



# **A Mathematician's Lament: How School Cheats Us Out of Our Most Fascinating and Imaginative Art Form**

*Paul Lockhart , Keith J. Devlin (Foreword)*

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“One of the best critiques of current mathematics education I have ever seen.”—Keith Devlin, math columnist on NPR’s *Morning Edition*

A brilliant research mathematician who has devoted his career to teaching kids reveals math to be creative and beautiful and rejects standard anxiety-producing teaching methods. Witty and accessible, Paul Lockhart’s controversial approach will provoke spirited debate among educators and parents alike and it will alter the way we think about math forever.

**Paul Lockhart**, has taught mathematics at Brown University and UC Santa Cruz. Since 2000, he has dedicated himself to K-12 level students at St. Ann’s School in Brooklyn, New York.

## **A Mathematician's Lament: How School Cheats Us Out of Our Most Fascinating and Imaginative Art Form Details**

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## From Reader Review A Mathematician's Lament: How School Cheats Us Out of Our Most Fascinating and Imaginative Art Form for online ebook

### Moses Hetfield says

I didn't realize when I checked this out from the library that I had already read Part 1 of the book in essay format for a math education class I took, but it is so persuasively written that I was happy to read it again. In this tiny book, Lockhart makes a compelling case for transforming the way math is taught in the United States, demonstrating that mathematics is an incredibly fun, artistic, and intellectually stimulating endeavor that is merely viewed as boring and practical because of the distorted way it is taught in schools. Lockhart is not very practicality-oriented, which makes sense for a mathematician, and at times this made his writing less convincing. I strongly disagree with his idea that teachers don't need training on how to teach math or that they don't need to plan anything—teaching math the way he wants would be very different from how people normally think of teaching, and thus would certainly require a fair amount of retraining (see Jo Boaler's books for implementation strategies). Furthermore, scaffolding mathematical exploration to maximize learning does require a lot of thought and planning. I also found that Lockhart has the same frustrating dismissiveness of practicality that I often see among humanities professors and students. I love his passion for mathematics as a pure intellectual pursuit, and I admire him for unabashedly supporting that, but I worry that he undermines his effectiveness by his frequent assertions that he does not care if math is in any way useful or practical. I think for parents, teachers, and policymakers to agree to changes in math education, it's important to note that even when mathematics is being studied purely for its own sake, that study has many incredibly useful byproducts. Despite these qualms, I think this is an insightful, convincing, and (perhaps most importantly) concise essay on the wonders of mathematics and the necessary changes for how it is taught.

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### Phil says

This book is fantastic. I recommend it to all those people who, upon hearing from me that I do math, have replied, "Oh, I suck at math" or "Oh, I always hated math in school." For years I've encountered a recurring frustration at the fact that, when I tell people that I'm studying mathematics, I tend to discover that they have a completely wrong impression of what it is that I do (or at least try to do), and that it is not easy to correct this impression. I try to tell them: you hate math because you don't know what it is, because the stuff they taught you in school was not math, but almost something else entirely; real math is fun and interesting and makes you think both logically and imaginatively, it is both beautiful and surprising. But I never quite feel like I get the whole truth across.

This book gets the whole truth across. It says everything I've ever wanted to say (as well as many things I hadn't thought of) in regards to all of this, but does a much better job than I ever could. He accurately portrays exactly how it is that people commonly misunderstand what mathematicians really do, the common misperceptions that they tend to have. Then he goes on to critique what is pretty obviously at the root of all this misunderstanding: the state of math education itself. Through a few clever analogies and a bit of simple explanation, the author demonstrates how the average student's assessment of the 'mathematics' that we are taught in school is completely accurate: namely, that it is arbitrary, stupid, and boring. He clearly and succinctly articulates the tragedy of the current state of the public math education system, and how it poisons the general public's understanding of what mathematics is, and never even comes close to giving the general public a real sense of what the subject is even about. He gleefully and accurately (and also quite humorously)

tears to shreds the current K-12 curriculum, exposing its idiocy.

But the book doesn't stop there; after showing us what is wrong with the current state of mathematics education, he goes on to give a brief and wonderful little demonstration, through several very accessible examples, of what mathematics really is, the types of things that mathematicians actually think about, and why they are interesting. I found this to be wonderful-the best part of the book.

The whole book is also superbly written; his choice of words had me laughing out loud at times.

Finally, reading this book actually made me feel somewhat ashamed of my sometimes aloof personal attitude towards my area of study; my tendency to think of my subject as something intractably esoteric and advanced, inaccessible to the general public (because, of course, only the intellectual elite such as myself are capable of comprehending it). At one point he makes note of the fact that many people make it most of the way through most of graduate school believing (because they've always been told) that they are good at math, only to discover, when they attempt to do some real mathematics, that all they were really good at is following directions. Ouch. I hope that isn't me...

So again, I recommend this book to all my friends and family who wonder what it is that I'm trying to do, and I may even be buying it for some of you, come Christmas time!

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### Amy T. says

The author of this book really loves math, and believes that what is being taught as "math" in schools is not math, but rather an exercise in soul-crushing drudgery and torture. He has some interesting points. He says that true mathematics is an art form and has no practical purpose other than to bring joy to those who practice it. It should be taught as an art form just for the sake of enjoying its true beauty, just like we would study great literature, art, or music. As a Charlotte Mason-inspired educator, I am intrigued. Miss Mason believed in a "liberal education for all," and did not think all learning had to be related to preparing for a particular trade. But I digress.

