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Q.E.D.: What Emily Dickinson Did With Her Mathematics Books

I am a retired professor of mathematics and statistics who enjoys reading poetry. This essay began as the final class assignment in a Whitman-Dickinson seminar I audited in 2013 at Grinnell College.[1] The topic I began with was Dickinson's use of mathematics. After exploring this topic for several months I discovered: (a) Dickinson used mathematics a lot, and (b) much has been written about her use of it. If (a) had been true, but (b) not, then I would have found myself in that happy circumstance of entering a particularly rich and under-mined area of research. But because (b) was also true, I found myself trying to read critiques in books and journal papers that left me feeling that I was in over my head. Initially, I hung out in the deep pool, treading water, doing little to get past my discomfort. Then I decided that maybe there could be some items hanging out in the shallow water that the more accomplished authors I'd read had left unexplored. I focused my efforts on finding small, unseen nuggets that others, in their penchant for the depths, had missed.

What began as a working hypothesis gradually evolved into this essay's thesis in two parts: (1) Emily Dickinson was a serious and very capable student of mathematics; (2) also, she *read* her mathematics textbooks as passionately as she read *any other genre of literature* — if she encountered therein interesting ideas, concepts, or words that could advance her project, she would (consciously or unconsciously) use them.

I will discuss several authors who use part (1) of this thesis in their work. They give Dickinson her due as a capable and interested student of mathematics. They also give mathematics its due in interpreting the poems. What I propose to contribute to the discussion is the notion that the *particular mathematics textbooks*

Dickinson used are reflected in the poems in ways that provide an additional—and fruitful—means of comprehending Dickinson's use of mathematics. The textbooks can provide a lexicon for the mathematical terms and ideas that appear so copiously in her poems. For this essay I concentrate on Dickinson's algebra textbook written by Jeremiah Day. A common motivational trope that gives meaning to our lives as teachers is that our legacy lives on through our students. My thesis would imply, then, that part of Day's legacy in this regard may have been Emily Dickinson, one of the least predictable products he might have imagined but, also, in retrospect, one of the more momentous.

My essay proceeds in this fashion: (1) A description of Dickinson's algebra textbook by Jeremiah Day; (2) a description of what biographers report on the nature of Dickinson's reading, suggesting—I will argue—that mathematical reading also influenced her poems; (3) a first example—"It troubled me as once I was—" (Fr516) — that illustrates connections between special vocabulary in the poem and Day's text, showing the impact of Day on the poem; (4) a digression to the work of three other Dickinson scholars (Gary Lee Stonum, Michael Theune, and Seo-Young Jennie Chu) that will lead to discussions of three more poems, which I hope will then lend support to the idea that Dickinson was affected by reading Day; and (5) some concluding remarks, including practical implications of this essay's thesis.

JEREMIAH DAY'S ALGEBRA BOOK AS LITERATURE

Mathematics textbooks and I go back a long way. My eighth-grade algebra book was the first that made an impression. It was far from perfect, but it still had a certain magic to it. Some textbooks were wonderful and I still have them: my algebra II book from tenth grade, my calculus book from college, my topology book from college, and an experimental design book from grad school come to mind. When I became a teacher, finding a good textbook could make the difference between a class's success and failure.

In her study of algebra, Dickinson used *An Introduction to Algebra*, by Jeremiah Day. Jack Capps lists this textbook as the one Dickinson would have used during her time at Mount Holyoke, where she took at least a quarter of algebra (171), and Carlton Lowenberg also lists it among books used at Amherst Academy during her time there (48). And since Dickinson studied algebra on her own between the Academy and Mount Holyoke, it is plausible she used Day for that purpose as well; the completeness of exposition in his book would have made it an excellent self-study text.

Day was a professor of mathematics who had a sixty-nine-year relationship with Yale as student, tutor, professor, president, and trustee. His *Algebra* was the most successful of the several textbooks he wrote, going through several editions (Johnson and Malone 161–62). I have a copy of the original 1814 edition, secured for me from the internet by Grinnell's Science Librarian, Kevin Engel. Whether this is precisely the book Dickinson used was not an issue I pursued. I thus assume that for portions referenced for this essay, my copy does not differ substantially from Dickinson's.

In his comprehensive biography of Emily Dickinson, Richard Sewall devotes an entire chapter to Dickinson's "Books and Reading." Sewall begins this chapter with an unattributed assertion that "in 1960, it was said of her, 'the best informed guess is that no poet was ever less indebted to books.' " He then proceeds to thoroughly dismantle this assertion, arguing persuasively for the centrality of books and reading to Dickinson's poetry: "the conditions of her life, and her temperament, made her especially dependent on books. … She could hardly have lived without them. …Few poets have ever confessed so voracious a passion [for books]" (669).

Sewall asserts that "she saw herself as a poet in the company of the Poets—and functioning as she did mostly on her own, read them (among other reasons) for company," with many of her poems appearing to be "her end of conversations struck up with what she found on printed pages" (670). At the same time, Sewall notes—almost contradictorily—that Dickinson's conversational responses to her readings were not limited either to poems or to the classics: "Scholars have recently been pointing out her similar uses of passages from such disparate sources as Hawthorne's stories, Ik Marvel's *Reveries*, Thoreau, Mrs. Browning's *Aurora Leigh,* Emerson's essays, Quarles's *Emblems,* and the endless string of fugitive verses in the periodicals (the *Republican,* the *Hampshire and Franklin Express,* the *Atlantic, Harper's,* and *Scribner's* were among those that came to her door.)" (671). Sewall adds, "She read hungrily, uncritically, and with her whole being" (671). "Moreover," Sewall continues, "her capacity for absorbing what we would consider banalities was, apparently, lifelong, not just an aberration of youth" (672).

Despite arguing for great breadth to her reading in genre, sophistication, and subject, Sewall nowhere in his rightly venerated biography discusses any of Dickinson's mathematical textbooks, of which there were several. Indeed, that Sewall would devote another entire chapter to "Schooling" and not mention mathematics suggests a conscious decision to avoid the topic. With a book that became 821 pages long, it is not unreasonable that Sewall would make a few such shortening decisions. But it seems likely from Sewall's descriptions of Dickinson as an *uncritical* reader that we would also include her mathematics textbooks in assessing the reading she used in writing her poems.

If we grant Sewall his inference that all of Dickinson's reading had the potential to influence her own work, it seems reasonable to extend this possibility to Day's *Algebra*. In making his inference, Sewall relied on two lines of evidence: (1) comparisons of Dickinson poems with passages from works such as Marvel's *Reveries of a Bachelor* or Longfellow's "Kavanagh," in which ideas in various Dickinson poems strongly reflect the reading; and (2) actual marked copies of such readings, where Sewall must do the sleuthing to figure out which markings are Dickinson's rather than some other family member's.

