Bridging the Theory and Empiry of Learning from Failure

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INTRODUCTION

Learning necessarily begins with 'not having learned something yet,' a gap that exposes the limitations of previously known paths of acting and thinking.[1] In this paper we discuss the nature of that gap and how it might be interpreted in pedagogical contexts.

We begin with the assumption that not-knowing is neither entirely objective or subjective, but rather emerges dialogically within the interaction of the subject with the world. An unknown thing only becomes 'a thing' in its difference to a known thing; the unknown thing is, therefore, already partially determined by the subject.[2] Learning, from this perspective, happens not in a vacuum but as part of the individual's experience of a new situation 'through' what was learned or experienced earlier.[3] A philosophical account of 'the unknown thing' is found in Hegel's description of the difference between the individual and the world as "the absolute negativity."[4] Absolute negativity describes difference as a mediated relation between the self—which is itself shaped dynamically in the mediated relation—and 'the other.' A meaningful 'other,' in turn, "is itself mediated by its relation to self-consciousness and hence it is relational in itself."[5] Difference that is "mere diversity or manifold"[6]—meaning unmediated and unrelated-to—becomes "indifferent" exteriority, or a form of "sameness (*Gleichheit*)." Hegelian not-knowing is therefore always mediated and relational.

Another premise of this paper is that implicit to negativity is a notion of a future-oriented 'not-*yet*-being', which makes negativity an educationally relevant category. Difference and negativity conjure a movement toward their own resolution. This "return to oneself, which presumes prior

alienation,"[7] as Gadamer describes it, is the essence of the lifelong formation of the individual (*Bildung*) in relation to the world. In that perspective, recurring 'alienation' and the accompanying negative experience of "disillusionment and perplexity"[8] are constitutive to the formation of the individual: the world reveals itself to us in our shortcomings and insufficiencies; it reveals itself to us in our *failure*.[9]

While the fact that learning is necessarily connected to negativity, i.e. difference, is easily understood, we argue that the notion of 'failure' remains undertheorized as a pedagogical category. Is failure the opposite of success, or does failure refer to the personal experience of insufficiency? Does every difference between me and the world leads to a negative experience that induces learning? What does it mean to 'fail' to solve a problem that someone posed to me if I do not care that I am unable to solve it?

Difference, negative experiences, and failure—failure interpreted in the traditional psychological sense of encountering evidence that violates expectations—have always been popular themes in educational thinking. Dissonance, struggle, or even pain are important narratives from Plato's cave metaphor to Rousseau's 'éducation négative' and Piaget's equilibrium. The argument that negativity is not only the foundation of learning but a guiding principle of pedagogical interaction can be found in a number of pedagogies and research programs: to illustrate, we find it in educational studies of uncertainty,[10] argumentation and collaboration,[11] impasse-driven learning,[12] constructivist design-based research,[13] and conceptual change pedagogies.[14] While these pedagogies and research programs bring forth convincing empirical evidence, we offer that the field's understanding of failure and the pedagogical nature of negativity remain underdeveloped and often unconnected to the rich theory of failure found in the philosophy of education.

We offer that bringing together empirical and theoretical traditions that rarely speak to each other may enrich both theoretical discussion and empirical research. Our paper ties on to Derry's recent discussion of the implications of Cognitive Load Theory for teaching, extending the fruitful interdisciplinary exchange it initiates by focusing on the other side of the

instructionist-constructivist debate.[15] We bring attention to an influential contemporary research program that positions invention activities and failure as pedagogically desirable: the experimentally-derived instructional design of "Productive Failure"[16] (henceforth PF), where failure is purposefully designed for and serves as preparation for future learning. We offer that PF makes a significant contribution to the normalization of failure in current discourses. Its notion of failure, however, remains underdeveloped. PF presents failure as a fixed category representing the opposite of observable predefined success at solving an externally posed problem, neglecting, amongst other things, the subjective dimension of failure and the accompanying complexities of failure as a pedagogical category. Our aim is to enrich the comparatively limited discussion of failure in PF by supplementing it with existing traditions in the philosophy of education that discuss failure: Dewey's theory of experience and Vygotsky's Zone of Proximal Development (henceforth ZPD). Finally, we aim to explore the ways in which these theoretical, philosophical, and empirical perspectives may enrich our understanding of negativity, negative experience, and failure as pedagogical categories. By bridging the paradigmatic boundaries between experimental and theoretical approaches that seldom speak to each other, we seek to enrich our conceptual understanding of failure as a pedagogical category and make a contribution to the normalization of failure in the current failure-aversive logic of educational research and practice.