The first part of the book is a mouthy rant against the current system and the second part is an introduction to "true mathematics," namely, problem solving. Figuring out how numbers work together, how patterns work, how lines relate to each other in space, etc. What is sorely lacking is any kind of practical description of how a person would lead a child in practicing "real mathematics." Perhaps he would say I am missing the point.

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### Nick says

Slightly expanded from the essay online (pdf) in that it has a Part II: Exultation where Lockhart wants to "tell you more about what math really is and why I love it so much." (p.92).

Seriously, this is a great essay/book. Worth reading probably once a semester, if not more. And *before* structuring a class (curriculum). The faux dialog at the end of every section is awesome, and indicates good ways to respond to nay-sayers (are there any?), even if not all of the questions/concerns are fully addressed.

When in doubt, remember that math is an art. Argue for it as you might for music or painting. Of course, to a Platoist, math is discovered, instead of created, like I think of for music or painting. But there's some famous

sculptor who said something about freeing a form from the marble, instead of making it, right?

## Part I: Lamentation

p.23:

... there is nothing as dreamy and poetic, nothing as radical, subversive, and psychedelic, as mathematics. It is every bit as mind-blowing as cosmology or physics..., and allows more freedom of expression than poetry, art, or music.... Mathematics is the purest of the arts, as well as the most misunderstood.

p.24: "If there is anything like a unifying aesthetic principle in mathematics, it is this: *simple is beautiful*. Mathematicians enjoy thinking about the simplest possible things, and the simplest possible things are *imaginary*."

p.25: "... major theme in mathematics: things are what you want them to be." and later "This is the amazing thing about making imaginary patterns: they talk back!"

p.27: "Somehow, I was able to create a profound simple beauty out of nothing, and change myself in the process. Isn't that what art is all about?"

p.29: "Mathematics is *the art of explanation*."

p.32-33: "gross misconception that mathematics is somehow useful to society!" later: "Music can lead armies into battle, but that's not why people write symphonies."

p.37: "The mathematics curriculum... needs to be *scrapped*." later: "Mathematics is *the music of reason*." later still: "you *gave* it sense and you still don't understand what your creation is up to" within "To do mathematics is... to be *alive*, damn it."

p.39: "We don't need to bend over backwards to give mathematics relevance. It has relevance in the same way that any art does: that of being a meaningful human experience."

p.43 (emphasis mine):

So how do we teach our students to do mathematics? By choosing engaging and natural problems suitable to their tastes, personalities, and levels of experience. By giving them time to make discoveries and formulate conjectures. By helping them to refine their arguments and creating an atmosphere of healthy and vibrant mathematical criticism. By being flexible and open to sudden changes in direction to which their curiosity may lead. In short, by having an honest intellectual relationship with our students and our subject.

p.44: "The trouble is that math, like painting or poetry, is *hard creative work*."

p.46: "Teaching is not about information. It's about having an honest intellectual relationship with your students."

p.47: "... your lesson will be *planned*, and therefore false." later: "Teaching means openness and honesty, an

ability to share excitement, and a love of learning."

p.48: "We teach them to read for the higher purpose of allowing them access to beautiful and meaningful ideas."

p.51: "... get curious about a question..."

p.52: part of one of the dialogues:

Simplicio: Yes, but before you can write your own poems you need to learn the alphabet. The process has to begin somewhere. You have to walk before you can run.

Salviati: No, you have to have something you want to run *toward*. Children can write poems and stories *as* they learn to read and write. A piece of writing by a six-year-old is a wonderful thing, and the spelling and punctuation errors don't make it less so. Even very young children can invent songs, and they haven't a clue what key it is in or what type of meter they are using.

p.53: "Mathematics is not a language; it's an adventure."

p.54: "We teach to enlighten everyone, not to train only the future professionals. ... think creatively and independently."

p.55-56: "the exact same things are being said and done in the exact same way and in the exact same order" <-- next two which I wrote: "internet!" Make the process more efficient. Of course, this isn't what Lockhart wants, and, thinking about it, likely not what I want.

p.56: "*Art is not a race*.... seeing mathematics as an organic whole."

p.58: "Of course, it is far easier to test someone's knowledge of a pointless definition than to inspire them to create something beautiful and to find their own meaning."

p.59-60: "Mathematics is about problems.... Painful and creatively frustrating as it may be..." Later on p.60: "English teachers know that spelling and pronunciation are best learned in a context of reading and writing. History teachers know that names and dates are uninteresting when removed from the unfolding backstory of events. Why does mathematics education remain stuck in the nineteenth century?"

p.62: "Teaching is a messy human relationship... if you need a method you're probably not a very good teacher."

p.63: "I'm sure most of them love their students and hate what they are being forced to put them through. They know in their hearts that it is meaningless and degrading. They can sense that they have been made cogs in a great soul-crushing machine, but they lack the perspective needed to understand it, or to fight against it."

p.64: done right, according to Lockhart, "there would obviously be a range of student interest and ability... but at least students would like or dislike mathematics for what it really is..."

p.66: "Doing mathematics should always mean discovering patterns and crafting beautiful and meaningful explanations."

p.72: ranting on geometry, the "two-column proof": "The effect of such a production being made over something so simple is to make people doubt their own intuition." I'd argue that making people doubt their intuition is actually a good thing. Later: "Rigorous formal proof only becomes important when there is a crisis"

p.75: "This is what comes from a misplaced sense of logical rigor: *ugliness*."

p.76: "Mathematics is about removing obstacles to our intuition, and keeping simple things simple."

p.78: "... private, personal experience of being a struggling artist..."

p.79: "definitions matter... And they are *problem generated*."

p.80: "I don't want students saying, "the definition, the theorem, the proof," I want them saying, "my definition, my theorem, my proof."" Later: "Efficiency and economy simply do not make good pedagogy."

p.81: "It's hard to completely ruin something so beautiful..." Later:

Simplicio: So we're supposed to just set off on some free-form mathematical excursion, and the students will learn whatever they happen to learn?