As I extend Sewall's inference, I am forced to rely on the evidential line (1), not having been able to avail myself of the copy of Day that Dickinson actually studied from. I am also flying in the face of an assertion by Jack L. Capps in *Emily Dickinson's Reading: 1836–1886*:

> She seems to recall terms from geometry and botany with ease, and they are fairly common in her poems; but algebra, like Latin and German, was abandoned for more compatible interests
>
> > Life set me larger - problems -
> > Some I shall keep – to solve
> > Till Algebra is easier -
> > Or simpler proved - above – (105)

The stanza Capps has excerpted, I hope to show, is part of the evidence suggesting Dickinson took Day to heart much more than Capps supposes from his rather casual interpretation of that stanza. I conjecture that Day's text is reflected in Dickinson's poems in ways others have either missed or, possibly, chosen to ignore.

A few reflections on Day's textbook are in order. I use the term "textbook" throughout this essay, even though Day described his book as outside the conventional genre that in his time was called a textbook; textbooks then, it appears, provided mere outlines of the subject. Such "outlines" still exist today, but we do not call them textbooks. So the terminology has simply changed and I am using "textbook" in the modern sense. Above, I used the phrase "genre of literature" to describe the universe of relevant Dickinson readings, and I wish to argue that Day should be viewed in that class. Having read and used many textbooks on mathematics over my career, I find the differences between modern books and Day to be striking in a fashion that would have appealed to someone of Dickinson's intellect and literary sensibility.

Strengthening the appeal of my hypothesis is the obvious delight Dickinson took in mathematics. Cynthia Griffin Wolff tells us that "Dickinson was fascinated with mathematics" (194), and Stonum asserts that "Roughly two hundred of Dickinson's poems include some reference to mathematical terms and ideas, often in a precise and pointed way, and a number of others depend on counting, measuring, and quantitatively assessing" ("Calculated Sublime" 101).[2]

Wolff describes another facet of Dickinson's education that seems logically connected to her interest in mathematics. Amherst Academy, Wolff says, "offered a course of study that was as strenuous as many colleges today. Dickinson was an outstanding student, and she was justly proud of the taxing curriculum she was pursuing" (77).[3] Both Amherst College and Amherst Academy also embedded education in the context of Christian religion. Dickinson's stay at the Academy began with President Heman Humphry, an old-school Puritan, and concluded with President Edward Hitchcock, scientist and professor at Amherst College. Wolff makes the point that with this transition of presidents, the science and mathematics curriculum went from strong to even stronger, and yet, "Religion was not diminished in importance … even though various departments of science were greatly strengthened; if anything, the power of religion was extended by Hitchcock's endeavor to make all branches of learning into forms of theology" (79). According to Hitchcock (as quoted by Wolff): "Mathematics … forms the very framework of nature's harmonies, and is essential to the argument for a God" (79). A "proof of the existence for God" was an ingrained first step in the Academy's rigorous study of religion (80). Given the integral place accorded to mathematics (and other sciences) in moral and religious study and given how pervasive the deep questions of the latter were for Dickinson, the case for her taking seriously the reading of a text like Day's seems strong.

A DIGRESSION ON MATHEMATICS AND ITS TEXTBOOKS

Mathematics is a language apart from English prose, and a very concise language at that. It works through a sequence of special symbols, with connecting words. And mathematics qua mathematics tends to lack the kind of redundancy we get used to in reading much expository prose. Consider the following statement and then proof of the quadratic formula.

Proposition: If $ax^2 + bx + c = 0$ is any quadratic equation (a non-zero), then its solutions are given by:

$$x = \left[\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}\right].$$

Proof of proposition: Starting with the equation, we derive the solution thusly:

$$ax^2 + bx + c = 0$$

$$ax^2 + bx = -c$$

$$x^2 + \left(\frac{b}{a}\right)x = \frac{-c}{a}$$

Complete the square at this step.
(Take 1/2 the coefficient of x, square it, and then add it to both sides)

$$x^2 + \left(\frac{b}{a}\right)x + \left[\frac{b}{2a}\right]^2 = \frac{-c}{a} + \left[\frac{b}{2a}\right]^2$$

Factor the left side.

$$\left(x + \frac{b}{2a}\right)\left(x + \frac{b}{2a}\right) = \frac{-c}{a} + \frac{b^2}{4a^2}$$

Get common denominator for the right side.

$$\left(x + \frac{b}{2a}\right)^2 = \frac{\left(b^2 - 4ac\right)}{4a^2}$$

Square root both sides and you'll get:

$$x + \frac{b}{2a} = \pm\frac{\sqrt{\left(b^2 - 4ac\right)}}{2a}$$

$$x = \pm\frac{\sqrt{\left(b^2 - 4ac\right)}}{2a} - \frac{b}{2a}$$

Combine into a single fraction. Common denominator is 2a.

$$x = \left[\frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \right] \text{ Q.E.D.}$$

Note how sparse English words are in this derivation. Written mathematics often looks like this. And the prose that does occur such as, "Complete the square at this step. (Take 1/2 the coefficient of x, square it, and then add it to both sides)" is redundant and could be left out without impairing the validity of the argument. This redundancy helps the reader; for an author writing for a journal, deciding how much redundancy to include depends on the author's style and the culture and conventions of the particular mathematical sub-field, journal, or audience.

One would naturally expect more such helpful prose in a textbook for students, but over the history of the mathematics textbook, less of this appears because a culture has developed of students not wanting it and teachers expecting students not to read it. Instead, the classroom becomes the arena for providing the helpful prose. Day, by contrast, is full of helpful explanations. For example, in his section introducing quadratic equations, he carefully outlines the distinctions between quadratic equations with only quadratic terms (so-called "pure equations") and those with both quadratic and linear terms (so-called "affected equations"). In this preliminary discussion he provides an overview of how the solving of each type proceeds. He follows this general discussion with examples of each type. When solving affected equations, he introduces the powerful method of "completing the square," includes several examples, and accompanies each step with a prose explanation of what makes that step valid (141–55).

Day's book includes two other features that are almost completely extinct in modern texts, and these features form the basis of much of my commentary. First, it contains relatively long and literate passages discussing "big picture" ideas such as the nature of mathematics, the nature and utility of algebra, and the importance of particular topics in algebra. These parts of his book would have been, I think, particularly appealing to Dickinson.

Second, Day writes in a literate style that would have appealed to Dickinson, especially in light of Sewall's assertions about the extent of what she read and thought interesting: Dickinson found compelling ideas in the strangest places, even, I assert here, in her algebra textbook.

Day begins with a seven-page "Preface" followed by a ten-page essay on "Introductory Observations, on the Mathematics in general." The Preface speaks to both student and instructor, while Observations speaks mostly to the student. No modern textbook contains introductory material even close to this length; a couple of pages would be more the norm, and these few pages would usually consist of boilerplate material of little use to the student. A similar difference applies to expositions of particular topics: Day abounds in explanatory prose; modern texts reduce it to a bare minimum.[4] The "Introductory Observations" comprises a sequence of twenty-two "articles" ranging over fundamental definitions of basic terms and methods, to short discourses on the role of mathematics in a liberal education, or the place and importance of mathematics in the world. It is an intriguing "essay" that caused me to make marginal comments such as, "ED would have found this interesting."

A SALIENT FIRST EXAMPLE: "IT TROUBLED ME AS ONCE I WAS—"

My thesis is that Dickinson read Day as she read any literature—as a potential source of ideas for her poetry. If true, this thesis would suggest we can find poems where ideas from Day find their way in. "It troubled me as once I was –" (Fr516) strikes me as a good first piece of evidence for this thesis.

