

Applying a Big History Analogy to Facilitate Information Sharing

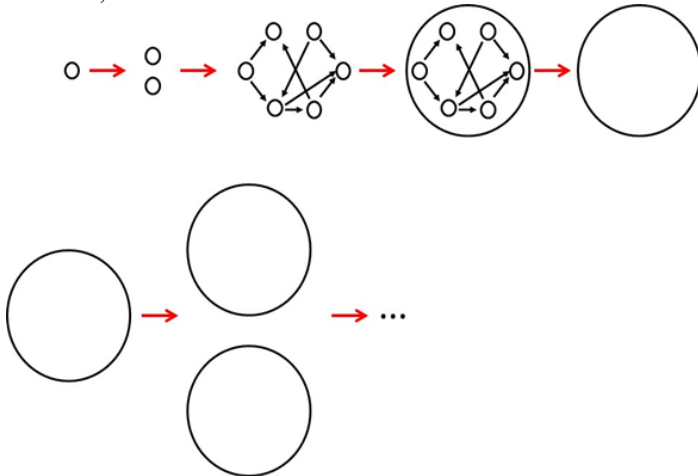
Gustavo Lau

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Abstract: Using analogies we generalize Tyler Volk’s combogenesis concept. A pedagogical application is a narrative that allows us to include some milestones of mathematics and physics in Big History courses. Applying the concept to books and book collections we suggest a philanthropic idea. This simple and potentially powerful application mixes low and high technology: using online bookstores, we propose the reproduction of personal book and video collections in public libraries. We give an example, at Simón Bolívar University in Venezuela, where this has already happened. We finish by proposing to use this idea to create a Big History book and video collection that could be donated to educational institutions around the world where a Big History course could be taught remotely.

1. Introduction

Once upon a time, there was one unit, then there were two, then three, and so on. Eventually many of these units had several relations among them and they became a new unit of a higher level. Then, at that new level, the story starts again: there was one unit, then two, and so on...



What interpretation can we give to this abstract story? Based on what we teach in the Big History courses, we can list the following interpretations:

Small units	Relations	Larger units
Elementary particles	→ Fundamental forces	→ Atoms
Atoms	→ Chemical bonds	→ Molecules
Molecules	→ Biochemistry	→ Cells
Unicellular organisms	→ Symbiosis	→ Multicellular organisms
Individuals	→ Social relationships	→ Societies

These examples are part of what Tyler Volk (2017), in *Quarks to Culture*, calls combogenesis: “The genesis of new types of things by combination and integration of previously existing things, restricted in this book to the types along the levels of the grand sequence.” The image below, taken from Tyler Volk (2017), shows how he defines the levels of his grand sequence:



We can see that Volk restricts the term to tangible things and social groups. In this paper we are going to generalize the concept

to other things that are not necessarily tangible. We call this generalization the bottom-up story.

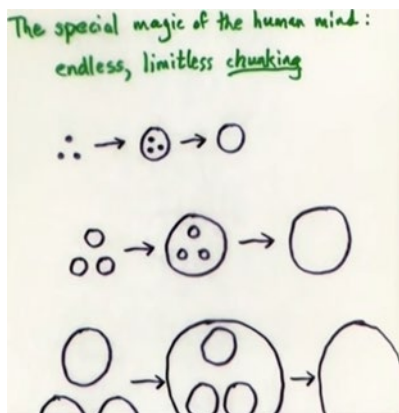
2 Concept formation narrative

Based on *Surfaces and Essences: Analogy as the Fuel and Fire of Thinking* by Douglas Hofstadter and Emmanuel Sander (2011), there is this bottom-up story:

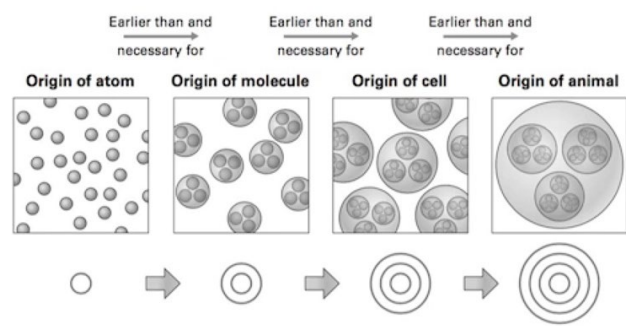
Small units	Relations	Larger units
Perceptions →	Analogies →	Concepts
Concepts →	Analogies →	More abstract concepts

For example, when we are very young kids, from the perceptions of some animals we create the concept of cat. Later, from groups of animals or objects, we create the concept of numbers and we go, for instance, from “four apples plus two apples is six apples” to just $4 + 2 = 6$. At school, in our first encounter with algebra, we go up in abstraction and we learn to use letters instead of numbers to write, for example, $x + 2 = 6$.