Salviati: Precisely. Problems will lead to other problems, technique will be developed as it becomes necessary, and new topics will arise naturally. And if some issue never happens to come up in thirteen years of schooling, how interesting or important could it be?

Plus, in all that time, students will have learned how to think and learn, and so picking something up later will be easier.

p.82: "a good teacher can guide the discussion and the flow of problems so as to allow the students to discover and invent mathematics for themselves.... individuals doing what they think best for their students."

p.87-88: "How ironic that people dismiss mathematics as the antithesis of creativity. They are missing out on an art form older than any book, more profound than any poem, and more abstract than any abstract."

## Part II: Exultation

p.91: "School has never been about thinking creating. School is about training children to *perform* so that they can be *sorted*."

p.92: "... mathematics is an art. Math is something you *do*. And what you are doing is exploring a very special and peculiar place - a place known as "Mathematical Reality." ... elegant, fanciful, wonderful, imaginary, fascinating, curious..." Later: "In this way, being a mathematician is a lot like being a field biologist." a nice analogy that he expands on.

p.94: "the difference between the thing itself and the *representation* of the thing.... The only thing that matters in mathematics is what things *are*, and more important, how they *act*."

p.100: "Mathematical objects... are still nothing more than figments of our imagination.... they are what we ask them to be."

p.101: "we mathematicians do not like being told what we can and cannot do."

p.103: "we play and create and try to get closer to ideal beauty."

p.104: "Being a mathematician is not so much about being clever... it's about being aesthetically sensitive and having refined and exquisite taste."

p.106: "The only thing I am interest in using mathematics for is to have a good time and to help others do the same. And for the life of me I can't imagine a more worthwhile goal. We are all born into this world, and at some point we will die and that will be that. In the meantime, let's enjoy our minds and the wonderful and ridiculous things we can do with them. I don't know about you, but I'm here to have *fun*."

p.108: "This is the Frankenstein aspect of mathematics - we have the authority to *define* our creations, to instill in them whatever features or properties we choose, but we have no say in what behaviors may then ensue as a *consequence* of our choices." Later: "I am drawn in by the possibility of a *connection*..."

p.109: "Nothing I have ever seen or done comes close to having the transformative power of math." Later: "Mostly I love the abstraction of it all, the sheer simplicity."

p.110: (on checking the first umpteen cases) "We could then say that it's true for all practical purposes, and be done with it. But that's not what mathematics is about.... Math is about reasoning and understanding." Later: "That is the goal of the mathematician: to explain in the simplest, most elegant and logically satisfying way possible."

p.111-112: "This is a unique art form within the world of rational science." Later: "imagine a Two-Headed Monster of mathematical criticism. The first head demands a logically airtight explanation... The second head wants to see simple beauty and elegance, to be charmed and delighted..."

p.113: "a lot of pain and frustration and crumpled-up paper."

p.114-115: "mathematics... is our most quintessentially human art form... We are biomechanical pattern-recognition machines and mathematics is nothing less than the distilled essence of *who we are*."

p.117-118: "what it's like to do mathematics. Playing with patterns, noticing things, making conjectures, searching for examples and counterexamples, being inspired to invent and explore, crafting arguments and analyzing them, and raising new questions."

p.118: "That's really what it means for something to have a pattern - if we can capture it with *language*."

p.119: "For a brief shining moment we lifted the veil and glimpsed a timeless simple beauty. Is this not something of value?"

p.120-121: "We're talking about a perfectly innocent and delightful activity of the human mind - a dialogue with one's own mentality. Math requires no pathetic industrial or technological excuses." Later:

To say that math is important because it is useful is like saying that children are important because we can train them to do spiritually meaningless labor in order to increase corporate profits.

p.126: "Mathematics is fundamentally an act of communication."

p.128: "problems can be classified... The point of this sort of framework...: to help us understand... helps us

make predictions and to know what to look for. Classifications are a guide for our intuition."

p.131-132: "The historical development of mathematics...: first come the problems,... *connections* are made... structures are then devised... New questions then arise... And then the process continues."

p.133: "as modern mathematicians we are always on the lookout for structure and structure-preserving transformations."

p.135: "math problems... come from *playing*."

p.137: "How bizarre that something so simple should turn out to be so hard!"

p.138: "Does math ever come to an end? No". Later: "learning and playing are the same thing."

p.139: "if you are a math teacher... throw the stupid curriculum and textbooks out the window!"

p.140: final paragraph:

And if you are neither a students nor teacher, but simply a person living in this world and searching as we all are for love and meaning, I hope I have managed to give you a glimpse of something beautiful and pure, a harmless and joyful activity that has brought untold delight to many people for thousands of years."

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## Angela says

*A Mathematician's Lament* is more of a long essay than a book--one man's problems with mathematics education without a viable solution. Now, I consider myself, while no mathematician, a mathematics...enthusiast, if you will. I read the occasional recreational mathematics book, I am one of the three people on earth who subscribes to the journal of recreational mathematics, I am constantly sneaking new variations on Tangrams and other puzzles into the house. And I am definitely not a fan of modern American elementary education; I consider my public school education to have prepared me adequately enough for the world, but it did seem largely like a waste of time. Oh, those purple dittos with the blocks that had to be colored in based on the results of math problems -- they were my nemesis, and not because I couldn't do arithmetic.