'PRODUCTIVE FAILURE'—AN EMPIRICAL APPROACH TO 'FAILURE' IN LEARNING

Even though educational thinkers, psychologists, and pedagogues have long argued for the importance of 'failure' in learning and education, this perspective is not always appreciated.[17] The space for failure in education seems to become increasingly precarious, particularly in the light of current policy- and market-driven educational discourse.[18] With an emphasis on evidence-based practice and predictability of educational processes, standardized learning *outputs* tend to be valued over the harder to grasp, longer-term

learning *outcomes*; struggle and failure present hindrances for measurable attainment. Consequently, "more often than not, researchers have tended to focus on different methods for structuring learning and problem-solving activities so as to achieve performance success."[19]

The PF learning design that we focus on in this paper—while arguably owing some of its popularity to the 'evidence-based-practice' discourse—also provides an important counterpoint to the current research climate in education. Guided by the observation that "learning and performance are not always commensurable,"[20] PF contends that short-term failure might have hidden efficacies for longer-term learning that are predominantly overlooked in performance-focused research. PF 'sacrifices' maximizing "performance in the shorter term"[21] in order for students to "notice inconsistencies and realize the limits of their prior knowledge."[22] PF consists of two phases: (1) a rich problem design that affords multiple representations and solution methods, and (2) follow-up instruction that compares and contrasts student-generated solutions with the canonical one. The problem design is tuned to such a degree that students are highly unlikely to initially solve the task (hence 'failure'), yet their initial struggles enhance their learning from subsequent instruction (hence '*productive* failure'). In a number of empirical studies, PF has been associated with measures of better 'conceptual understanding' and 'transfer' compared to direct instruction, where direct instruction is defined as the typical paradigm of providing explicit instruction followed by problem solving. In short, asking students to explore prior to instruction—even when this exploration leads to failure—leads to better learning than typical direct instruction.

As a research program, PF has produced high-profile publications in cognitive science, educational psychology, and learning sciences journals. Its design principles have been implemented internationally, and PF has contributed to the increasing appeal of student-centered activities as preparation for instruction in other research programs.[23] We contend that PF is both an important counterweight to current trends in educational discourses toward quick and measurable output, as well as an empirical program that

steps into and has the potential to revive the negativity-discourse in education. PF normalizes failure in a climate of educational research and practice that pulls away from failure and negative experiences as catalysts for learning. We find, however, that PF is theoretically wanting. In particular, PF's notion of 'failure' receives limited attention, being defined simply as the inability of students to "generate or discover the correct [normative] solution(s)"[24] to a posed problem. To date, the underlying theoretical framework remains largely implicit and focused on isolated mechanistic interpretations. In order to develop this framework, we will draw from two of the most well-known proponents of a failure- and negativity-oriented educational theory: Dewey and Vygotsky.

NEGATIVE EXPERIENCE AND DISCONTINUITY IN DEWEY

Dewey thought of education as a process of growth by experience.[25] Rather than an external 'event,' he defined experience as a process of *doing* or acting in the world, and subsequently *undergoing* the consequences of that action. The individual learns from experience by reflecting on the connection between doing and undergoing, and incorporating the gained understanding into future activity.[26]

Negativity and negative experiences are essential to Dewey's understanding of experiences as "transactions of living organisms and their environment"[27]: in interaction with the world—both material and social—the individual repeatedly experiences "friction" and "resistance."[28] When incapable of achieving an end-in-view, the individual realizes that existing skills or beliefs are insufficient or false, which, in turn, causes perplexity and confusion.[29] Based on that negative experience of insufficiency, the individual tries to understand what caused the 'resistance'.