It troubled me as once I was -
For I was once a Child -
Concluding how an atom - fell -
And yet the Heavens - held –

The Heavens weighed the most - by far -
Yet Blue - and solid - stood -
Without a Bolt - that I could prove -
Would Giants - understand?

Life set me larger - problems -
Some I shall keep – to solve
Till Algebra is easier -
Or simpler proved - above –

Then - too - be comprehended -
What sorer - puzzled me -

Why Heaven did not break away -
And tumble - Blue - on me -

Textual Notes:[5]
3 Concluding] Deciding
5 weighed the most - by far -] were the weightiest
- far -
6 solid] easy
8 Would] did - | might
10 keep] save
10 solve] *interlined above* prove
11 Till] where

I encountered this poem first in an essay by Michael Theune. His main goal is to investigate Dickinson's use of visual mathematical signs in her poems. The signs discussed are the + sign, the - sign, and the ____________________ sign. In mathematics + is used for addition, - is used for subtraction, and ____________________ is used as a "summation line" in a problem indicating the summing of a column of numbers or algebraic expressions. Theune asserts that "a consideration of the use of these signs suggests that they may be more than arbitrary or idiosyncratic forms of punctuation" (100), a thesis not central to my interest in how Day's *words* affected Dickinson's poems. Day's words do, however, enter Theune's discussion because his essay begins with a dialectic between the "metaphysical concerns" of Dickinson's poems and their mathematical and scientific expressions. For this first part of his essay, Theune quotes passages from Day's Preface extolling mathematics' ability for "training of the mind" (107), or as Day puts it (in a passage quoted by Theune), "It is the *logic* of the mathematics which constitutes their principal value, as a part of a course of collegiate instruction. The time and attention devoted to them, is for the purpose of forming *sound reasoners*, rather than expert mathematicians" (Day 4). Theune sees "It troubled me as once I was – " and other poems as questioning such assertions, and while his analysis achieves his goals, this is not the use of Day that my thesis advocates and that I now proceed to illustrate. But I will return to Theune below for my third example.

The speaker in "It troubled me as once I was –" is describing a childhood puzzle: how can gravity pull down the smallest bit of mass—an atom[6]—and yet something as weighty as heaven—with its departed souls and various deities—which children are taught to picture as existing above us, in the sky—can stay put, unaffected by the same gravitational pull? The repetitiousness of "as once

I was" and "for I was once" preceding "a Child," emphasizes that this question could only be puzzling to a child. The puzzle is stated simply in lines 3 and 4, but then the second stanza explicates the puzzle more precisely, relating how the child views heaven as having great weight, yet is somehow able to defy gravity despite having no apparent means of support, i.e., no bolt.[7] That last line of stanza 2, "Without a Bolt - that I could prove - / Would Giants - understand?" boldly illustrates that "out of the mouths of babes" deep problems can arise. If I, as a child, cannot explain it, would even "Giants" figure out the puzzle? The pun in "understand" paired with "stand under" suggests the "Giants" might even be unwilling to stand under the sky, for fear it might, indeed, fall down on them as well. Here we must surmise what "Giants" are: they could be adults, scholars, or earthly authorities of some kind. "Giants" might even allude to the Atlas of Greek mythology holding up the world as a punishment, and any of these interpretations lends gravitas to the child's puzzlement.

The third stanza states that as the speaker ages, the problems get "larger" and the speaker then considers the solving of these larger problems. It is not clear what these problems are, but we are told that: (a) they are not all solved now, but some, rather, are solved "later," (b) something called Algebra seems central to the solutions, and (c) Algebra will become easier "above," so that by postponing the solving, we gain ease in the solving. The phrase "Some I shall keep" suggests that it is by the speaker's choice that the solutions are postponed.

I interpret "above" as a stand-in for heaven or afterlife, so that the solutions become easier after one is dead and in a realm where things become clearer.[8] I also surmise that the sticky questions alluded to by the speaker are related to the religious realm—they are Godly concerns. There is the pun of "atom fell" doubled with "Adam fell," and beyond this Theune sees also a possible allusion to the passage in Matthew 10: 29–31, "Are not two sparrows sold for a farthing? And one of them shall not fall to the ground without your Father …" (106), both possibilities reinforcing the theological concerns underlying the poem.

And then comes the elliptical fourth stanza. After we have waited to solve the problems later, "above," and with the improved power of an "easier" Algebra, we will be able to solve "larger problems" in heaven. The word "too" intensifies our expectation of larger problems, but then the speaker surprises us by restating the same problem that puzzled her as a child, because she was a child. But now there is a difference. Since in heaven we have the "simpler" algebra, the speaker has a higher standard: she expects to "comprehend" the puzzle, a word suggesting a deeper mastery than the "solving" of stanza 3. Webster defines comprehend as "to understand," but also "to imply; to contain by implication or construction" (170).[9] And we are led to believe that the simpler algebra "above" is capable of such inference-based understanding, whereas the earthly algebra is not. This circling back to the original childhood puzzle after speaking in a way that makes us expect "larger" ones reasserts that the puzzle is enduring, deep, important, but also, perhaps, one only a child is capable of really contemplating in the earthly sphere.

DAY'S INFLUENCE ON THE POEM

In those final two stanzas the speaker has placed her hope on an apotheosized ideal algebra, and it is by consulting Day's *Algebra* that we gain insight into this hope and this apotheosis. In articles 9–14 of "Introductory Observations," Day lays out what is usually called the axiomatic method, the foundation upon which mathematical ideas are developed through a process of deductive reasoning. This is the process introduced famously in Euclid's *Elements.* One begins with definitions of basic terms, along with a minimal set of propositions that are deemed "self-evident" and which serve to illuminate how these concepts introduced in the definitions relate to one another. These self-evident propositions are the axioms. In article 11 Day says, "There are however, comparatively few mathematical truths that are self-evident. Most require to be proved, by a chain of reasoning. Propositions of this nature are denominated *theorems* and the process, by which, they are shown to be true, is called *demonstration*" (3–4).