So partly, I think his argument - that mathematics education gets tripped up in unnecessary formalism and syntax before conceptually interesting problems are tackled, and that the whole thing is defended with the ridiculous "you might need this someday" pragmatism that children will instantly tune out - is a sound one. It would be great if every elementary school teacher were the kind of engaged leader capable of putting his or her students to work on an interesting geometry or abstract algebra problem and wandering around not to give answers, but to provide the occasional hint. Unfortunately, I just don't see how this is going to provide anyone with a well-rounded mathematics education. Lockhart argues that what they get now -- not learning anything because they're so bored -- is worse.

It's tempting to believe all of this. And yet, I couldn't get a nagging thought out of my mind: I managed to get through all that arithmetic, algebra, geometry, and calculus with an ability to apply most of it. I didn't go through school memorizing formulas and I never felt forced to do so either; to this day I couldn't tell you most trig identities without starting at the Pythagorean theorem and deriving them. Is the state of things

really that bad?

Even accepting that it is, Lockhart's book is breezy and quick....what might have been called a pamphlet, perhaps, in earlier days. And like satirical pamphlets, it does an excellent job lampooning the state of things but offers very little in the way of realistic alternatives. I am all ears to hear new ways of teaching children math; I imagine classrooms could be greatly improved by incorporating topics from recreational math, calculus, and abstract algebra at an earlier age, and have never understood the obsession with arithmetic that dominates the first years of mathematics education. But Lockhart doesn't provide much in the way of real solutions--just the clue that he really likes circumscribed triangle problems. Spend all of mathematics class playing chess and go? That might be fun, but I'm unconvinced that the primary purpose of school is to entertain.

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### **?Misericordia? ~ The Serendipity Aegis ~ ?????? ✨❤️ says**

This is brilliant! After reading this I finally remember what fascinated me about maths before I was trained to sit maths exams.

The author's stunningly poetic approach to math as a study of world and its transcendent nature that is so eloquently explained in this work can make even the most antimathematically thinking person to fall in love with maths!

A sure must reread.

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### **Diego says**

"Now hold on a minute, Paul. Are you telling me that mathematics is nothing more than an exercise in mental masturbation? Making up imaginary patterns and structures for the hell of it and then investigating them and trying to devise pretty explanations for their behavior, all for the sake of some sort of rarified intellectual aesthetic?"

Yep. That's what I'm saying. In particular, pure mathematics (by which I mean the fine art of mathematical proof) has absolutely no practical or economic value whatsoever. You see, practical things don't require explanation. Either they work or they don't.

[...]

Anyway, the point is not whether mathematics has any practical value-I don't care if it does or not. All I'm saying is that we don't need to justify it on that basis. We're talking about a perfectly innocent and delightful activity of the human mind-a dialogue with one's own mentality. Math requires no pathetic industrial or technological excuses. It transcends all of those mundane considerations. The value of mathematics is that it is fun and amazing and brings us great joy."

Un libro excelente, de lectura necesaria. No fue revelador, porque siempre pensé que la matemática es un arte, un juego que a veces tiene aplicaciones en "el mundo real". El tono del autor y las geniales analogías que usa mantienen el interés a lo largo de todo el libro. Coincido en que en la escuela no se enseña matemática, sino definiciones sin contexto histórico y manipulaciones algebraicas varias.

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### **Ioana says**

As a mathematics teacher and long-time student of mathematics, I was overjoyed when I came across this

book. Finally, I thought, an ode to the profound beauty and elegance of this most precise and direct human languages. And, hopefully, an expose on the state of mathematics education, and a plea to change course, maybe even some practical suggestions on how we may begin to do this.

Lockhart and I started in lock-step. YES. The current state of mathematics education is a TRAVESTY - we are most emphatically *not* teaching students to fully appreciate its abstractive powers, philosophical implications, and inherent structure. Instead, we are taking the artifacts of *doing mathematics* and positing that these are what math is *about*.

**An example: numbers.**

My absolute favorite. As a math teacher, I get this a lot on my first day of a new school year, "Ms. S., what  $36 \times 129$ ?" I am, of course, expected to do this quickly without a calculator. Since, unfortunately, most students have been taught to think that math is *about* numbers, or shapes, or equations, or graphs, or in general, mathematical objects.

Mathematician Paul Halmos (1916-2006) wrote an excellent essay on this misconception. An excerpt:

"to begin with, mathematicians have very little to do with numbers. You can no more expect a mathematician to be able to add a column of figures rapidly and correctly than you can expect a painter to draw a straight line or a surgeon to carve a turkey-popular legend attributes such skills to these professions, but popular legend is wrong. There is, to be sure, a part of mathematics called number theory, but even that doesn't deal with numbers..." PDF File here (YES! What number theory is about, by the way, is the concept of *counting*; numbers are but an artifact...)

I've never been a human-computer type of whiz-kid, and I can't compute 'in my head', without the aid of pen and paper. I don't, in fact, even like numbers particularly, and thankfully never had to deal with them much in school (as a math major). I'm not even a quantitative type of person. And I certainly do not believe in the applicability of mathematics to all human endeavors (well, I believe it *can* be applied in every circumstance, but not with positive effects; take, for example, the current testing regime in education as a prime example of the devastation that can be wreaked by our belief in numbers to solve all problems).

But, I still *love* math. And I choose to prove my teacher worthiness by beginning the year-long conversation with my students about how math is not about its objects, but is rather a language. A language unlike any other we speak, one predicated on conciseness, precision, and directness. A language that may also be applied widely, but with caution and attention to ethical and social implications.

