 1984). For this reason, we lack control over events: “[a]esthetic activity as well is *powerless to take possession* of that moment of Being which is constituted by the transitiveness and open-endedness of Being” (Bakhtin, 1993, p. 1). A theory of experience must include this open-endedness of “lived-life,” which, as we see in the episode, affects Carrie and Jane in ways that they could not anticipate (i.e., know in advance). But open-endedness means that there are limits to the extent that science teachers can plan the outcomes of the curriculum that they prepare (Wagenschein, 1999).

Experience Integrates Over Space and Time

In the episode, one word, statement, or turn arose from and led to another. There was a continued flux in which the give-and-take between Carrie and Jane took place; and this

give-and-take in fact produced the (conversational, eventual) flux. In and reflecting the unfolding event-specific relation, we observe manifestations of affect that Jane and Carrie make available to each other. An appropriate category of experience, therefore, has to capture the spatial distribution—here across Carrie and Jane—temporal *flux*, and affect as determined and determining manifestation. Dewey and Vygotsky propose the category experience (*pereživanie*) to do precisely that. Experience is a category of analysis that includes the individual and its world (environment). When we observe some happening, therefore, what is happening cannot be understood based on characteristics of the individual, as (radical) constructivist approaches do, or in terms of the environment, as behaviorist psychology did (Roth & Jornet, 2013). This irreducibility of organism and environment in the study of behavior is a recurrent topic throughout Dewey's writings, a unit that he already postulated in his early work (Dewey, 1896). The parts of the irreducible analytic unit—e.g., environment and person—cannot be understood as independent entities acting by themselves or as given elements of an interaction. This approach is consistent with unit analysis over analysis by elements (Vygotskij, 1935/2001, 2005). It is precisely because experience integrates across time and environments that it allows us to understand living through and undergoing an experience anew rather than repeating it under constraint (Waldenfels, 2011), as the empiricist tradition seems to suggest. Experience then is to be understood in this way: “when a name is wanted to emphasize the interconnectedness of all concerns, affairs, pursuits, etc., and it is made clear that experience is used in that way, it may serve the purpose better than any word that is as yet available” (Dewey & Bentley, 1949/1999, p. 187). As a result, “[t]he 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 can not be identified with either as an independent isolate” (p. 193). Empirical contributions in science education have come close to these ideas when operationalizing the students' recalls during learning activities not as “actualizations” of given experiences that have already been had, but as re-actualizations in which prior experiences are made significant in current experience throughout situated, joint action (Lidar, Almqvist & Östman, 2010).

Experience is a Moving Force

Experience is a moving force. Its value can be judged only on the ground of what it moves toward and into. (Dewey, 1938/2008b, p. 21)

The actual dynamic unity of consciousness, that is, the total of which there is consciousness, will be an experience. (Vygotskij, 1983, p. 383)

When we observe Carrie and Jane, their conversation appears to have an internal force. One turn leads to another, taking up (from) and completing the preceding turn at talk, while opening up another. The path the conversation is taking—even though there is an intended outcome that may likely be achieved given the ruling relations between teacher and student in an elite school—unpredictably arises from the sequentially ordered turns at talk. The momentum of the conversation, both its rate and its instantaneous directions, comes from within the conversation itself. To capture this aspect, Dewey and Vygotsky propose considering experience *as a moving force*. This character of experience is so important that “[f]ailure to take the moving force of an experience into