In an early discussion of the different branches of mathematics and their reliance on the axiomatic method, Day cuts algebra some slack in terms of the level of precision demanded:

> Algebra requires to be treated in a more plain and diffuse manner, than some other parts of the mathematics; because it is attended to, *early* in the course, while the mind of the learner has not been habituated to the mode of thinking so abstract, as that which will now become necessary. He has also a *new language* to learn, at the same time he is settling the *principles* upon which his future inquiries are to be conducted. … Algebra and geometry may be considered as lying at the foundation of succeeding branches of mathematics, both pure and mixed. Euclid and others have given to the geometrical part, a degree of clearness and precision which would be very desirable, but is hardly expected, in algebra. (Preface 5)

Emily Dickinson studied geometry from Playfair's *Euclid*, the preface of which corroborates Day's assertion of geometry's preeminence in the teaching of the axiomatic method.[10] John Playfair first notes that some people might object to proving many simple propositions that most people would consider obvious. He then disagrees with such critics:

> those who make this objection … do not seem to have reflected sufficiently on the end of Mathematical Demonstration, which is not only to prove the truth of a certain proposition, but to shew its necessary connection with other propositions, and its dependence on them. The truths of Geometry are all necessarily connected with one another, and the system of such truths can never be rightly explained, unless that connection be traced, wherever it exists. It is upon this that the beauty and peculiar excellence of the mathematical sciences depend. (Preface xiii-xiv)

Day cedes the axiomatic pinnacle to geometry based primarily on curricular concerns, a decision I find sensible. Algebra's use as a tool for future study of mathematics (and other disciplines) is more pervasive than geometry's. Moreover, geometry seems like the more natural discipline for teaching students the logic of mathematics—the axiomatic method—that is such a powerful conceptual tool in itself. Much of the credit for geometry's occupation of this curricular niche is due, of course, to Euclid's classic work. As Day said, "A more finished specimen of clear and exact logic has, perhaps, never been published, than the *Elements of Geometry* by Euclid" (Lowenberg 48).[11]

Day's compromise with Euclidean axiomatics does not mean his book is conceptually easy; it is not. While he could have written a mere "how to" book,[12] simply showing mechanical procedures, he instead develops conceptual understanding through the solving of specific, carefully scaffolded problems that teach the logic without the inclusion of formal proofs. For example, the quadratic formula and its proof never appear, but an assiduous student will leave Day's book knowing how to solve quadratics and why the method makes sense. But despite this level of intellectual rigor, his exposition does fall short of the ideal of axiomatic rigor, and this fact is not lost on Dickinson, because Day doesn't just make pedagogical choices, he also—as quoted above—explains them. And Dickinson, the careful reader, has paid attention and used this distinction in her poem.

Dickinson's description of an ideal algebra "above" that improves on the more workmanlike variety on earth is strengthened by another clear and specific influence of Day on this poem: the interplay between the words "prove" and "solve." Day discusses these words in Article 15 of "Introductory Observations":

> The immediate object of inquiry, in the mathematics, is, frequently, not the demonstration of a general truth, but a method of performing some operation, such as reducing a vulgar fraction to a decimal, extracting the cube root, or inscribing a circle in a square. This is called solving a problem. A *theorem* is something to be *proved*. A *problem* is something to be *done.* (4–5)

In the discipline of algebra the quadratic formula is an example of a theorem: it is a *general truth,* in this case a general method, for *solving* any particular quadratic equation. I produced the proof of this theorem above.[13] A particular equation would be, in Day's language, the "problem to be solved." An example of a problem related to the quadratic formula might be:

Solve the equation
$2x^2 - x - 15 = 0$
Its solution would use the quadratic formula and proceed like this:
Here a = 2, b = -1, c = -15. So the solutions are:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{-(-1) \pm \sqrt{(-1)^2 - 4(2)(-15)}}{2(2)}$$

$$x = \frac{1 \pm \sqrt{1-(-120)}}{4}$$

$$x = \frac{1 \pm \sqrt{121}}{4}$$

$$x = \frac{1 \pm 11}{4}$$

So x = [1+11]/4 or x = [1–11]/4, or
x = 3 or x = -2.5 are the two solutions.[14]

The theorem is a general thing; the problem solution requires a mechanical application of the theorem.

In "It troubled me as once I was—," Dickinson uses interplay between the terms "prove" and "solve" to further her goals for the poem. In line 10, she considered using the word "prove," but settled on "solve" instead. The textual note says that "solve is interlined above prove," a statement that does not fully convey the fact that "prove" is also aggressively crossed out.[15] Dickinson has made a clear and deliberate choice, and the choice is salient. Solving algebraic problems is an endeavor of the earthly realm; proving algebra as an abstract, theoretical methodology is something hinted at on earth, but only really realized in heaven. The poem's speaker is clearly resting her hopes on a fully proved algebra before tackling the "larger" problems. We get a hint of the speaker's desire for this ideal algebra in the word "concluding" in stanza 1. "Concluding" is a word used routinely in axiomatic mathematics. It is a strong word, one demanding a logical argument or a mathematical proof for its justification. (Her variant "deciding" is less mathematical, but similarly strong. A word like "observing" would be an expected word for describing this childhood puzzle, but it does not carry the expectation of proof that "concluding" does.)

Close reading—Dickinson's and ours—of Day's discussions on the nature of algebra, on mathematical truth, on mathematical pedagogy, and on the distinction between proving and solving has added credence to our interpretation of "It troubled me as once I was—." I hear in this poem an occurrence of what Sewall called Dickinson's "recurrent mortuary theme," of which he writes, "Every death, every illness she heard among her friends, set Emily Dickinson wondering about 'those great countries in the blue sky of which we don't know anything'" (535). I am reminded, as well, of the famous words she wrote to Thomas Wentworth Higginson: "How do most people live without any thoughts … how do they get strength to put on their clothes in the morning?" (Sewall 566). The speaker in "It troubled me as once I was—" cannot shake these deep and troubling problems of her youth, and she has come to realize that she can only hope to comprehend them in death, in the presence of a God, or a fully proved algebra that finally is revealed to her.

The conceit of a fully proved algebra for God borders on the far-fetched: fully proved algebra with its precision, concreteness, and deductive nature would seem to be utterly incomparable to God, whose characteristics are polar opposites of these. John Crowe Ransom gives poets a special role in religion when he asserts:

> It is the poet and nobody else who gives to the God a nature, a form, faculties, and a history; to the God, most comprehensive of all terms, which, if there were no poetic impulse to actualize or "find" him, would remain the driest and

> deadest among Platonic ideas....Religion depends for its ontological vitality upon a literary understanding and that is why it is frequently misunderstood. (880)

Dickinson struggled with her religious feelings, and this poem gives us one of many of her expressions of this struggle. Through such poems, Dickinson picks up the gauntlet that Ransom throws down regarding the poet's responsibility to religion. She breathes life into God through the vitality of a conceit that allows us to accommodate different valid readings and reactions, much like having a deity that can accommodate different relationships for different believers might vitalize a religion.

OTHER APPROACHES TO DICKINSON'S USE OF MATHEMATICS

It is worth shifting gears to summarize what other critics have said about Dickinson and mathematics. I'll start with Gary Lee Stonum, who describes Dickinson's use of mathematics as "a means by which the self constructs, controls, organizes, and takes possession of experience" (*Dickinson Sublime* 33). Stonum says, "Dickinson's poetry undoubtedly courts the romantic sublime. Her work is everywhere manifestly concerned with transcendent experience." He goes on to assert that the "central dilemma in Dickinson's poetry" is "the conflict between internal freedom and external power. On the whole, Dickinson is about as extreme a poet our country has produced in the strength of her resistance to alien power." Stonum sees mathematics as one of the tools Dickinson uses to counter that alien power, to assert individual freedom over it, and to serve as a defense mechanism ("Calculated Sublime" 101,107).