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**But let me get back on task. So I absolutely agree with Lockhart: mathematics, as language, is an art.**

It is indeed a tragedy that in too many schools today, math education consists of futile exercises in computation, memorization of formulas, of solving contrived word problems, and, more recently, manifests as an endless quest to eliminate wrong answer choices on standardized tests. YES of course I agree: math should not be taught in procedural fashion, formulas should not be blindly memorized, problems should not be contrived to be about "real life" situations.

I'm also in agreement that we need to invest in programs that will train all of our math teachers in formal mathematics. At the moment, most math teachers in the US have transitioned from the workforce (engineering mostly, some physics and other sciences) or have degrees in math education. It is my and Lockhart's contention that a deep understanding of the subject is required in order to be able to relate the *essence* of math.

[In an ironic twist, badly applied quantitative measures of unquantifiable phenomena (such as the experience of student learning) suggests that math degrees don't make a difference in terms of student "success" (See this Edweek Article)].

**While I agree with Lockhart's assessment of the inadequacy of the current state of math education, I strongly dissent to his suggestions for how we should move towards reform. *A Mathematician's Lament* lacks any kind of historical understanding, and does not at all consult pedagogical and curriculum literature.**

For example, Lockhart writes that "word problems" should not be contrived to be about real life (I agree with this point), but then he continues that *mathematics is beautiful precisely because it is irrelevant to 'real life'.*

I cannot comprehend how another mathematician could possibly believe the beauty of mathematics comes from the "irrelevance" of its abstractions: in fact, the reason math is SO powerful is that these abstract representations have all been historically "discovered" or "invented" (depending on what you believe math is: inherent in the world, or a human game of abstraction)--particularly in order to try to model and explain phenomena observed in "the real world."

Lockhart says math was created by humans "for their own amusement" (p. 31), but ignores that in fact all branches of mathematics in the past were created in response to actual world problems, and not only that, but now, some of the most fascinating mathematics is being created again in response to solving some of the most complex problems we have imagined, such as the mathematics behind string theory. I don't know how Lockhart could possibly consider that humans invented counting, ways to measure their plots of land and keep track of money, or ways to measure the orbits of planets (thus leading us to the current "space age") as "purely amusement"--perhaps, if *life is amusement* in general, but really, all of these inventions had a very *real*, concrete, specific historical cultural purpose and are not "just made up" for fun!!

I teach functions (precalculus, AP calculus) and the main theme is how basically, in life, we track patterns of change in anything and everything--public health data, unemployment, polling, the stock market, baseball stats, etc. Functions are just the most abstract way to represent these changing patterns over time (or some other variable) and thus give us the powerful tool of projecting into the future/past and otherwise analyzing trends. Yes, functions are abstract, but they are *not* "just fantasy play," irrelevant to the real world, or made up simply for the fun of it, in fact, quite the opposite of all of these.

My (and I believe, many) students would be aghast to learn that someone is suggesting an overhaul of math education based on the idea that "kids don't really want something that is relevant to their daily lives." This is the most absurd statement I have ever read so I am guessing Lockhart knows nothing about adolescent/child development, interest, and pedagogical literature. Learning in general is based on making connections to prior knowledge, and I have never heard any question asked more often in math class when I didn't explain the relevance in advance than "Why do I need to know this? How is this relevant to my life?" This is probably the MOST pressing question for adolescents in general...\* (**See very long note on Dualism in Lockhart & Real Life Applications**)

Other examples of pedagogical tragedies in this book include Lockhart's admonitions that "you can't teach teaching," that "schools of education are a complete crock" and that teachers shouldn't lesson plan because this is somehow "not real" or authentic (p. 46-47). While I agree schools of education are not preparing our teachers well and what we need is much more systemic training in content knowledge, *it is absolutely not supported by any peer-reviewed research that teaching is something you "have" that you don't need to "learn" and, further, that you shouldn't plan because this is inauthentic.*

A plan should of course never prevent a teacher from moving in new directions as suggested by the course of

the class, but coming in without a plan is certainly not considered sound practice in any theory of learning and from any angle, and in general is not a sound principle of life (i.e., just doing everything by the seat of your pants and counting on your "genius" to lead you through whatever you should have planned usually doesn't work, unless you are in a feel-good movie). Only in Lockhart's fantasy "lala land" of irrelevancy is planning a vice and not a virtue. Plus, there's so much more to "planning" than thinking about the flow of the lesson, how you will help students make connections, etc. I assess and plan hand in hand for example, and I tailor my classes for my particular students that year.

### **\*Very Long Note on Dualism in Lockhart & Real World Applications**

Math is a language, and as such, art, that captures the most abstract essence of our world. Some even go as far to say that math is a structure of our very universe (see Penrose and Tegmark); I'm trudging through their work at the moment and am not convinced, but this may change.

Rather, what I've always believed is that **math is embodied in our cognitive schemas and perception**, and that **this is precisely what makes it so wonderful**: humanity's inherent capacity for thinking about the real world in this abstract way (see *Where Mathematics Come From: How the Embodied Mind Brings Mathematics into Being* by George Lakoff & Rafael Núñez). The point is, these ideas *are born in experience*: and, in turn, our experiential perceptions are shaped by these ideas, creating the cyclical process of learning and expanding our horizons.

From this perspective, in which experience/perception are perpetually interconnected to our cognitive schemas in a cycle of expansion, to say as Lockheart does, that math, or that *anything*, for that matter, is purely "of the mind" is basically Descartes all over again, "only the thought exists". And we all know how well *that* turned out.

Now, I am *not* proposing the other side of the dualistic coin: teaching "math for engineering" type courses in which the emphasis is on the application. What I think is essential is to teach math *in the context of its history, its applicability, its ethics, its abstractive prowess, its meaning*.