account so as to judge and direct it on the ground of what it is moving into means disloyalty to the principle of experience itself” (Dewey, 1938/2008b, p. 21). The category of experience denotes movement/change itself, which affords a holistic way of theorizing the situated nature of cognition (Roth & Jornet, 2013). This implies that it simultaneously refers to a learner throughout the entire course of a science laboratory investigation (Lidar, Lundqvist, & Östman, 2006). Experience therefore cannot be captured by means of a noun that denotes a thing: it is movement and force, simultaneously. “*Experience*” names “this *dialectical* movement that consciousness exercises on itself and that affects both its knowledge and its object, *inasmuch as the new true object issues from it*” (Hegel, 1807/1979, p. 78, original emphasis, underline added). A precedent for a self-moving system is economy (Marx/Engels, 1962). Thus, Marx elaborates “the system of capitalist relations as a ‘self-developing system,’ as a concreteness closed in itself, of which the motive forces of development lie within itself, in its internal contradictions, in the immanent contradictions of the economic form” (Il’enkov, 1982, p. 121). However, “unless the productive forces develop, no ‘internal’ dialectics of the system . . . will produce an evolution” (p. 121). Therefore, experience, if it is to be a force, must itself encompass change. This is precisely what Dewey makes a requirement of his theory of the continuity of experience: “Every genuine experience has an active side which changes in some degree the objective conditions under which experiences are had” (Dewey, 1938/2008b, p. 22). In the unity of experience, the development of the forces is to be taken “not by itself, not only as a cause, but also as a consequence, result, and product of the reverse action of the system of production relations on the productive forces” (Il’enkov, 1982, p. 121). The production relations exist in the transactions within and constituting the system that for Dewey manifests itself as context and individual.

Experience is Transformation

Carrie subsequently described the episode as a transformative one. First, she noted that Jane was losing interest, and this loss was tied to the point in time when the student was asked/forced to change her experiment rather than doing it in the way she wanted. Second, the event also changed Carrie, who noted that it had made her more aware of the needs of students, of having become aware that she needed to express herself in ways that do not upset students. That is, the event, as *an* experience, was transformative. Dewey as Vygotsky created the analytical category to denote transitions: from a first object and the knowledge about it into a second object that experience is said to be about. Experience is a traversal of the self into the self, “the advent of the self in itself in the absolute difference with itself” (Romano, 1998, p. 197). This change is not the change of a subject identical with itself right to the core of its changes (e.g., the same before and after its construction of an “identity”), but a “coming of self in the self in the absolute difference with itself” (p. 197). Thus, in experience there is a process of transformation that exceeds any intention or anticipation, and of which Dewey was well aware. In that process, “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). Researchers concerned with the aesthetic aspects of (science) learning have pointed out the need to consider not only the conceptual and discursive aspects of students’ interactions, but highlight that we need to consider science learning also as

“something to be swept-up in” (Girod, Rau & Schepige, 2003, p. 575). These authors consider the goal of science education to be not only to teach students concepts, but facilitating “transformative, aesthetic experiences” that will transform the way the students approach the world after this learning experiences are had, and have called the science education community to attend more carefully to this issues (Pugh, 2011; Pugh & Girod, 2007). Throughout this study, we provide an account for just what it means for an experience to be transformative, an account that is entirely consistent with the non-dualist, non-teleological and anti-representationalist stance that marks the philosophical traditions we bring together here.

Discussion

The purpose of this study is to (a) contribute to the building of a theory of experience that takes into account recent philosophical developments of the analytic category and, in so doing, (b) raise science educators’ awareness about the importance of the phenomenon of experience to education and learning. For Dewey, experience is the means and goal of education. It is the means, because experience is a traversal, a going through and exposure to the unknown (and therefore alien). It is the goal of education, because *any* (significant) experience arises some of the flux of inchoate experiences. Teachers can speak out of experience only because they have gone through and been exposed to experiences; it is only through a number of significant experiences that they become experienced as teachers. For Dewey, as for Vygotsky, experience (*pereživanie*) is an encompassing category, a unit that differently and differentially manifests itself in and through its practical, intellectual, and emotional shadings. The reality of the encompassing experience is reflected differently in, and manifests itself differently to, any individual participant. The dimensions (manifestations) of this unit cannot be considered in isolation—i.e., as elements—without losing the phenomenon because the practical always also is intellectual and emotional, the emotional always also is shaded practically and intellectually, and the emotional always also has an intellectual and practical side. In this study, we highlight the fact that the emotional (affective) dimension is integral aspect of the intellectual—it is not the result of an interpretation—because the intellectual itself is perfused with affect. A case study is provided that exhibits the relation of these dimensions in a teacher-student meeting concerning a change of plans in the design of an extended empirical investigation. Our analysis shows how the affective dimension is tied to the intellectual issue of the experimental design. The case study was chosen because students’ experience in and with science arise from many such individual experiences that recursively shape future experiences. We suggest that a better understanding of the continuity of experience, in the sense of Dewey (1938/2008b) or Leont’ev (1983), is required for understanding the role of science education in the development of personality.