One poem Stonum considers will serve as my second example:

> Bound - a trouble -
> And lives can bear it!
> Limit - how deep a bleeding go!
> So - many - drops - of vital scarlet -
> Deal with the soul
> As with Algebra!
>
> Tell it the Ages - to a cypher -
> And it will ache - contented - on -
> Sing - at it's pain - as any Workman -
> Notching the fall of the even sun!
>
> (J269)

Because his interpretation of the poem is brief, I'll quote it in full:

> Mathematics can serve as one form of the defensive discipline invoked in "I can wade grief." Algebra, for example, defends against the agonies encountered in poem 269. The first stanza's especially compressed syntax allows it to be read alternately as a cry of desperation and of exultation. The former reading appeals for some boundary to agony, one that would preserve the calm rationality needed for algebraic computation. The latter exclaims that algebra erects just such a boundary and can therefore defend the soul's integrity. Bleeding does not confound algebra, only the algebraist. Thus the second stanza advises that calibrated accounts can make life bearable, as any laborer knows when he counts the hours until quitting time and as any poet knows when she sings the fall of what seemed a just and kindly natural world.
>
> Counting the ages of pain down to zero makes for a notably dim glory, however, one that belongs more to stoic consolation than sublime heroics. ("Calculated Sublime" 108–09)

In his reading of the first stanza as both a cry for desperation and exaltation, Stonum illustrates Heather McHugh's pronouncement that "… Dickinson's sentences and lines often seem designed (in judicious ellipses, elisions, contractions, puns, and dashes) to afford the greatest possible number of simultaneous and yet mutually resistant readings" (105). But I think we can gain further insight into the poem by considering my thesis—that reading Day influenced Dickinson's poems. The last two lines of stanza one can be read as a summary of the first four, if we read that dash ending line 4 as a colon or an em dash. That is, the first four say that if one can somehow constrain a pain, then the pain is more bearable. Then the final two lines compare this conjecture—in a simile—to doing algebra on the soul. Rather than posit the need for a calm rationality in order to do algebra, I see the algebra itself as a controlling mechanism for the desired constraint, or maybe better said, as a metaphor for such a mechanism.

In a chapter titled "Algebra," the first topical chapter of his book, Day describes the power algebra has for controlling, simplifying, economizing. Day begins, "Algebra may be defined, a general method of investigating the relations of quantities, principally by letters." And he goes on to add,

> The solutions in Algebra, are of a more general nature, than those in common Arithmetic. The latter relate to particular numbers; the former, to whole classes of quantities. On this account, Algebra has been termed a kind of universal

> Arithmetic. … In Arithmetic, when a problem is solved, the answer is limited to the particular numbers which are specified, in the statement of the question. But an algebraic solution may be equally applicable to all other quantities which have the same relations. (10)

Then, in a sub-section of the chapter labeled "Notation," Day talks about the special language of algebra, which I illustrated above with the derivation of the quadratic formula:

> To facilitate the investigations in algebra, the several steps of the reasoning, instead of being expressed in words, are translated into the language of signs and symbols, which may be considered as a species of short-hand. This serves to place the quantities and their relations distinctly before the eye, and to bring them all into view at once. They are thus more readily compared and understood, than when removed at a distance from each other, as in the common mode of writing. But before any one can avail himself of this advantage, he must become perfectly familiar with the new language. (12)

To lend some concreteness to Day's description, consider two small examples. The mathematician or student of mathematics will encounter numberless quadratic equations requiring solution over his or her lifetime. This prospect would be utterly daunting—a sublime feeling of being overwhelmed by the outsized onslaught of each new equation, in perpetuity—if it were not for the quadratic formula or at least (as in Day's preferred exposition) a clear set of procedures for handling any quadratic equation. Or perhaps an even simpler example is the formula for the area of a circle. If each new computation of an area required a rethinking of the solution, we would again find ourselves overwhelmed. But how much more easily we bear such a problem when we remember the formula, so succinctly algebraic, $A = \pi r^2$.

Day's description of algebra as a vehicle for control gives Dickinson, I submit, the controlling trope that Stonum asserts.[16] For me the simile in lines 5 and 6—"Deal with the soul / As with Algebra!"—prescribes the handling of severe pain as best done through a form of control similar to how algebra works, which is, according to Day, as a special language for controlling the runaway, sublime chaos one encounters in more particular mathematical situations. Dickinson's line "Tell it the Ages — to a cypher —" may refer to this process of attempting to achieve control. *Cypher* in Dickinson's Webster's has several meanings. As a noun, *cypher* can mean the number zero, as Stonum interprets it, or it can mean the special property zero has in the context of whole numbers—where appending increases ten-fold—or decimals—where appending can decrease ten-fold. As a verb, it can mean to "use figures or practice arithmetic" (Webster 146). In the last case, we could imagine Dickinson intending the *act* of using figures or practicing arithmetic or even the *person* doing these actions. But for each of these cases, I can interpret "to a cypher" as the particularity of the quantities and processes of arithmetic. Then in the same way that Day describes algebra's control of the chaos of arithmetic's particularity (e.g., the "numberless quadratic equations" mentioned above), the soul that can bound trouble or limit bleeding will be able to handle the particularities of trouble. In the phrase "Tell it the Ages," I read "Ages" as some aspect of the trouble (such as the ages of a departed loved one or his or her date of death) that even though hard to recollect, the "ache" is now "contented" because of the soul's ability to bound trouble, much as algebra controls the particularities of arithmetic. This idea is affirmed in the final two lines where the "Workman - / Notching the fall of the even sun!" is again the algebra-like soul at work making a pain more bearable, as evidenced by its being accompanied by singing.

The word "cypher" has another meaning as a specially coded-up message (Webster 146). Recalling that Day called algebra a "new language" or "species of short-hand," I can also hear in the phrase "to a cypher" an affirmation that a soul that bounds trouble does so by handing off the particularities of arithmetic (the "Ages"), which can be frightful, to this "new language" we call algebra, where the pain is diminished by algebra's efficiency.[17]

I now return to Michael Theune's essay, which argues for the possibility that Dickinson used mathematical signs for clear poetic purposes while also exploring the philosophical aspects of poems in relation to Day's statements on mathematics education. I now use one of the poems Theune used—"I reason, Earth is short"- to illustrate how Day can be used as a lexicon for mathematical terms to open up other possibilities in a reading. This is my third example.

I reason, Earth is short -
And Anguish - absolute -
And many hurt,
But, what of that?

I reason, we could die -
The best Vitality
Cannot excel Decay -
But, What of that?

