

Authoring One's Own Learning

Measuring the Emergence of Authorship in Education, and the
Generative-Relational Ethics Behind It

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1 The problem, concretely

Two students score 90 on the same calculus exam. One can carry the method to a problem she has never seen, and begins to pose questions of her own; the other can reproduce the drilled problem types and stalls the moment the teacher steps away. Standard assessment records them as equal. They are plainly not. One has become an *author* of her own learning; the other has not. Examinations measure what a student can reproduce—a stock of knowledge that can be transferred and tested—but they are largely blind to whether the student has come to author her own questions, and that is often the thing education most wants to produce.

This project asks three connected questions. *What* exactly is the difference between a student who has become an author of her learning and one who has not? *Can it be measured*, longitudinally and independently of exam scores? And *which kinds of teaching produce it*—under what conditions does a teaching relation transfer authorship to the student rather than holding her in dependence? The claim that makes the project more than a study of “autonomy” is that these questions have a precise answer drawn from a general theory of how value and authority are generated within relations, and that the answer yields a falsifiable prediction standard evaluation cannot make: that generativity and exam performance can come apart, so that a curriculum can produce high scores and low authorship at once, and this can be detected.

2 The quantities measured

For each student we track, over a term, three quantities that educational research already records in some form: *autonomy* a —the rate at which she initiates questions and tasks unprompted; *dependence* d —the degree to which completing work requires the teacher’s intervention; and *generative output* g —the rate at which she produces new, non-reproductive contributions (original questions, transfer to unfamiliar problems), coded so as to be distinct from reproduction a recording could replace.

The signature of authorship being transferred to the student is a trajectory in which autonomy rises while dependence falls. A single index captures its direction over a teaching cycle,

$$\Theta = \Delta a - \Delta d,$$

read as follows: $\Theta > 0$ (autonomy up, dependence down) is teaching that returns authorship to the student; $\Theta \approx 0$ is mere transfer of information, generating nothing the student now owns; $\Theta < 0$ (dependence up) is teaching that fixes the student in reliance on the teacher. The framework that motivates Θ (Section 4) gives it a deeper reading—the sign of a circulation of

value through the teaching relation—but the index itself is simple and directly estimable from longitudinal data.

The project also distinguishes, sharply, the *stock* of knowledge (what an exam measures—countable, transferable, appropriable) from the *surplus* an authored relation generates (the non-reproducible capacity that is not localizable in either party). The central empirical prediction is that these can diverge.

3 The study: lecture-drill versus inquiry-based instruction

Two cohorts are followed over a term, one taught in a lecture-and-drill mode, one in an inquiry-based (broadly Socratic) mode, with (a, d, g) sampled at regular points and interaction coded from classroom video or learning-management-system logs. The framework issues its predictions *before* the data, which is what makes the study falsifying rather than merely descriptive:

- the inquiry cohort shows a $\Theta > 0$ trajectory (dependence decaying, autonomy rising);
- the lecture-drill cohort shows $\Theta \leq 0$, and where students are held in dependence, $\Theta < 0$;
- *crucially*, the two cohorts may post comparable exam scores—comparable stock— while diverging in Θ and in transfer ability—the surplus.

The verdict rule is explicit. If the Θ trajectories diverge as predicted *and* independently of exam score, the framework is supported; if Θ covaries entirely with exam score, or the inquiry cohort's Θ is not higher, it is falsified. The prediction that authorship and score come apart is the project's empirical signature, and it is directly relevant to how teaching is evaluated: a system optimizing scores alone may be systematically producing low authorship without any current instrument registering it.

One limit, stated plainly. Behavioural autonomy a is a *necessary but not sufficient* measure of authorship in the full sense. A student may initiate freely yet still work entirely inside a problem-frame the teacher has fixed—active, but not the author of the questions themselves. Falling autonomy almost certainly marks damaged authorship; rising autonomy is only one of its conditions. Full authorship requires that the student come to author *the standing questions*—to redefine tasks, to contest the criteria of assessment—which calls for richer indicators (task redefinition, criterion contestation) beyond Θ . The project measures one observable dimension behaviourally while keeping the concept it answers to irreducible to that dimension.