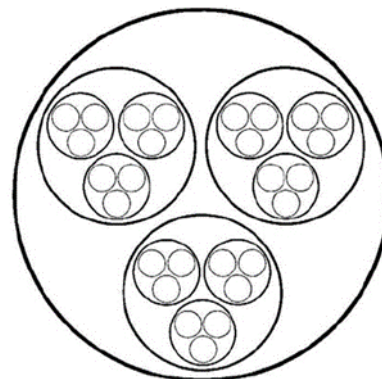
The thesis of Hofstadter and Sander is that repeated analogies create and expand concepts. Note that to introduce the concept of the bottom-up story we used repeated analogies instead of a formal definition. In the video [Analogy as the Core of Cognition](#), Hofstadter defines chunking as the process by which primordial concepts in some interrelationships become a larger conceptual unit:



This Hofstadter diagram is strikingly similar to this one shown by Tyler Volk (2017):



Arthur Koestler (1967), in *The Ghost in the Machine*, introduced the concept of the *holon*: something that is simultaneously a whole and a part. He also showed, as an example of hierarchy, three circles within circles:



In *Janus: A Summing Up*, Koestler (1978) said that “The term ‘holon’ may be applied to any structural or functional sub-system in a biological, social or cognitive hierarchy” but in the diagram above he was describing a structure, he was not telling a story, while Hofstadter and Volk describe how the structures came to be. They are telling bottom-up stories.

There is a similarity between the perceptions/concepts interpretation and the way that David Christian, Cynthia Stokes Brown and Craig Benjamin (2013), in *Big History: Between Nothing and Everything*, describe symbolic language:

Rather than using sounds or gestures to refer to one particular thing, we can use sounds as conceptual parcels that refer to whole categories of ideas and things.

In the [OER Project Big History course](#) the only threshold that is not tangible is collective learning. All the other thresholds have to do with matter or energy. Collective learning is the only one that is only about information. We propose to teach some collective learning milestones using the bottom-up story: concept formation narrative. This could be in a separate History of Science course or in lessons within a Big History course. In particular, we can use the concept formation narrative as tool to help tell the stories of

mathematics and physics.

A common misconception about mathematics is that its objects of study are only numbers and figures, when it is really more about abstractions. The history of mathematics is full of examples of higher and higher abstractions, here are some of them:

Small units		Larger units
Geometry, algebra	→	Analytic geometry
Clocks, evens and odds, . . .	→	Modular arithmetic
Arithmetic operations, Rubik's cube moves, . . .	→	Group theory
Area, volume, probability, . . .	→	Measure theory

In the history of physics many milestones can be seen as the unifications of concepts:

Concepts		Unified concepts
Terrestrial mechanics, celestial mechanics	→	Newtonian mechanics
Electricity, light, magnetism	→	Maxwell's equations
Heat, sound, gravitational energy, . . .	→	Energy
Space, time	→	Minkowski spacetime
Energy, mass	→	Einstein's $E = mc^2$

Many of these syntheses have been achieved using increasingly abstract mathematical theories. For example, Newton invented calculus to find how planets move based on his laws of motion and his law of universal gravitation.

A more ambitious project would be to teach the Big History of information. Here are some sources for this possibility:

- In the preface of *The Origins of Life: From the Birth of Life to the Origin of Language*, John Maynard Smith and Eörs Szathmáry (1999) state that:

...evolution depends on changes in the information that is passed between generations, and ...there have been 'major transitions' in the way that information is stored and transmitted, starting with the origin of the first replicating molecules and ending with the origin of language.

- In *Where Good Ideas Come from: The Natural History of Innovation* Steven Johnson (2010) draws many analogies between biological evolution (starting with theories about the origin of life) and cultural innovations and analyzes how their stories are told.
- Ken Solis (2018) and Ken Solis and David LePoire (2020) take an even broader perspective, including before the origin of life. Additionally, they mention a form of information well-known in economics but not so much by the wider public: price signals, which are the information conveyed by prices to producers and consumers. They are an abstract form of communication.