For example, imagine I grew up in one place and, by experience, learned culturally accepted and socially appropriate ways to engage in small-talk with strangers. If I then went to a different country and approached locals in the same way that I always do (the *doing*), I would likely be con-

fronted with some resistance (the *undergoing*). People might react differently from what I am used to, or they might even disengage from talking to me, perceiving me as rude. This would lead to a negative experience; I might feel confused as to why people do not want to talk to me, or feel upset or lonely by the lack of connection. I may then realize that what I had previously accepted as appropriate small-talk with strangers has certain previously-invisible cultural boundaries. Whereas, before these encounters, I had a consistent idea of what small-talk is, afterwards, I would no longer have that stable frame of reference. Likely, I would be keen to change my behavior in such a way that my conversations with strangers are more fruitful. To achieve that end, I would have to reflect on my previous ideas of small-talk in relation to people's recent reaction to it. Whereas before there was but one way to small-talk, this experience of a difference would lead to learning. The same structure of educative experience as illustrated in this example of small-talk also applies to formal learning situations.

This process, in which doing and undergoing are connected reflectively, is the natural drive of the individual to re-establish continuity in experience. Continuity in experience means to "make a backward and forward connection between what we do to things and what we enjoy or suffer from things in consequence."[30] Dewey defines *continuity* of experience as a criterion "by which to discriminate between experiences which are educative and those which are mis-educative."[31] An experience is educative, therefore, if it leads to new connections.

While *dis*continuity is not explicit in Dewey's own words, but as Andrea English points out, it emerges implicitly as the pre-reflective interruption in experience that, upon reflection, can be understood as a 'problem.'[32] In Dewey's view, discontinuity is not "a mere void of lack"[33] to be overcome in a predefined way, but rather the essential counterpart to continuity that produces motion for change and development. Discontinuity is "the power to grow."[34] Discontinuity incorporates and goes beyond the Hegelian 'absolute negativity'; it combines the *fact* of negativity—meaning the difference—with negative *experience*. Therefore, a Deweyan perspective can aid the devel-

opment of a clearer differentiation of the two, which, in turn, has important implications for the development of negativity as a pedagogical category.

In Dewey, experiences are not externally determined, but rather the result of a complex, contingent and relational process of meaning-making. The environment and the individual are not two independent forces 'clashing' in encounters; the environment "is what an organism experiences; that is, what they incorporate into their functioning."[35] Only what, upon reflection, can be understood as a 'problem' can become a matter of further inquiry based on "careful observation of the given conditions."[36] To some differences, we can safely assume, the learner remains indifferent. Educative experiences, i.e. experiences that produce connections between doing and undergoing, however, depend on 'real' moments of perplexity that spark a *genuine* experiencing of negativity. Such genuineness, in Dewey, is connected to an act of doing, the volition to achieve a certain aim. A negative experience is thus more than a 'knowledge awareness gap': In addition to being confronted with something that one has not yet learned, this 'something' has to be connected to something one wants to achieve.

VYGOTSKIAN ZONE OF PROXIMAL DEVELOPMENT (ZPD)

Another well-known account of not-knowing comes from Vygotsky. In *Thought and Language*, Vygotsky acknowledges the truism that a novice will, by definition, encounter failure. To this end, he offers the metaphor of a child's mind bumping "into the wall of its own inadequacy," whereupon the resultant bruises "become its best teachers." However, he continues, "one must inquire whether that series of failures is the sole 'teacher' of the child. Is it possible for the inadequacy of the child's thought to be the only real source of [learning]?"[37] Vygotsky answers in the negative—failure cannot be the sole teacher—and highlights the educational importance of social guidance in the ZPD, defined as the distance between present development as determined by independent problem-solving and potential development as determined by guided problem-solving (e.g., parental guidance). Vygotsky

explains that,

> With assistance, every child can do more than he can by himself… The child is most successful in solving problems that are closer to those solved independently; then the difficulties grow until, at a certain level of complexity, the child fails, whatever assistance is provided.[38]

Here and elsewhere, Vygotsky views failure (the counterpart to success) as an inescapable element of development. For this reason, avoiding failure is unproductive. Note, also, that this establishes two categories of failure: there are failures that can be pedagogically worked with—that is, failures that occur within the ZPD—and failures that cannot.