I reason, that in Heaven -
Somehow, it will be even -
Some new Equation, given -
But - What of that?
(J301)

I am continuing my pattern of summarizing a scholarly interpretation of a Dickinson poem constructed without consideration of Day's influence and then demonstrating that we can gain additional insights by considering Day's book. I first reproduce Theune's interpretation of the poem:

> "I reason, Earth is short –" appears to be a very predictable poem. When its brief meditation on life's hardships is questioned, the poem moves to death, for death is the answer to, or at least marks the end of, life's hardships. When its brief meditation on death is questioned, the poem moves to heaven, for heaven is the answer to the inevitability of death; traditionally, heaven makes death seem trivial enough to dismiss with a curt question. However, when the poem arrives at heaven, the point where most questioning ceases, this poem repeats the same question. The same skepticism which was applied to the vagaries of life and death in order to allow for speculation regarding heaven is applied to the promise that heaven will sort everything out, will make things "even." What seemed to have been a poem following that line of thought a Christian "sound reasoner" might follow in the end is a poem which privileges a process of skeptical inquiry over any results. Again, a mathematically expressed idea is rejected in favor of further questioning. (111)

Theune's interpretation seems solid.[18] What supports my thesis, however, is the word "equation" in line 11. This is the only instance of that word in all of Dickinson's poetry, and it is the only clearly mathematical term in the poem. Day devotes considerable exposition to equations because, as he puts it, "the peculiar province of algebra" is "the investigation of the values of unknown quantities, by means of equations" (78). He goes on in this chapter called "Simple Equations" to describe in detail the process of "bringing the unknown quantity by itself, on one side, and all the known quantities on the other side, without *destroying the equation*" (78, my emphasis).

I agree with Theune that the word "even" in stanza 3 refers to a heaven where things are to be sorted out. Webster's definition of "even" uses descriptors like "calm," "settled," and "balanced." That word may also possibly signify "equally favorable" or "fair" as well as the more mathematical "capable of being divided into equal parts" (311). This last definition would imply an equation of some kind. Dickinson has chosen a rich word in "even," but all meanings suggest a more favorable condition in heaven than the speaker has found on earth or in death. And it appears that the force or entity that will do the sorting out in heaven is this "new equation." The implied old equations of the first two stanzas were one and the same. They have been manipulated as one manipulates an equation (operations that Dickinson would have learned about from Day's book), but these manipulations—first earth's anguish, then death's decay—did not "destroy the equation" (using Day's language here). And for the speaker this means that things on earth and in death are the same. To make things "even" requires the "new equation" that is introduced in the third stanza. So then what do we make of the speaker's repetition of the same question that ends each stanza—"But, what of that?" I think Theune's surmise is good, namely that the repetition of the question "privileges a process of skeptical inquiry over any results." But let me propose another possibility suggested by consideration of a variant of the poem.

There are two facsimiles of this poem (Franklin variorum 403),[19] the first of which had several words underlined, including the word "equation." In that version the final stanza looks like the following (underlines rendered as italics):

> I reason, that in
> "Heaven" -
> *Somehow* - it will be *even* -
> Some *new Equation* - given -
> But - *What of that!*

This facsimile was sent to Susan, who had been a mathematics teacher for two years (Hart and Smith xxxii). These italics would support giving "equation" a fuller consideration. The italicizing of "somehow" and "What of that!", the extra pause created by the dash between "But" and "What," and the exclamation point, in place of the question mark, suggest not so much a triumph of skeptical inquiry over results, but rather a shifting in that final stanza from the certainty of earth's and death's disappointments with their anguish and decay to a celebration of a new order of reality, or if not a celebration, at least an exclamation of some sort.

By taking a deeper look at the mathematics inherent in the one quintessentially mathematical term in the poem—equation—we obtain a possibly different view of the poem. I am almost embarrassed that this view of a Dickinson poem could embrace an optimistically religious viewpoint. But, I also think the word "somehow" (underlined, no less) implies that the poem does not necessarily endorse any religious orthodoxy so much as suggest a celebration or exclamation of a mysterious future reality that so clearly bests the earthly one.

Seo-Young Jennie Chu's "Dickinson and Mathematics" explores a different critical approach to Dickinson's use of mathematics that is characterized this way: "Not only did [Dickinson] have a poetic understanding of mathematics, but she had a deeply mathematical understanding of her own poetic enterprise" (36). Chu submits the first clause of the compound sentence as a summary for the approaches of other critics and carves out the second clause as new territory provided by her essay. I will plant my essay's thesis in a third logical option implied by Chu's statement: that Emily Dickinson had a solid mathematical understanding of *mathematics*. In opposition to the idea that Dickinson used mathematics "suggestively" or "impressionistically" (quoting Theune, in this instance), Chu argues that "the exactness of mathematical language often allowed Dickinson to formalize how she thought and felt about ineffable subjects." Chu further asserts that Dickinson used mathematical concepts "accurately, logically, and with tremendous care" (36). I agree with Chu's statement but come at it differently and take it in a different direction.

Chu's contention is that "Dickinson uses specific mathematical principles to account for mysteries like death, wonder, the relation of self to God, and the limits of human knowledge," and the stated goal of her essay is "to show that the nature of mathematics was fully consonant with Dickinson's lyric sensibility" (36). In reflecting on a selection of Dickinson poems, Chu illustrates her points by finding mathematical structure within them in interesting ways.

The approach that I adopt may seem more pedestrian, but adds, I propose, a fruitful strategy for understanding what Dickinson means in poems using mathematical language. As Webster's is to the poet, so Day's textbook is to the mathematician.[20] We all consult the dictionary when puzzling out words in Dickinson poems, especially the 1844 Webster's. And since Dickinson was both poet and mathematician, we should consult textbooks like Day's when puzzling out her use of mathematical language. If we don't unpack the mathematics in her poems, we will likely be stuck using colloquial or familiar meanings for the mathematics. Going to the source of Dickinson's mathematical education seems a logical extension of current critical practice in regard to Dickinson's poetic lexicon.

To illustrate the difference in approach between my thesis and Chu's, I reflect on a poem that she discusses in her essay.

I could suffice for Him, I knew –
He - could suffice for Me –
Yet Hesitating Fractions - Both
Surveyed Infinity –

"Would I be Whole" He sudden broached –
My Syllable rebelled –
'Twas face to face with Nature - forced –
'Twas face to face with God –

Withdrew the Sun - to other Wests –
Withdrew the furthest Star
Before Decision - stooped to speech –
And then - be audibler

The Answer of the Sea unto
The Motion of the Moon –
Herself adjust Her Tides - unto –
Could I - do else - with Mine?

(Fr712)

In response to other critics' discussions of Dickinson's "broken mathematics," Chu uses this poem to show that "Even in poems where Dickinson's use of mathematics is 'broken' or more evocative than logical, there is a precision in how she 'breaks' her mathematics":

> These stanzas invoke mathematics not only by alluding to 'Fractions' and 'Infinity' but also by raising the specter of mathematical equality. Several words and phrases—'suffice,' 'Twas face to face,' 'Withdrew'—appear in duplicate form, reminding us of the reflexive axiom '$a = a$'. And insofar as to suffice for something is to be equal to it, the first two lines set up the following equations:
>
> I = Him
>
> He = Me
>
> These equations are complicated, however, by the fact that the 'Fractions' represented by 'I' and 'He' are described as 'hesitating' to make themselves equal to each other. (50–51)

Chu continues to find connections between mathematical and grammatical structures in the poem and concludes with this statement: "By bringing grammatical and mathematical frameworks into a single space, Dickinson creates what we might call the 'pronoun-fraction'—a unit of poetic expression corresponding to the loneliness experienced by the disconnected self" (51).