3 Publication narrative

This narrative could start with Lawrence Husick's (2011) concept of *intentional pedagogy*. He says:

Innovation #0 [at the top of his ranking], in my view, is one that outshines and underlies every other innovation we have discussed. That is the concept of intentional pedagogy.... It's the idea that humans can intentionally transmit culture and generalize knowledge from the specific instance to that which is teachable, and then intentionally give that knowledge to another person across time and space.

Therefore the first times that humans performed intentional pedagogy can be thought of as the first instances of publication, albeit with a primitive, possibly just gestural, communication.

David Christian's (2004) influential *Maps of Time* contains this table:

TABLE 10.4. INFORMATION REVOLUTIONS IN HUMAN HISTORY

Era	Approximate Date	Ways of Moving Information
Paleolithic	Paleolithic, beginnings of human history	Modern forms of language; information sharing between different groups
	Upper Paleolithic	Cave paintings
	From Upper Paleolithic?	Communication at a distance using drums, beacons, smoke signals
Agrarian	From ca. 3000 BCE	Writing as congealed information
	From ca. 2000 BCE	Syllabic writing
	Era of agrarian civilizations	Government-sponsored or military courier system
Modern	From 8th c. CE	Printing using wood blocks
	16th c. CE	Global world system; worldwide systems of communication and transport
	18th and 19th c.	Print used for mass communication: newspapers, postal services
	From 1830s	Telegraph
	Late 1880s	Telephone
20th c.	Electronic mass media: radio, film, TV	
Late 20th c.	Internet; instantaneous global communication of information	

That table omits the following bottom-up story, which we suggest to emphasize in the publication narrative:

Small units	Larger units
Published books	→ Libraries

In the series/book *Cosmos*, in episode/chapter 11, *The Persistence of Memory*, Carl Sagan (1980) pays tribute to books and libraries:

Books permit us to voyage through time, to tap the wisdom of our ancestors. The library connects us with the insights and knowledge, painfully extracted from Nature, of the greatest minds that ever were, with the best teachers, drawn from the entire planet and from all of our history, to instruct us without tiring, and to inspire us to make our own contribution to the collective knowledge of the human species. Public libraries depend on voluntary contributions. I think the health of our civilization, the depth of our awareness about the underpinnings of our culture and our concern for the future can all be tested by how well we support our libraries.

In that episode of *Cosmos*, Sagan states:

The units of biological evolution are genes. The units of cultural evolution are ideas. Ideas are transported all over the planet. They reproduce through communication. They are selected by analysis and debate.

Perhaps Sagan was influenced by Richard Dawkins (1976), who introduced the term *meme* in *The Selfish Gene*. There, in the chapter *Memes: The new replicators*, Dawkins explains:

The analogy between cultural and genetic evolution has frequently been pointed out ...The analogy between scientific progress and genetic evolution by natural selection has been illuminated especially by Sir Karl Popper.

In the book *In Search of a Better World*, in the chapter *Books and Thoughts: Europe's First Publication*, Karl Popper (1994) describes a hypothesis:

...for some time I have had the idea that the Greek miracle, and especially the Athenian miracle, might perhaps be partially explained – and surely only very partially – by the invention of the written book, of book publishing and of the book market...

...My hypothesis is that, by making books available for sale in Athens, Pisistratus had put in train a cultural

revolution comparable in its importance to that started by Gutenberg two thousand years later; but my hypothesis is of course not testable. ...Of course there are authors who work in a different way, but as a rule thoughts can be criticized and improved most effectively when one attempts to write them down for the purpose of publication, so that they may be understood by others...

...This thesis of the powerful role of feedback, especially the feedback between the world 3 of books¹ and the world of our mental experiences, is important. That there are such objective contents we owe almost entirely to the invention of our specifically human language. For the first time in the history of the evolution of life on our wonderful planet, the invention of language made it possible for objective thought contents to exist; and by making it possible for us to look upon our thought contents as objects, it became possible for us to criticize them – and so to become critical of ourselves.

The discovery of writing was the next step. But the most momentous step was the invention of the book and of the critical competition between books.

Popper's hypothesis seems plausible because, as can be seen in [Ancient Literature](#), in Classical Greece (the 5th and 4th centuries BC) there is an explosion in the number of known authors that have some books that are still published nowadays. Popper argues that the publishing of books created a positive feedback cycle of learning. That is why we call this bottom-up story the publication narrative. Popper's hypothesis fits very well with David Christian's ideas about positive feedback loops:

Transitions to new levels of complexity often depend on positive feedback mechanisms (Christian, 2004).