An example of pedagogically workable failures can be found in Vygotsky's account of the development of pointing, which begins with a failed grasping movement towards some object that is beyond one's immediate reach. A caregiver observes this failed grasping action and moves the object towards the infant. With repetition, the child comes to understand that other people can provide a means of reaching beyond his or her capacity. This elementary example provides insight into how humans incorporate new (social) means of surmounting failure.

Essentially, humans learn to incorporate a range of artifacts—formulae, techniques, tools, etc.—in order to control behavior. These artifacts are a means of surmounting failure within ZPD. The old behavior is not merely enhanced but transformed, in precisely the same way that "The adolescent who has mastered algebraic concepts has gained a vantage point from which he sees concepts of arithmetic in a [new] perspective."[39] In his private notebooks, Vygotsky emphasized the new not merely building incrementally upon the old, but transforming and superseding it: "The formula of a concept…: to lose something in order to find something."[40]

However, Vygotsky did not elaborate how this process of transformation takes place in educational settings. For a closer reading of proximal development, we turn to the work of Wertsch.[41] Wertsch argued that proximal development rarely, if ever, follows the simple linear trajectory of a child

failing, acknowledging their not-knowing, and the resultant 'gap' being 'filled' by the expert. Rather, the process follows a certain logic in which the child, after initially failing to interpret the adult's utterances in a way meaningful to the activity, becomes increasingly (not incrementally) able to follow directives and transitions from other-regulation to self-regulation. With growing responsibility in regulating the activity, the child completes the transition to self-regulation and carries out the task without requiring expert guidance.

Therefore, the key to understanding proximal development is recognizing that there is not one task situation, but the situation as the child perceives it and the situation as the adult perceives it. Before the child can follow directives, the awareness of what is not-known must be established. For this reason, Wertsch emphasizes that a shared understanding must be "created rather than assumed."[42]

According to Wertsch, shared awareness is developed for the child by carrying out the behaviors specified by the adult and *then* building a coherent account of what those behaviors mean in a given situation. In later work, Wertsch revisits these findings to emphasize that a "fundamental characteristic" of ZPD involves "giving up a previous situation definition in favor of a qualitatively new one,"[43] anticipating Vygotsky's statement, not published at the time, that to learn we "lose something in order to find something."[44] This qualitative change means that the development in the ZPD cannot be understood purely in terms of additive increments. Instead, it involves a leap that occurs through the child becoming regulated by the adult's understanding of the situation. Note that this is not the same as the child understanding how to solve the problem embedded in the situation; rather, it means that the child is simply able to see the problem as a thing in the world. It means, in other words, that the child is able to comprehending their failure and inadequacy.

DISCUSSION

Dewey's theory of educative experience, Vygotsky's ZPD, and PF all

root the beginnings of learning in the difference between the individual and the world, and, to some degree, the experience of that difference. They differ, however, on the purpose they assign to difference and failure in pedagogical and educational contexts. Here we draw together the key points of the paper and explore the implications of bringing these perspectives together on the notion of failure and its pedagogical dimension.

In the analysis of Dewey's theory of experience, different aspects to the concept of 'negativity' were established that are constitutive to learning. First, there is the Hegelian understanding of negativity as mediated difference between the subject and the world. Second, there is the pre-reflective awareness of that difference, and third, the reflective meaning-making potentially resulting from that difference. From Dewey's account of 'discontinuity' we gather further that difference is educationally meaningful in the sense that it creates a 'negative experience' which the individual seeks to overcome. Educationally meaningful difference, in other words, emerges in the context of activity and dialogue. It requires not only difference and awareness of that difference, but self-relation.

Pedagogical interaction can support the processes of self-relation—only, however, if difference and negative experience are considered fruitful in educational processes, rather than unnecessary obstacles for immediate, measurable performance success to be 'scaffolded away.' Creating meaningful difference in classrooms, however, is challenging. If we assume that the difference and the negative experience of that difference are not the same thing—nor necessarily concurrent, yet required for learning to begin—then it is not sufficient to merely confront the learner with something they cannot yet do or do not yet know. Creating moments in which students might fail at tasks does not necessarily lead to negative experiences that, in a Deweyan view, are educationally meaningful. The individual learns from negativity that causes a *genuine* negative experience. Dewey emphasizes: "The only way in which adults consciously control the kind of education which the immature get is by controlling the environment in which they act and hence think and *feel*."[45] Not all difference, in other words, constitutes discontinuity in the

Deweyan sense. What makes failure potentially meaningful is the quality of the individual's engagement with failure.