Nothing is "born in our mind" alone; nothing exists in our "mind" alone; and for anything to make sense, the very idea of something having a sense, comes from our experiential perception.

**Example #1:** take the case of Zero (see Charles Seife's *Zero: The Biography of a Dangerous Idea*). We tend to think of "0" as a number, perhaps like any other, but this is far from accurate. Zero has a complex history within that of counting, and it was not at first even considered a number, but a place holder for "nothing." While anthropologists have discovered potential counting artifacts as old as 30,000 years, zero is only a few thousand of years old, if that. It took many tens of thousands of years after the adoption of numbers to "invent" the concept of "zero"-most likely because zero/the idea of cataloging "nothing" was not part of the daily experience of tracking items, livestock, or people. In fact, mathematicians to this day continue to refer to the set of integers "1" and above as "natural numbers", and do not include 0 in this set.

**Example #2:** the concepts of positive and negative, the number line as a construct. The number line parallels our perceptive ability to set dualistic reference points in/with our bodies, such as east-west, up-down, right-left, and so on; this reference-setting tendency is further related to our bipedal structure. Of course, we also *think* in terms of "continuums", mostly one-dimensional (linear). I often wonder what our mathematics would be like if humans had the anatomy of octopuses!

**I read this book some time ago (2008?). Posted the first review in 2010, which has been significantly edited from its original version in this April 30, 2016 update**

## Kim says

An insightful read...agreed with a lot of what he said re: math being more about discovery and adventure and art. He wrote: "So let me leave you with the only practical advice I have to offer: just play!" Yet, not sure how, in our current society and education model, it's quite possible to break out of the math mold especially in the older/late years. Still pondering that and would love to read more about how to practically flesh that out (making math more about discovery) in everyday life.

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## Vilém Zouhar says

Definitely a must read for all math teachers. I was starting to get a bit bored in the end, but when I started to realize that, the book was over. Paul Lockhart shows where the current system leads us to: a mass production of pattern-recognition machines (read: students). I really liked the introduction parable.

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## Gavin says

*if I had to design a mechanism for the express purpose of destroying a child's natural curiosity and love of pattern-making, I couldn't possibly do as good a job as is currently being done—I simply wouldn't have the imagination to come up with the kind of senseless, soul-crushing ideas that constitute contemporary mathematics education.*

*Everyone knows that something is wrong. The politicians say, "we need higher standards." The schools say, "we need more money and equipment." Educators say one thing, and teachers say another. They are all wrong. The only people who understand what is going on are the ones most often blamed and least often heard: the students. They say, "math class is stupid and boring," and they're right...*

[Excerpt free here]

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## Sally says

I know - 4 stars? Really? The content and the ideas and the presentation are 5-star material. He's a bit crude sometimes, and there's a particularly hedonistic phrase used near the end of the book (part 2, not the free essay material) that I felt was just unneeded. And since I recommended this to all my dear homeschooling friends, some of whom have tender sensibilities, I knocked a star off. Disclaimer done.

Now, for the high praises!! YES, math is supposed to be FUN. It's about noticing, thinking, discovering, beauty, "coincidences," patterns, sense, reasoning and FUN. I typed all sorts of quotes into the goodreads database (just check the right sidebar on this book's page, and you'll see a link to more quotes from this book).

I was blessed, I suppose, to not only inherit nerdy genes, but critical-thinking genes; to have been exposed to

puzzle-fun growing up; and to have had a great public school experience over-all; AND to have had a go-at-your-own-pace math curriculum in 5th grade, which was the highlight of every day. I didn't particularly enjoy timed multiplication tests in 3rd grade (I choke under pressure), and Linear Algebra kicked my fanny in college. But everything in between was fun! (Ok, I lied: Mrs. Oyamoto used to mark off point for misspelled words on our Algebra tests, which I thought was a bit cranky.)

The point being, Lockhart's Lament is preaching to the choir with me. I've always loved math. And I've always loved it because of the fun of exploring and discovering, and its beauty. I \*got\* that out of math class, even though it wasn't taught that way.

Also, I'm on the educational fringe already. I homeschool and don't use curriculum; I'm so far away from being concerned with K-12 curriculum it isn't funny.

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From my notes:

p46 "Honest intellectual relationship" caused me pause - I suppose because it looks so different depending on the setting and the age. And I take honesty for granted.

p48 "We learn things because they interest us now, not because they might be useful later..." There's truth in that, and it's certainly more true for the young and the immature and some personalities. But I hope that if someone is becoming truly educated and not just "taught" they develop a desire to learn useful things. Of course, that's gradual.

p49 [Large-digit addition is too advanced for most 3rd graders.... Wait until they're naturally curious about numbers.] I mostly agree with this; primarily because this is how I handled reading. I didn't push reading on my kids, rather I exposed them to lots of books, I modeled reading and I read TO them. Especially because math is so maligned in today's world, I think exposure to "playing" math is essential. If you wait until someone develops a natural curiosity without exposing them to said subject, it might never happen. Exposure in a playful, fun way is essential.

p50 "Preparing tomorrow's workforce today" is such a sarcastic, loaded remark!!

p52 He contrasts memorizing poetry (the "awful" way of teaching) to writing your own (the only "good" way), and I believe them to be points on a continuum. It's asking a lot for a child to write poetry without any exposure. Exposure, again, is key.

p63 "Cogs in a great soul-crushing machine" rivals the oft-quoted Titanic reference in the beginning.

p64 More staggering cruelty towards The System: "The problem is not that the students can't handle it, it's that none of the teachers can."

p78-9 This pretty much epitomizes his criticism: "The problem with the standard geometry [or any math] curriculum is that the private, personal experience of being a struggling artist has virtually been eliminated. The art of proof has been replaced by a rigid step-by-step pattern of uninspired formal deductions. The textbook presents a set of definitions, theorems, and proofs, the teacher copies them onto the blackboard, and the students copy them into their notebooks. They are then asked to mimic them in the exercises. Those that catch on to the pattern quickly are the "good" students.