4 The ethics behind it: authorship, and the refusal of imposed meaning

Why call this *authorship* rather than merely autonomy, and why does it matter ethically? Because the educational question is a special case of a question in the theory of justice: when is a person the author of a judgement that binds her, rather than merely its recipient? Nadia Mazouz's deliberative theory of justice argues that a theory is only half deliberative if it fixes the good by an external stipulation (a *Festsetzung*) handed down to those it is meant to orient: the just is deliberated, the good is quietly posited, and the persons oriented are the *affected* but not the *authors*. Top-down ethics, in this sense, produces a hermeneutic alienation—meaning about how to live is imposed rather than generated by those who must live it.

Teaching is exactly this structure in miniature. Instruction that fixes the student's interpretive frame—deciding for her what the questions are and what counts as a good answer—is a

Festsetzung: the student is affected but not author. Instruction that lets the student come to constitute her own questions transfers authorship to her. The ethical distinction between top-down imposition and bottom-up generation is, in the classroom, the difference between $\Theta \leq 0$ and $\Theta > 0$. This is why the measurement is not merely psychological but ethical: it tracks whether a teaching relation respects the student as a potential author or treats her as a recipient of fixed meaning.

A further point connects the project to Mazouz’s own commitments. A bottom-up ethics that genuinely emerges must still take some stable form; the question is which. If it descended to a settled rest—a fixed point—authorship would end, since a fully settled question is one no longer being authored. The stable form of an emergent ethics is therefore not a static equilibrium but a *dynamic* one: a self-maintaining process that keeps returning to its questions while carrying something forward, generative rather than terminal. Good teaching has exactly this shape—it returns to the same material while the student grows more autonomous each cycle—and so does a living ethical relation. The project’s formal core makes this “dynamic equilibrium” precise.

5 The formal core

The indices above rest on a general framework the author has developed, in which value and power are generated within relations rather than possessed by individuals. The empirical proposal can be grasped without it, but the framework is what gives Θ its meaning, supplies further measurable quantities beyond it, and fixes what may and may not be claimed. This section states the generation chain compactly and then derives the full, computable measurement pipeline that the educational study implements.

5.1 The generation chain

Structure is generated, not assumed, by spontaneous symmetry breaking of a relational pre-structure, and value and power are read off the generated structure:

$$\begin{array}{ccccc}
 \underbrace{G}_{\text{pre-structure}} & \xrightarrow{\text{breaking}} & \underbrace{M = G/H}_{\text{order-parameter space}} & \longrightarrow & \underbrace{\pi_k(G/H)}_{\text{subjects (defects)}} \\
 & & & & \\
 \longrightarrow \underbrace{\text{hol}(\gamma)}_{\text{value}} & \xrightarrow{H \text{ non-abelian}} & \underbrace{[\text{hol}(\gamma_1), \text{hol}(\gamma_2)] \neq 0}_{\text{power}} & &
 \end{array}$$

A symmetry G breaks to a residual symmetry H ; the space of relational states is the coset $M = G/H$; subjects emerge as its topological defects, classified by $\pi_k(G/H)$. The coset bundle $G \rightarrow G/H$ carries a canonical connection A , and the value a subject accumulates around a closed loop γ is the holonomy

$$\text{hol}(\gamma) = \mathcal{P} \exp \oint_{\gamma} A. \quad (1)$$

The loop γ is not given: to read a relation as a closed circuit that returns is an act of *interpretation*, so ethical value is $\text{hol}(\gamma)$ with γ the path interpretation constitutes, and whoever constitutes the path authors the value carried along it. An externally imposed γ is a *Festsetzung*; a self-constituted one is authorship. Two further facts are used below: the *sign* of the holonomy is the good/bad criterion (positive returns value to its generators; zero or negative extracts it); and power is the *non-commutativity* of holonomy, which is non-trivial exactly when H is non-abelian.

5.2 Discretization: the computable pipeline

The continuous objects of (1) are estimated from interaction data as follows. Nodes are individuals in the teaching relation. Each node i carries a relational state vector

$$s_i(t) = (a_i(t), d_i(t), g_i(t)) \in \mathbb{R}^3, \quad (2)$$

with a autonomy, d dependence, g generative output (Section 2). The connection A is discretized as a state-transition operator $T_{i \rightarrow j} \in \mathbb{R}^{3 \times 3}$ estimated from the time-stamped interaction sequence: $T_{i \rightarrow j}$ is the least-squares map carrying i 's state to j 's subsequent state across logged interactions,

$$T_{i \rightarrow j} = \arg \min_T \sum_{\tau} \|s_j(\tau+1) - T s_i(\tau)\|^2, \quad (3)$$

the sum running over interaction events in which i acts on j . The continuous holonomy (1) then discretizes to the ordered product of transitions around the teacher–student loop,

$$\hat{H}(\gamma) = T_{i \rightarrow j} T_{j \rightarrow i} \in \mathbb{R}^{3 \times 3}, \quad (4)$$

an estimable matrix. From $\hat{H}$ the three scale-invariant quantities follow.