In the Vygotsky-Wertsch account, we find an emphasis on teachers using directives and guidance to modify the child's environment so that the child can carry out the task even as they build a coherent narrative for their actions. In other words, the child engages in guided activity, and through this emerges the awareness of the adult-meaning of the situation. Some educational designers have called this the "action before concept" design framework.[46] The essential understanding of learning underlying this design can be found in the following quotation: "Learning itself is not conscious […] Nevertheless, the process depends on conscious processes in feeling and detecting changes. The consequence is felt as difference."[47] The child is guided through the activity in order to feel/experience how this other-guided action differs from their more spontaneous performance.

PF presents an interesting addition to this discussion of failure in pedagogical contexts as it factors in failure—and therein 'meaningful difference' that contributes to learning—as a constitutive element of its learning design. Failure, following Kapur, has the potential to benefit learning, "*if well designed for*."[48] In well-designed failure, an understanding of educationally meaningful difference as something that can be—or even must be—created externally emerges. 'Failure,' therein, appears as an objective difference—*any* objective difference, to be precise. Inherent to such a conception of negativity as a design principle are certain assumptions about the nature of experience and the 'pedagogical availability' of someone else's experience. Difference is not understood as a process of mediation and self-relation; PF fails to acknowledge the relevance of negative experience by omitting the 'doing' part of an educational experience. Vygotsky's idea of failure, despite being similar to that of PF in that they both stand in as the opposite to 'success' at a task, is different from PF in at least one fundamental way: in Vygotsky, failure is located within an activity chosen by the individual. Activity, in Vygotsky, is not reactive to external events, but defined by what is "taken up by people."[49]

In all three approaches—PF, Dewey, and Vygotsky—failure and negative experiences function as a sort of 'preparation for seeing': only once I fail do I become aware of what I cannot do and can learn. Difference, therein, is connected to awareness with the hope of creating a negative experience that induces learning. In light of the discussion of failure developed in this paper, the idea of failure as a means of 'preparation' requires further differentiation. Dewey provides a critical perspective on PF's position of failure as a preparation for future performance:

What, then, is the true meaning of *preparation* in the educational scheme? In the first place, it means that a person, young or old, gets out of his present experience all that there is in it for him at the time in which he has it. When preparation is made the controlling end, then the potentialities of the present are sacrificed to a supposititious future.[50]

Reducing failure to preparation for future instruction in order to achieve a certain goal, from a Deweyan perspective, throttles the educational potential of the experience of failing. He notes further, pointing at the impossibility to know the future we seek to prepare individuals for in education: "The ideal of using the present simply to get ready for the future contradicts itself. It omits, and even shuts out, the very conditions by which a person can be prepared for his future."[51]

Vygotsky notes that awareness starts with noticing differences, seeing what is not the case. In turn, the purpose of an educational activity is about building awareness rather than reaching a performative end state. Its educational purpose is growth in awareness of difference, which emerges from a felt difference in a socially-guided activity. This coincides with our Deweyan argument that the endpoint of an educational activity (e.g., solving a task, getting the correct answer) is not the educational purpose of said activity. Educational practices that prescribe pre-defined outcomes, from a Deweyan perspective, also fall short on enabling genuinely educative experiences: "To make an end a final goal is but to arrest growth."[52]

In this paper we have argued that what makes difference meaningful

is the quality of a learner's engagement with failure, which itself has to be understood as an authentic experience of negativity that urges the learner to attempt establishing continuity.[53] Pedagogical interaction supports processes of self-relation rather than leading the student toward a predefined end. Despite the underdeveloped conception of 'failure' in PF—which lacks a differentiation between these different layers of failure and disregards the role of the teacher in relation to difference and negativity—reflecting on its notion of 'failure' in a cross-disciplinary discussion presents an unique opportunity for discussing the merits of failure in learning and education. Rethinking PF with Dewey and Vygotsky can help us to reframe the aims of education and the role of teaching beyond the current focus on testable academic achievement. More broadly, it may eventually enable us to reframe the disciplines not as "filled with content" but as particular forms of not-knowing.[54]

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