In studying collective learning and human history we find many positive feedback cycles. Let's look at one particular type: those based on improvements in the way information is exchanged, stored, and circulated within networks – in essence, innovations having to do with communication and transportation (Christian, 2023).

Therefore, we suggest continuing the publication narrative with the impact of book publication in Classical Greece, during China's Song and Ming dynasties and in Europe after Gutenberg's movable type printing. We could also include the histories of postal systems and of personal and public libraries. Many things could be said about the relationship between personal and public libraries. Merlin Donald calls them memory palaces and revolutionary (Donald, 2001). A famous personal collection of books in Classical Athens was Aristotle's one. Some think that such a collection could

¹ We can listen to Popper explaining his three worlds terminology in the video [Karl Popper on the Three Worlds \(1989\)](#).

have been the basis for the Library of Alexandria (Casson, 2001; Norman, 2014), others do not mention that possibility (Donald, 2001).

In the last centuries there are numerous cases of people influenced by personal and public libraries. The story of William Kamkwamba is a prime example of how one book helping one young person can have great impact. The image below is from the film *The Boy Who Harnessed the Wind*. This takes us to a donation idea.



4 Philanthropic proposal

[The trick is to know which books to read.](#)

—Carl Sagan, *Cosmos* (1980)

Applying the bottom-up story concept leads us to wonder: could we reproduce and publish personal book and video collections?

Small units	Relations	Larger units
Published books/videos	References, similarities, contrasts, sequence, ...	Personal book/video collections
Personal book/video collections		Public libraries

The answer, thanks to online bookstores, is that it is easy (given enough purchasing power).

As an example, Bill Gates writes in his blog, *How energy makes life possible* (2017), “I’m a fan of Vaclav Smil ...I’ve read nearly all of his 37 books. I wait for new Smil books the way some people wait for the next Star Wars movie.” In another entry, *Three cheers for the dull, factually correct middle* (2022), he writes, “I have learned more about energy and its impact on society from Vaclav than from any other single source.”

The philanthropic proposal in this case is that Bill Gates could donate copies of a collection of Vaclav Smil’s books to universities in developing countries. That would not only promote the books in those universities but also would generate publicity for Vaclav Smil’s books around the world. The reviews of Smil’s books in Bill Gates’ blog would be like a guided tour of that part of his personal library. In this image, from the Netflix documentary

Inside Bill’s Brain: Decoding Bill Gates, we can see him showing his collection of Vaclav Smil’s books:



We don’t need to be Bill Gates to use this philanthropic idea. There are thousands of professionals that have emigrated from developing countries to developed ones. They could choose the best books from their disciplines and donate them back home. The donations could be “live”, in the sense that as soon as new worthwhile books are published, they can be donated and made accessible in countries where those books may never be published.

It is very common to assume that the new information network, the internet, replaces the old one of books and libraries. This philanthropic proposal implies using the new network to improve the old one. As the [Keep it simple](#) article from *The Economist* says: “High tech is not the only tech.” In the video [It’s Not Information Overload. It’s Filter Failure](#), Clay Shirky argues that we should have better information filters (Rosen 2014). The proposal is to have three filters for the books: publishers, donors, and librarians.

5 Donation of History of Ideas Collection

...every subject has a history, and its history is an integral part of the subject.

...No one can claim adequate knowledge of a subject unless one knows how such knowledge came to be.

—Neil Postman, *Building a Bridge to the 18th Century* (1999)

This philanthropic proposal is not just theory. Since 2001 I have been donating a collection of books and videos, called *History of Ideas* to Simón Bolívar University in Venezuela. In general, I bought the books twice, once for me and once to donate. When I started donating the only condition I gave to the library was to keep the books together. The questions that led to this were: why do the history sections of bookstores and libraries focus on political and military history but not on the creative side of history: sciences,

arts, technologies, discoveries, businesses, etc.? Could we have a section with the history of everything?