In this text, we chose an event in which conceptual aspects are more tangential. Bluntly stated, a science teacher tells (attempts to convince) her student that she cannot pursue the investigation for which she has already purchased all the necessary equipment but has to do another one. Our choice of the episode was explicit because, as the subsequent comments on the part of participants appear to suggest that it was “*an* experience” in the Deweyan sense, that is, an experience that made a difference in and to

the lives of the two protagonists. It made a difference in the way in which Jane related to and engaged with physics, and perhaps with science more generally. A pragmatic approach highlights for us the importance to consider such experiences, for the perhaps “greatest of all pedagogical fallacies is the notion that a person learns only the particular thing he is studying at the time” (Dewey, 1938/2008b, p. 29). Perhaps even more important than the intellectual aspect of a particular science lesson is what students learn without intending it—i.e., “the formation of enduring attitudes, of likes and dislikes” (p. 29). Some science education research has highlighted this dimension, using the Deweyan term “collateral learning” (e.g., Lundqvist, Almqvist, & Östman, 2009). Concerning content-related experience, it would be “a mistake to suppose that the mere acquisition of a certain amount of arithmetic, geography, history, etc., which is taught and studied because it may be useful at some time in the future, has this effect” (Dewey, 1938/2008b, p. 28) just as it would be “a mistake to suppose that acquisition of skills in reading and figuring will automatically constitute preparation for their right and effective use under conditions very unlike those in which they were acquired” (p. 28). That is, Dewey suggests that we should not expect the transfer between specific experiences even though they are part of the flux of experience. That is, *an* experience in one situation, and the “skills” we develop therein, is not *automatically* mobilized later, especially under conditions unlike those in which they were originally experienced (e.g., Lave, 1988). Thus, the way in which Jane has been changed in the course of this experience may be in terms of how she experiences the quality of subsequent events in science classrooms. This, more so than doing or not doing an investigation may have led to loss of interest, withdrawal, and failure in this course and, perhaps, science in general.

Throughout this paper, we point to the mutual interdependence of environment and person, and, therefore, to the fact that the same environment will influence the continuous flux of experience (development) in very different ways. Thus, for science teachers to contribute to the education of their students, “must have a long look ahead” “to see [their] present work in terms of what it accomplishes, or fails to accomplish, for a future whose objects are linked with those of the present” (Dewey, 1938/2008b, p. 50). They therefore “need to be able to find the relationship that exists between the child and its environment, the (emotional) experience [pereživanie] of the child, in other words, how a child becomes conscious of, comprehends, emotionally relates to a certain event” (Vygotskij, 1935/2001, p. 75). This will assist them in adapting their actions to lead to an experience such that it has positive influence of the science student’s growth. Here again, the intellectual is inseparable from the affective, for the nature of the steps to be taken, the nature of the design of the experiment Jane will undertake, is irreducible related to the further affective moment and, therefore, to her subsequent experiences and the experience of the physics course as a whole.

Current science education theorizing often makes thematic boundaries and borders, which learners are said to have to cross—including the notions of border-crossing, boundary worker, and third space in science classrooms (e.g., Aikenhead, 1996; Akkerman & Bakker, 2011; Tan, Barton, & Lim, 2009). In the same way as cultural-historical activity theorists (e.g., Bakhtin, 1993; Leont’ev, 1983), Dewey (1938/2008b) emphasizes the *continuity* of experience in the face of difference. Thus, even if students were crossing boundaries, such events would themselves be experiences in the continuity of experience and integrated into the developing personality—which is what has been

shown in the transitions between school and workplace apprenticeships among electricians (e.g., Roth, 2012b). Dewey (1938/2008b) writes that every experience takes up something from previous experiences and modifies not only subsequent experiences but also the one who acts in and undergoes experience. This is so in any case, “since every experience affects for better or worse the attitudes which help decide the quality of further experiences, by setting up certain preference and aversion, and making it easier or harder to act for this or that end” (p. 20). This also means that experience never is precisely the same, always is something new, because once-occurrent (Bakhtin, 1993). Because experience is always new, it does not signify other than the transformational process itself.