"The result is that the student becomes a passive participant in the creative act.... They are being trained to APE arguments, not to INTEND them. So not only do they have no idea what their teacher is saying, THEY HAVE NO IDEA WHAT THEY THEMSELVES ARE SAYING."

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Part 2 of the book models a few instances of questioning and working for the answer. My favorite was the one about odd numbers and square numbers. I never knew that one! :) The second part of the book was a nice complement to the first, but simply reading the essay online certainly communicates the point.

His detractors are fair when they say that he gives little concrete suggestions about how to \*go about\* teaching math without curriculum, but on the other hand, one of his main points is that you can't teach math if you don't love it. Your enthusiasm and guidance will facilitate math-learning, based on where your students are and your time together, etc. BUT, the world would certainly benefit from more "this is what we did to explore math today" ideas.

Highly recommended if you think you're "not good at math." If you dislike math there's a good chance you don't understand what it is AT ALL.

Happy mathing!

(see also <http://www2.ed.gov/about/bdscomm/list...>

<http://www.noetic-learning.com/gifted...>

<http://www.artofproblemsolving.com/Vi...> especially "doodling in math class")

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## Scott says

An excellent book that lays out a strong case that schools fail - yet again - at a task at which it is meant to be good. Teaching math is the target, but the same arguments could certainly be applied to any number of areas of study. For instance, as a social studies teacher charged with leading my students through various curriculums, I feel the awful pull of those vocab terms, those textbook pages etc. The best thing for a history student is to practice being a historian, and I do my best to both replicate that experience as well as follow the curriculum.

For the most part I agree with, sympathize, and understand the "lamentation" portion of this two-part book. I did find it a bit heavy-handed and repetitive, which is to be expected for a fierce defense of artistic and academic freedom, but the dialogues, the examples, the chummy frustrated-friend-at-the-bar-letting-all-his-frustrations-out tone were all very well done; this was a readable, eye-opening book (especially so, probably, for non-teachers).

In parallel (intersecting at a point an infinite distance away, of course) to the lament in this book, I taught a global history course this past year where I left the content open for the students - beyond assigning a few cool books meant to alter their perception of western history by substituting it with non-western and non-traditional perspectives - I focused on bolstering the critical skills of history and social sciences. It was harder for us all than I had expected, namely because when students were faced with content and current issues (we did quite a bit with the underlying history of modern issues) that they selected, they freaked. It was as if they couldn't handle that autonomous, authentic inquiry. They were already stuck in the vortex of teachers telling them what to do and just doing it mindlessly. Such is school, and this book illuminates that quite nicely.

Thanks to Niles and Andrew for recommending this to me. Sorry it took so long for me to finally get to it!

## K. says

Disclaimer 1) This is only a review of the 25 page essay, which can be found here:

<http://www.maa.org/devlin/LockhartsLa...> Why am I reviewing the essay instead of the book? Well, I don't have the book, but I did read the essay and thought that posting a review of even part of it would be of worth to some poor, sad, math-challenged-but-don't-know-why soul.

Disclaimer2) I know next to nothing about mathematics, but am endeavoring to want to learn it. God bless you, Sally B., for sending me the link to this paper before I went out and bought a set of Saxon math!

Okay, I admit it. I'm math-o-phobic. Always have been. What are you going to do? Bad teachers. Boring subject. No natural tendency nor talent. Can't see the relevancy (what are calculators for, anyway?) I just plain don't get it. I'm just not a math person, I guess.

Does that sound familiar? Do you suffer too? Well, I think that some relief may lie herein.

But seriously, this essay turned me on my head concerning all things mathematical. I have a 12 yo whom I have been feeling needs to "begin" learning math, he's getting on in years, it's time I suppose. I truly was all set to get down to the dirty business of it and buy him the Saxon books this year and then give him the "some things are just plain boring, hard, and hateful, and we have to do them anyway so we can someday get into college" lecture. It could work.

Lucky for my kid. Lockhart saves the day (well, Sally saved the day really...).

You must know that Lockhart's essay is more a treatise on great, inspirational (and inspired) teaching than mathematics. It also happens to be very well-written and laugh-out-loud hilarious, which really helps, as the subject matter (that millions of souls have been damaged or destroyed by being "taught" the all-time worst of subjects, math) can get a little downheartening. Truly it is so. You don't believe it? Give this little essay a try.

Lockhart's premise is this, if I can adequately sum up: Mathematics is the world's oldest and most beautiful form of art. It is inspiring. It is gorgeous. It is simple. It is fun! Oh, except to everyone who has ever been taught it. I quote: "There is surely no more reliable way to kill enthusiasm and interest in a subject than to make it a mandatory part of the school curriculum." The way we are taught math is as if we were mandatorily taught art by first learning theory and how to properly identify colors, mediums & utensils. Then if we're lucky we can move on to "pre-paint-by-numbers" and then further on to real "paint-by-numbers." And this is all without ever seeing a real work of art or hear a story of the life of a famous artist. If they are really good at that, and somehow still retain interest, maybe in college we'll let them actually paint on a blank canvas and look at some art. (Lockhart's analogy.)