(i) Sign of the holonomy (good/bad), exact and proxy. The deviation of $\hat{H}$ from the identity, projected onto the autonomy-minus-dependence direction $\mathbf{r} = (1, -1, 0)^\top$, gives the holonomy's sign; to first order this is the directly estimable index

$$\Theta = \mathbf{r}^\top (\hat{H} - I) s_i \approx \Delta a - \Delta d, \quad (5)$$

so the index of Section 2 is recovered as the first-order reading of (4). $\Theta > 0$ is generative (power-to), $\Theta \approx 0$ appropriative, $\Theta < 0$ dominative (power-over).

(ii) Strength of power (non-commutativity). Power is the failure of the two interaction orders to commute,

$$\mathcal{C} = \|T_{i \rightarrow j} T_{j \rightarrow i} - T_{j \rightarrow i} T_{i \rightarrow j}\|, \quad (6)$$

zero for a near-symmetric (peer) relation, large for a strongly asymmetric one; estimable from the same operators.

(iii) Surplus versus stock. Stock is exam-measured, transferable knowledge; surplus is the part of generative output not attributable to either party alone, proxied by the off-diagonal, joint component of $\hat{H}$ acting on g , and tracked alongside Θ . The central falsifiable prediction—surplus and stock diverge—is the statement that Θ and the surplus proxy vary independently of exam score.

5.3 Dynamics and solidification

Across a term these quantities have a trajectory. Writing ρ for the value-stock density and $\mathbf{u}$ for its flow, the transport dynamics and a power-accumulation law

$$\partial_t \rho + \nabla \cdot (\rho \mathbf{u}) = S, \quad \partial_t \mathbf{p} = \alpha \rho \mathbf{u} - \beta \mathbf{p} \quad (7)$$

govern whether circulation is maintained (β dominant) or collapses to a frozen channel (α dominant). The latter is *solidification*: the dynamical collapse of a circulating, surplus-generating relation to a fixed point at which $\hat{H} \rightarrow I$ and $\Theta \rightarrow 0$ —the formal counterpart of authorship dying into stipulation. Empirically this predicts a measurable signature: a teaching relation solidifying over a term shows Θ decaying toward zero and $\mathcal{C}$ freezing, even as exam scores may rise.

5.4 Two honesties

Holonomy has no absolute scale: only the *sign* of Θ , the *order* among relations, and the magnitude of $\mathcal{C}$ are meaningful—never an absolute amount of value attached to a relationship. And the identification of *the good* with a *structure of holonomy* (positive, value returned, no one made fuel) is an interpretive proposal, not a derivation of *ought* from *is*: the formalism does not prove good circulation good; it proposes that the good be understood as that structure. Both are maintained throughout, and both constrain the empirical claims to sign, order, and trajectory rather than magnitude.

6 The rationale for this collaboration

The project sits on the intersection of its supervisors' competences and cannot be done from one side alone. The ethics—authorship, the refusal of external *Festsetzung*, and the normative concept of the author that the measurement must not betray—belongs to deliberative justice in Mazouz's sense; her oversight is what keeps Θ from quietly reducing a normative concept to a behavioural frequency. The dynamical and numerical form—circulation versus solidification, the scale-invariant computation of holonomy and its volumetric analogue (helicity)—belongs to the mathematics of continuous and fluid systems, where Deparis's methods are a natural resource for realizing and simulating the dynamics (a resource the project draws on without resting its core on any particular fluid model). The formal framework that joins them, and the educational study that makes the whole falsifiable, are the author's contribution. The result is a practical ethics in the strict sense: not a verdict handed down, but an account—and a measurement—of how a teaching relation can return authorship to the student rather than hold it, and of when meaning is generated with a person rather than imposed upon her.