While Chu finds useful mathematical structure in the poem, she does not derive or infer it from the mathematics Dickinson necessarily learned. For example, the reflexive axiom is not part of Day's treatment of algebra and was not part of Euclid's standard "axioms of equality" (Playfair 6–7). This is one of several instances in her essay where the mathematical structures suggested to Chu by the poems lack the historical backing of Dickinson's education; Chu shows that Dickinson is steeped in mathematics, but to do so she relies on anachronistic readings.[21] Going to Day (or other appropriate textbooks) would obviate this need.

Chu's use of the word "alluding" in reference to "Fractions" does reflect her view that for this poem Dickinson has given up "logical" use of mathematical language for "evocative." I prefer not to give up the logical, but rather see where it takes us. I, too, like the word "suffice" as a starting point. Consider this definition from Dickinson's Webster: "To be enough or sufficient; to be equal to the end proposed" (807). So when Chu says "insofar as to suffice for something is to be equal to it" and that the implied equations are "complicated," it is the word "suffice" itself that suggests this complication, not the hesitation in the fractions. The word *suffice* implies an *approximate equality* in which the standard for closeness is determined by some *proposed end*. Thus the first stanza of the poem sets up these *approximate equations*:

$$\text{I} \approx \text{Him}$$
$$\text{He} \approx \text{Me}$$

The "He" of the poem could be a loved one (Master?), [22] could be God, or could be some abstract entity (the poetic enterprise?), but in any case He is desired by the poem's speaker, and the first stanza opens up a relationship that is complicated. Having both parties survey infinity adds mystery to the conversation.

Infinity has meaning both within and without the world of mathematics, of course, and Day has much to say about it. He speaks of its "ambiguity" and as "occasion of much perplexity" (220). Day devotes two chapters to the concept of infinity, the first on general notions and then a later chapter on infinite series. An infinite series is just a sum of numbers (or algebraic terms) that is extended beyond "any determinate limits" (Day 246). For example, 3/10 + 3/100 + 3/1000 + 3/10000 + … is an infinite series, the ellipses indicating the sum extends indeterminately. If we truncate the series successively further out we get the sequence of partial sums: .3, .33, .333, .3333, etc. As we go further out the sequence, we get better and better approximations to the number this series represents, in this case the simple fraction 1/3. We thus say that the infinite series has a value exactly equal to its limiting value, namely 1/3, and we would write this mathematically as expression (1):

$$1/3 = 3/10 + 3/100 + 3/1000 + 3/10000 + \ldots \quad (1)$$

This series illustrates one of the mysteries of infinity that Day discusses: a series that is infinite can have a finite value (246). (Many—most—series do not: for example, the series 1 + 1 + 1 + 1 + … would have a value properly called infinity, and denoted by the mathematical symbol ∞.)[23]

Infinite series derive their utility from giving us ways to approximate numbers hard to corral with numerical precision. Consider Day's description of this: "It is frequently the case, that, in attempting to extract the root of a quantity, or to divide one quantity by another, we find it impossible to assign the root with exactness. But, by continuing the operation, one term after another may be added, so as to bring the result nearer to the value required" (246). If we want an approximate value of 1/3 to any desired level of accuracy, we need only take the partial sum out sufficiently far. So, for example, 3/10 + 3/100 + 3/1000 + 3/10000 = .3333 would be an approximation to 1/3 good to within one ten-thousandth. But how well an approximation *suffices* depends on an external standard dictated by context. If we are working in dollars for everyday activity, then 1/3 of a dollar is well approximated by .33, but if we want to weigh out 1/3 of an ounce of gold dust, we might need greater precision.

In the first stanza I take "Hesitating fractions" as this process of an infinite series converging to a true value through a sequence of approximations.[24] Dickinson uses this phrase as metaphor for the two spiritual questions of the stanza. The statement "I knew" suggests that the speaker feels confident she suffices for Him (God?), but line 2 raises the more open question of whether He is sufficient for her. The speaker corresponds to the true value, He (God?) is the approximating series, and it is the speaker who decides on the sufficiency of the approximations through her "surveying of infinity."

The second stanza finds the speaker confronted by a demanding "He." I read in "Whole" an unrelenting standard, the mathematical analog of being able to calculate the entire infinite series to exactness, a standard against which the speaker rebels, and which Day's language suggests is infeasible. This demand and the rebellion are part of the surveying and hesitating, part of the deliberative process that attempts to reconcile the approximate equations of the first stanza. I interpret the "God" of line 4 as a revelation that the "He" is either God or a religious authority. The word "forced," set off by dashes, is compelling. Forced means "compelled; impelled; driven by violence; urged; stormed; ravaged." But a second meaning is "affected; overstrained; unnatural" (Webster 352). It is a strong word that seems to signify the speaker setting off lines 3 and 4, acting as kind of a bridge between the two. After initially rebelling against His imposition of too high a standard, the speaker is "forced" to juxtapose her face-to-face encounter with Nature to her face-to-face encounter with God.

The speaker considers this juxtaposition in the final two stanzas. Thinking of the Sun setting on planets beyond Earth, her perspective increases. Reading "son" (i.e., Jesus) for "sun" in that first line suggests also the widening of God beyond Christianity, which Dickinson herself struggled with so famously. She goes from the nearest star in line 1 to the furthest in line 2. And then—"Before Decision – stooped to speech – / And then – be audibler"—which describes so beautifully the budding awareness, before the ability to even talk about it. Stanza 3 is contemplative, searching, inchoate. Then comes the concluding stanza, although less a conclusion than a question. It is hard to ignore that second occurrence of "unto," sticking out so. This "entirely obsolete" contraction of "on" and "to" (Webster 893), serves first to retain the perfect hymn meter of the poem. Also, the perfect rhyme of the repetition highlights the distinctly imperfect rhyming of "moon" and "mine," drawing us to consider those words. The speaker seems to be saying, "If the sea adjusts her tides to the force of the moon, how can I not adjust my tides—my beliefs?—to the presence of nature in my life?" That "motion" and "moon" form an accordion pun adds to the centrality of that motion to the moon's important role as described here.[25]

I hear in the poem a search for God's sufficiency through the power of nature. But I do not suggest this search is easy for our speaker, that she can simply sing, as in the old Anglican hymn, "All Things Bright and Beautiful" and find God. At best she is deciding to "adjust" her motions, and there is no firm promise in that. I hear Dickinson using mathematics to explore ideas "about the relation of self to God" (Chu 36), but, unlike Chu, I have used Day to unpack the mathematical language that introduces this exploration. That unpacking is the operational side of this essay's thesis.

CONCLUDING REMARKS

If Dickinson read mathematics as passionately as she did other literature, and if she was a serious and capable student of mathematics, then reading her mathematics books can help us respond to the "Roughly 200 of Dickinson's poems" that "include some reference to mathematical terms and ideas" (Stonum "Calculated Sublime" 101). The critics I studied and cited—Theune, Stonum, Chu, and Wolff (see below)—responded to Dickinson's mathematics with no (or little, in Theune's case) reference to the textbooks. This fact does not detract from their work, but in establishing this essay's thesis I have hoped to add to it.