Here are some book lists of the collection:

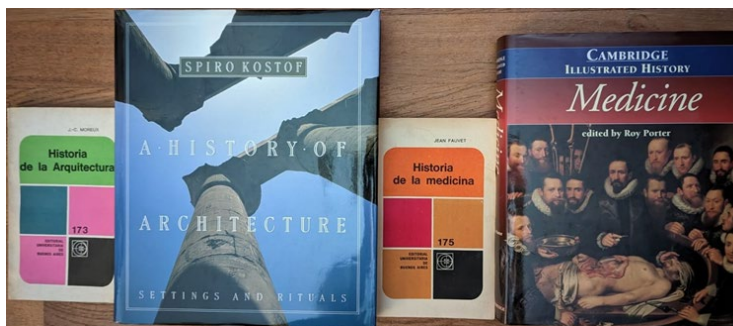
- | | |
|------------------------------|-------------|
| Universe | Earth |
| Humans | Life |
| Mythologies | Philosophy |
| Some science classics | Science |
| La Plus Belle Histoire du... | Arts |
| La historia más bella de... | Cartoons |
| Nonfiction Pulitzer Prizes | Photography |
| Children books | Technology |
| Education | Religions |
| <i>250 Milestones</i> | |

Here are some video lists of the collection:

- | | |
|------------------|--------|
| Universe | Earth |
| Life | Humans |
| History of Ideas | |



250 Milestones arrival, Simón Bolívar University Library staff including then Director Alejandro Teruel, December 2017



While sitting at home in London, I sent books to Venezuela from several countries using these online bookstores: USA: amazon.com; UK: amazon.co.uk; Spain: fnac.es, casadellibro.com, and iberlibro.com; Argentina: cuspid.com; France: amazon.fr; and Russia: urss.ru.

I had the idea when I read that the family of the late founding president of Simón Bolívar University, Ernesto Mayz Vallenilla, was donating his personal library to the university. I wanted to help my alma mater and I had collected books on the history of a variety of subjects that I thought I could share. I set a goal to reproduce my personal library. I called this copy of it a *telelibrary* because it was like offering to the university community the opportunity to visit my personal library, which is in another continent.

Small units	Relations	Larger units
Published books/videos	References, similarities, contrasts, sequence, ...	Personal book/video collections
Personal book/video collections		Public libraries

Popper (1994) says “*thoughts can be criticized and improved most effectively when one attempts to write them down for the purpose of publication.*” Something similar happened with my library. Since I started to “publish” it, I criticized it more and some friends gave me feedback. So I improved it as much as I could. For example, in the image below you can see a couple of pocket books that I had since the 1980s and two other books that I bought after deciding to donate the collection.

This [link](#) has a letter that I sent in 2001 to Venezuela’s Simón Bolívar University when I started donating this collection and a quote from *The Open Society and Its Enemies* by Karl Popper (1956) about how “*science can be taught as a fascinating part of human history...as a part of the history of problems and of ideas.*” The letter mentions some writings by José Ortega y Gasset (1930, 1935).

6 Donation of Big History collections

I propose to create a Big History book and video collection that could be donated to educational institutions around the world where a Big History course could be taught remotely. How does one choose such a collection? There are many options, here are a couple:

- All the books referenced in the material of the [OER Project Big History course](#).
- All the books referenced in the bibliography of (Christian et al., 2013).

A reader in some developing country may find it difficult to get a hold of some referenced books/videos. If we think of books and

their references as a network (directed graph) then the intention of making all the books referenced available is to facilitate navigation in such network. The references would work, metaphorically, like the hyperlinks of web pages. The Big History course of the OER Project is designed to be taught in person. This idea could help to teach the course remotely by giving students the opportunity to investigate more in depth.

Another example of a possible Big History collection can be found in these links: [Big History book collection](#) and [Big History documentary collection](#). I suggest to include stories of scientists that could provide inspiration. Not just of old and famous ones, but also some about living scientists. For instance, *The Star Builders: Nuclear Fusion and the Race to Power the Planet* by Arthur Turrell (2021) could inspire future nuclear fusion scientists and engineers.

The donation of such a Big History collection would be a way to promote those books/videos and would be a complement to the resources available online. That would be particularly important where/when electricity or internet accesses are faulty.

7 A small suggestion for YouTube

A final application is a very simple one. Inspired by my experience teaching Big History online, I have a suggestion for YouTube: to allow users to like, dislike and post comments about playlists in the same way that they can do it about videos. YouTube playlists are created for varieties of reasons:

Small units	Relations	Larger units
YouTube videos	Sequences, similarities, references, contrasts, ...	YouTube playlists

For example, the YouTube channel [Web of Stories - Life Stories of Remarkable People](#) has playlists where their interviews with notable scientists, writers, and other creative people are split in sequences of small videos. See for instance the [interview of the evolutionary biologist John Maynard Smith](#).