Wong et al. (2001) argue against the widely held and naïve view often attributed to Dewey that students will learn better science by the very fact that they generate scientific ideas by themselves instead of by passively learning them from instruction. Indeed, the debate concerning whether instruction is to be teacher-led (direct instruction) or student-led (free exploration) often falls within a dichotomous views in which either-or positions seem to be the only alternatives (e.g., Kirschner, Sweller & Clark, 2006; Mayer, 2004). Moreover, the discussion is always held in terms of the emergence (either from within or from without) of “conceptual” structures (e.g. Kapur, 2008). Considering learning experiences as indivisible units of intellect, emotion, and praxis, however, suggests the need of avoiding discourses that limit themselves to intellectual dimensions, as this often is the case in our field. Emerging approaches in science education that already assume such irreducibility of the category of experience exist. Such is the case of the *practical epistemology analysis* framework (Lidar, Almqvist, & Östman, 2010; Wickman & Östman, 2002). Investigating how students “fill gaps” that are noticed in “encounters” with others and with the world, researchers applying this framework have shown that there is more to science learning than generalized conceptual and propositional explanations; the contingent, material aspects of the learning situation usually involve learning to make and recognize as continuous perceptual distinctions that emerge as learners participate in normative practices (e.g. Hamza & Wickman, 2009, 2013). The category described in this study suggests that such analytical frameworks may be expanded so as to capture not only how students “construct” new relations across situations, but also how students are subject and subjected to these new relations that, if not considered to be reduced to the individual, must emerge in the ongoing societal relation prior to any grasping of what “stands fast” in a situation.

The inherent motion implied in the category of experience suggests that the discussion must avoid one-sided interpretations of learning as processes of “construction” or “appropriation.” According to Vygotsky, the final form of child development is already present in its initial moments, because it is the societal relation that forms part of the unit of *pereživanje* [experience] that will affect and be affected by its own confronting to itself (Vygotskij, 1935/2001). Thus, “*something which is only supposed to take shape at the very end of development, somehow influences the very first steps in this development*” (p. 84, original emphasis). This makes possible considerations of learning as coming from within the unit of experience, yet being something inherently strange to it. It is the dramatic collision between people in experience (Veresov, 2010) that “takes root in the mind” and comes to influence the objective conditions (internal and external to the individual) in which further experiences are had. Similarly, in Dewey’s account, it is

in the collision between anticipation and consummation that experiences acquire “vital” character and therefore come to be integrated into the continuity of experience and, hence, in future (learning) experiences. What these two lines of argument suggest is that both the notion of “direct instruction” and that of “pure discovery” are at odds with a view of learning as part of vital (significant) experiences. Scholars in the cognitive and learning sciences have for long time claimed that, despite what seems to be the most extended belief, the biggest challenge that educators face is not to develop better learning materials, but to stimulate students’ desire for learning (Csikszentmihalyi, 1990).

Experience is an important category for science educators, because “it is impossible to obtain an understanding of present social forces . . . apart from an education which leads learners into knowledge of the very same facts and principles which in their final organization constitute the sciences” (Dewey, 1938/2008b, p. 54). That is, both as an introduction to habit of becoming a scientist as well as to understanding social forces more generally, experiences in/with/of science as part of schooling is tremendously important. The relationship between relevant experiences and education are intimate and necessary. However, the progressive organization of subject matter should reside in present experience organized in a way that “is free, not externally imposed, because it is in accord with the growth of experience itself” (p. 55). Grounding future in current science experiences constitutes “the basic principle of using existing experience as the means of carrying learners on to a wider, more refined, and better organized enviroing world, physical and human, than is found in the experiences from which educative growth sets out” (p. 55).

Experience is a category that leads us to see and analyze classroom events in ways that differ from current practices in our field. The holistic way of approaching science learning questions the reduction of classroom events to (the minds of) individuals. The latter tend to be thought of as the agents that bring about the events rather than as patients who are subject and subjected to events that they are never under their (complete) control. The category experience (*pereživanie*), in the form of irreducible individual-acting-in-and-affected-by-the-setting units, constitutes challenges to the current constructivist epistemology that privileges the self-sufficient constructing mind.

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