Lockhart says this is exactly how we teach mathematics. We've extracted all the miserably boring parts and shunted off all the beautiful parts, because, well, because it's only the boring parts that can be adequately **tested**. HOLY BUCKETS!! You mean all the hell we all went through "learning" "math" was only a devilish device for testing? To see if we can follow directions? That is it?

There were only two things I disagreed with in this essay (at this reading, anyway.) One was Lockhart's assumption that math is beautiful because it is so totally irrelevant (just flights of fancy and such). I'm not sure I read it right, and I'm not sure that's even what he meant. Assuming that he meant what I think he said, I disagree in that I think it is very probable that as there are mathematical patterns in every living thing, God

knows pretty advanced mathematics and He used them for a purpose. I think it is highly applicable to have fun discovering that relevancy.

Second, I disagree with this statement: “English teachers know that spelling and pronunciation are best learned in a context of reading and writing. History teachers know that names and dates are uninteresting when removed from the unfolding backstory of events.” So, if you get what I disagree with, sue me or wink too, whichever suits you best.

Really, there’s too much to say about this essay. I’d end up regurgitating it all and I really think it would do EVERY. SINGLE. PERSON. ON. THE. PLANET to give it a read. You don’t have to agree, but it’s worth a look. Sorry for the enthusiasm. But hey, it’s the first time EVER I’ve been enthusiastic about something mathematical. Let’s have a party.

I’ll leave you with a little excerpt from one of the little delightful question and answer “dialogues” Lockhart intermingles within the essay.

SIMPLICIO: But don’t we need people to learn those useful consequences of math? Don’t we need accountants and carpenters and such?

SALVIATI: How many people actually use any of this “practical math” they supposedly learn in school? Do you think carpenters are out there using trigonometry? How many adults remember how to divide fractions, or solve a quadratic equation? Obviously the current practical training program isn’t working, and for good reason: it is excruciatingly boring, and nobody ever uses it anyway. So why do people think it’s so important? I don’t see how it’s doing society any good to have its members walking around with vague memories of algebraic formulas and geometric diagrams, and clear memories of hating them. It might do some good, though, to show them something beautiful and give them an opportunity to enjoy being creative, flexible, open-minded thinkers— the kind of thing a real mathematical education might provide.

SIMPLICIO: But people need to be able to balance their checkbooks, don’t they?

SALVIATI: I’m sure most people use a calculator for everyday arithmetic. And why not? It’s certainly easier and more reliable. But my point is not just that the current system is so terribly bad, it’s that what it’s missing is so wonderfully good! Mathematics should be taught as art for art’s sake. These mundane “useful” aspects would follow naturally as a trivial by-product. Beethoven could easily write an advertising jingle, but his motivation for learning music was to create something beautiful.

SIMPLICIO: But not everyone is cut out to be an artist. What about the kids who aren’t “math people?” How would they fit into your scheme?

SALVIATI: If everyone were exposed to mathematics in its natural state, with all the challenging fun and surprises that that entails, I think we would see a dramatic change both in the attitude of students toward mathematics, and in our conception of what it means to be “good at math.” We are losing so many potentially gifted mathematicians— creative, intelligent people who rightly reject what appears to be a meaningless and sterile subject. They are simply too smart to waste their time on such piffle.

SIMPLICIO: But don’t you think that if math class were made more like art class that a lot of kids just wouldn’t learn anything?

SALVIATI: They’re not learning anything now! Better to not have math classes at all than to do what is currently being done. At least some people might have a chance to discover something beautiful on their own.

SIMPLICIO: So you would remove mathematics from the school curriculum?

SALVIATI: The mathematics has already been removed! The only question is what to do with the vapid, hollow shell that remains. Of course I would prefer to replace it with an active and joyful engagement with mathematical ideas.

SIMPLICIO: But how many math teachers know enough about their subjects to teach it that way?

SALVIATI: Very few. And that's just the tip of the iceberg....

Heck, someday, if I go about it right, I may even end up as math nerdy as Sally. But I'm not sure I can ever get to that level of cool.

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P.S. Per reading some of the unfavorable reviews here on goodreads. Sure it is true that Lockhart does not offer many solutions to his problems. However, we live in an age where we always WANT other people to do the work and give us the solutions. I think half the fun of this journey (and definitely ALL of the reward) will be in finding our own way. I am so grateful for the freedom & opportunity & drive to educate my kids the way I see fit.

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To Sally: Perhaps I ought to have found more to disagree with...but maybe that will come as I actually learn what math can and should be. I'll have to reread it a year or so from now. For now, it was like lightning. And I can hardly wait to talk to you more about the whole subject. You are my self-chosen mathematics mentor, should you yourself choose to be appointed. With humble, yet enthused, gratitude; Krislyn

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## Tracy Black says

This was TERRIBLE. The first chapter began so well and had me so psyched about the book. Lockhart made an analogy between mathematics and music, where a musician wakes from a terrible dream in which public schools teach only the mechanics of music, but students are not allowed to compose or listen to music until college level. I thought it was a brilliant analogy. But it was downhill from there. His solution to the problem of math not being "fun" seemed to be to no longer teach the mechanics of math, but to just emphasize over and over that math is "art". I drug myself a quarter of the way through the book before giving up. I love math, but I have no clue what the hell he meant by "art". And I'm not sure how anyone who doesn't know the mechanics of math could ever make it to the fun part, which is solving puzzles. A good analogy for his method would be a French teacher who doesn't require that her students know any actual words in French, but instead tells her students over and over what a beautiful language it is. Can't be boring them with the "mechanics" ya know.

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