While teaching Big History remotely, I create for each meeting a playlist with videos selected for it, intercalated with videos recorded during the session.

There are many excellent YouTube playlists that can be used to teach Big History, for instance the [Human Evolution Learning Playlist](#) from the YouTube channel [PBS Eons](#). It is a pity not to be able to comment or hit a like button for a playlist. It is as if YouTube is focused just on the atoms and not on the molecules! Given that users can create the additional levels of aggregation below, ideally they could also like, dislike and post comments about them.

Small units		Larger units
YouTube playlists	→	YouTube collections
YouTube collections	→	YouTube channel

8 Conclusions

You should keep in mind no names, nor numbers, nor isolated incidents, not even results, but only methods. ...The method produces numerous results

—Emanuel Lasker, *Lasker's Manual of Chess* (1925)

This paper shows that we can make pedagogical and philanthropic decisions about the present using Big History stories. This is an example of what Bob Bain describes in the video [What Makes History Usable?](#):

...Students, and indeed all of us, must make decisions about the present that involve understanding what happened in the past...we all need to know how to take apart, work with, and create multiple stories about the past that influence how we think and act in the present. Stories are vital and essential in making history usable... Adding narratives to history courses promises to make them far more usable and useful...So, what are your stories? And how will you use them?

I would like to mention some of my stories that I consider relevant. When I was a teenager my father taught me chess and instead of the many details of chess openings he preferred to teach [chess strategy concepts](#) – like piece activity, open files and pawn structure – that are useful to analyze numerous chess positions. A few years later, the Computer Science professors at Simón Bolívar University emphasized to us, their students, that it was more important to learn the concepts of the different [programming paradigms](#) instead of learning the particular syntax of numerous programming languages. These were some of the experiences that showed me the power of abstraction.

In the 1990s I read in Steven Levy's (1992) *Artificial Life*, a very abstract condition for life: self-reproduction, which is not necessarily biological reproduction. It could be the self-reproduction of a computer software, for example a computer virus. From the ideas of Dawkins and Popper mentioned above, I understood that what makes humans special is cultural reproduction because any form of communication, from the invention of language to any communication media, implies an attempt to reproduce in the mind of the receiver something that is in the mind of the sender. The term "cultural reproduction", which I see as a synonym to "collective learning", has the advantage of emphasizing the similarity with one of the things that makes life special: reproduction. That was the concept that I had in mind when I decided to reproduce my personal library at Simón Bolívar University.

The course Big History can provide concepts – like positive

feedback cycles, bottom-up stories, and reproduction – that can be used in a variety of contexts. For instance, self-fulfilling prophecies, vicious and virtuous circles are particular cases of positive feedback cycles. In clinical psychology there are many examples of vicious circles and an instance of a self-fulfilling prophecy in finance is a bank run.

In this paper, I try to show that sometimes it is enough to have a conceptual model – not necessarily mathematical – and apply analogies to come up with practical applications to something that is very important: education.

In summary, this paper:

1. Introduces a Big History concept, the bottom-up story, which is a generalization of Tyler Volk's (2017) combogenesis. It has as particular cases the concept formation and the publication narratives.
2. Introduces the concept formation narrative:
 - a. The appearance of symbolic language as it is usually taught in Big History courses, see for example (Christian et al., 2013).
 - b. The way that, according to Hofstadter and Sander's (2011), we use analogies to create and expand concepts.
 - c. Many milestones of the history of mathematics and physics can be seen as a series of unifications of increasingly abstract concepts.
3. Introduces the publication narrative:
 - a. Lawrence Husick's (2011) concept of *intentional pedagogy*.
 - b. Karl Popper's (1994) hypothesis about the impact of book publishing in Classic Athens, see [Books and Thoughts: Europe's First Publication](#).
 - c. The impact of book publication during China's Song and Ming dynasties.
 - d. The impact of Gutenberg's movable type printing in Europe.
 - e. A short history of postal systems and of personal and public libraries.
4. Based on the bottom-up story and the publication narrative, makes a philanthropic proposal: the publication of personal book collections in public libraries. This would be a way to do something about a great inequality: some people have access to very good book collections and most do not.

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