I chose to constrain my evidence to one textbook and four poems. Consider this a defensive strategy for my personal sublime stemming from the magnitude of the task—the 1789 Dickinson poems, the roughly 200 mathematical ones. Each of these four poems resides in a different fascicle. In scrutinizing the 83 poems comprising these fascicles I find no preponderance of mathematical terminology in any of the four. From this I conclude that mathematics is not an organizing principle in any of the four fascicles.[26] Rather, mathematical words were simply part of Dickinson's vocabulary, with Day providing (part of) the dictionary. I hope, of course, that my excursion has uncovered some ideas of worth to others interested in Emily Dickinson and her mathematics. She has certainly left us with innumerable opportunities to find out.

Notes

1. Steve Andrews taught the course, and it was Steve who encouraged me to rewrite my original essay for publication. Without Steve's generous readings and suggestions this essay would not have been written. Without his superb class, I would have not conceived the idea for an essay in the first place.
2. In an email response to my query about the evidence for this assertion, Stonum said, "facts that interest you are from my own count, aided much by a concordance to the Johnson edition of the poems edited by S.P. Rosenbaum in the late 1950s. I just logged terms (ratio, sum, circumference, etc.) and then added them up. And by 'roughly' I am fudging an occasional ambiguity about whether a term is really mathematical or not." He also informed me that he had not saved notes from this exhaustive effort, his only record now being extensive annotations in his Johnson variorum edition.
3. Wolff tells us that Amherst Academy was so thoroughly identified with Amherst College that "there was really no difference in educational policy at the two schools" (77). This companionship of college and academy must have been common in the early history of many American colleges; for example, both Grinnell and Carleton had local academies of their own.
4. When I was in tenth grade I used an "experimental" textbook, on the crest of the "modern mathematics" movement in U.S. education following the launch of the Sputnik. It was produced by the School Mathematics Study Group (SMSG). That book was returning to a more rigorous and conceptually based mathematics education, and by today's standards it abounds in meta-discussions on the nature of things, but the quantity of SMSG's discussion paled in comparison to Day's. My SMSG text contained no preface meant for the student reader, and no general overview of mathematics.
5. Any textual notes of this sort come from the Franklin variorum edition listed in the "works cited" page.

6. In a discussion of "It troubled me as once I was –," Guthrie presumes that "atoms" would be "in the form of snow, ice, or rain" (126). Higginson, in a discussion unrelated to the poem, refers to a hummingbird as an atom (368). The definition from Webster that seems most relevant would be "Any thing extremely small" (60), for which any of these possibilities or still others might be candidates.

7. I am interpreting "bolt" as a fastening device of iron or other metal, although interpreting it as a thunder or lightning bolt or bolt of cloth (Webster 97) could also be fruitful. Lightning bolt, for example, suggests the poem "Tell all the truth but tell it slant –," and its lines "As lightning to the Children eased / With explanation kind," and so we could compare that poem to Fr516. My choice makes good sense as well, and, for economy, I choose to restrict my attention to this single interpretation of "bolt."

8. This picture impels me to recall the legendary twentieth-century mathematician Paul Erdős who, although an atheist really, would talk about "the Book" of proofs that only God had, in which all the good proofs of theorems resided. The most laudatory remark that Erdős could make on a colleague's proof would be that it came from "the Book."

9. All references to Webster in my essay refer to the 1841 edition secured from the internet, of which Dickinson's 1844 edition was a reprint: See https://www.researchgate.net/publication/236752376_Translation_and_the_Emily_Dickinson_Lexicon

10. Day provides elsewhere a description of these two facets of mathematics he calls "pure" and "mixed." Pure mathematics is mathematics for its own sake, a purely theoretical branch; mixed—what we would today call "applied"—is all those uses made of math in other disciplines, such as navigation, finance, physics, engineering, and so on.

11. I can hear Day's and Playfair's thoughts reflected in the poem "The Best Witchcraft is Geometry," which could be read as a paean to geometry. One way to read "thinking of mankind" is as the "clear and exact logic" where Euclid sets the standard for exposition. The "ordinary acts" of geometry really are, as Playfair admits, pretty basic facts about simple objects: points, lines, triangles, etc. But through the "magic" of how they are arranged—and this is the magic of the axiomatic method of Euclid that Playfair calls "beauty and peculiar excellence"—they do lead to this lofty feat of logic.

    Best Witchcraft is Geometry
    To the magician's mind –
    His ordinary acts are feats
    To thinking of mankind –
    (Fr1158)

12. What in his day would have been called an "outline."

13. Technically, we showed the *derivation* of the quadratic formula above. The proof rests on the fact that all the steps are logically reversible, so that the asserted solutions do solve the quadratic equation written in the first line. By stating this reversibility of steps we have our proof.

14. One wonders if Dickinson would have seen a link between a quadratic's possibly two solutions and her own use of variant words. Consider this remark of Day's in his quadratics section: "Although a quadratic equation has two solutions, yet both these may not always be applicable to the subject proposed" (151).

15. In the variorum edition Franklin says, "ED canceled 'prove' and wrote 'solve' above it" [704]. See Franklin (*Manuscript Books* 545) for the image of Dickinson's manuscript.

16. Stonum does not acknowledge a Day connection.

17. It is worth pointing out that Franklin's version of this poem in his Reading Edition is quite different:

Bound a Trouble – and Lives will bear it –
Circumscription – enables Wo –
Still to anticipate – Were no limit –
Who were sufficient to Misery?

State it the Ages – to a cipher –
And it will ache contented on –
Sing, at it's pain, as any Workman –
Notching the fall of the even Sun –
(Fr240)

The poem is still about the need for controlling life's pains. But without the striking metaphor of algebra as a controlling mechanism, I suspect my discussion of Franklin's version would proceed much differently, which only serves to raise the enduring question about what purpose Dickinson's variants were meant to serve. Here, I think, Franklin and Johnson have chosen two quite different poems.

18. Theune is comparing this to his discussion of "One and One – are One –."

19. You can also consult the Emily Dickinson archive to see both versions: http://www.edickinson.org/

20. I thank Steve Andrews for this sentence.

21. In discussing Fr578, "The Angle of a Landscape – ," Chu discusses the mathematical structure of polar coordinates as a "key to a mathematical understanding" of the poem (42). It is almost surely the case that Dickinson never studied polar coordinates, and so this poem provides another instance of the difference between my approach and Chu's.

22. Dates of the Master letters are murky, but Sewall says that "They are in the handwriting of the late 1850s and early 1860s" (512). And Franklin dates the poem as 1863. Thus it seems plausible that "He" could be Master.

23. Magdalena Zapedowska's essay "Dickinson's Delight" features a short Dickinson poem—"Unto the Whole – how add?"—that reflects for me Day's descriptions of infinity. Zapedowska does not discuss the poem mathematically, but one could do so, and employing Day would expedite such a reading.

24. Thanks to an anonymous reviewer for guiding me toward a simplified explication of Fr712.

25. And the excised letters of that pun, the "ti," are the letters that provide the "sh" sound of the sea, adding yet more strength to the moon-sea connection. Thanks to Steve Andrews for suggesting the accordion pun.

26. "It troubled me as once I was – " is in fascicle 24; "Bound – a trouble –" in fascicle 9; "I reason Earth is short" in fascicle 20; and "I could suffice for Him, I knew –" in fascicle 33.

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