e-Learning Ecologies

Innovative Approaches to Teaching and Learning for the Digital Age

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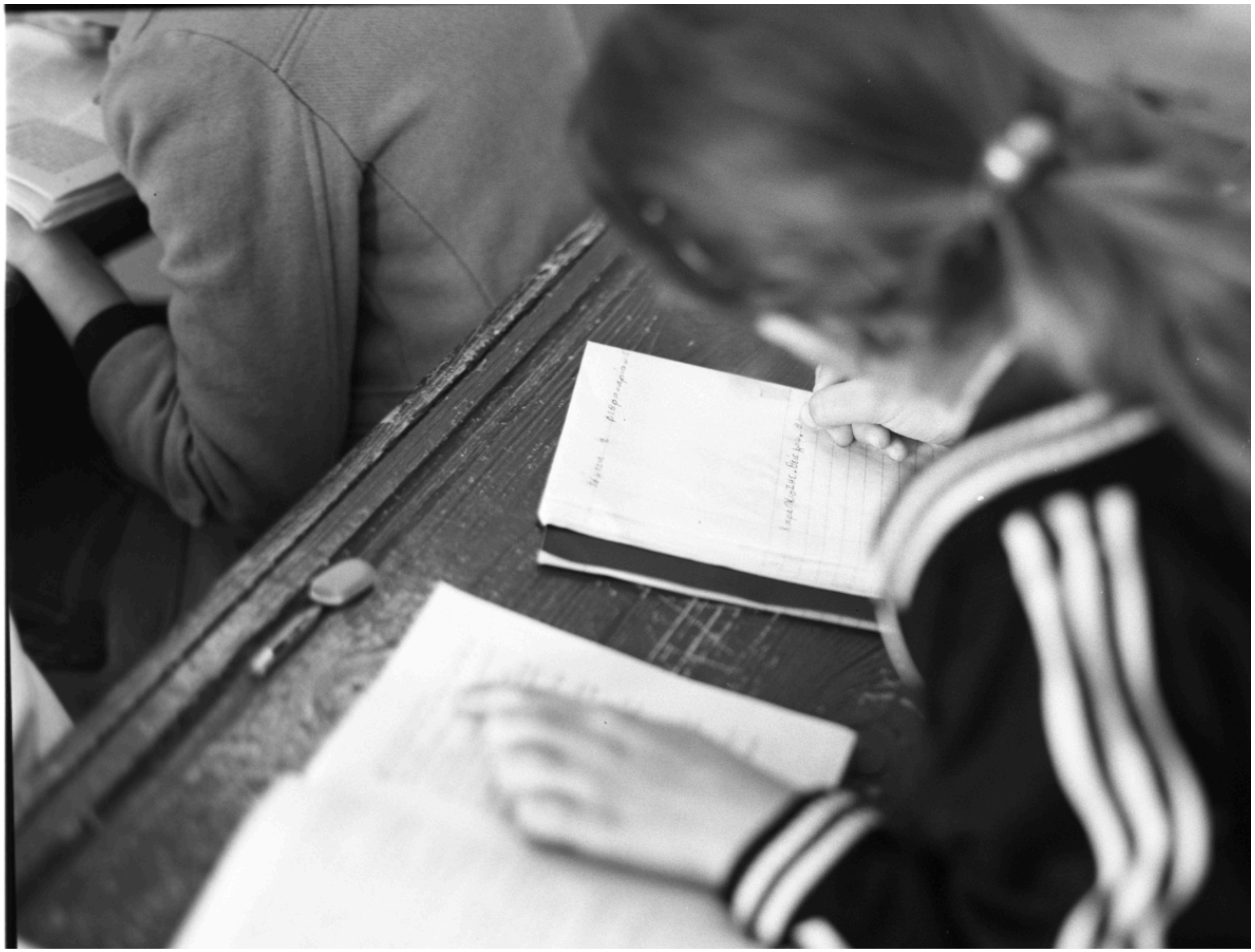
University of Illinois

The Old School

Here we are at school. All is well, the students are busily at work …

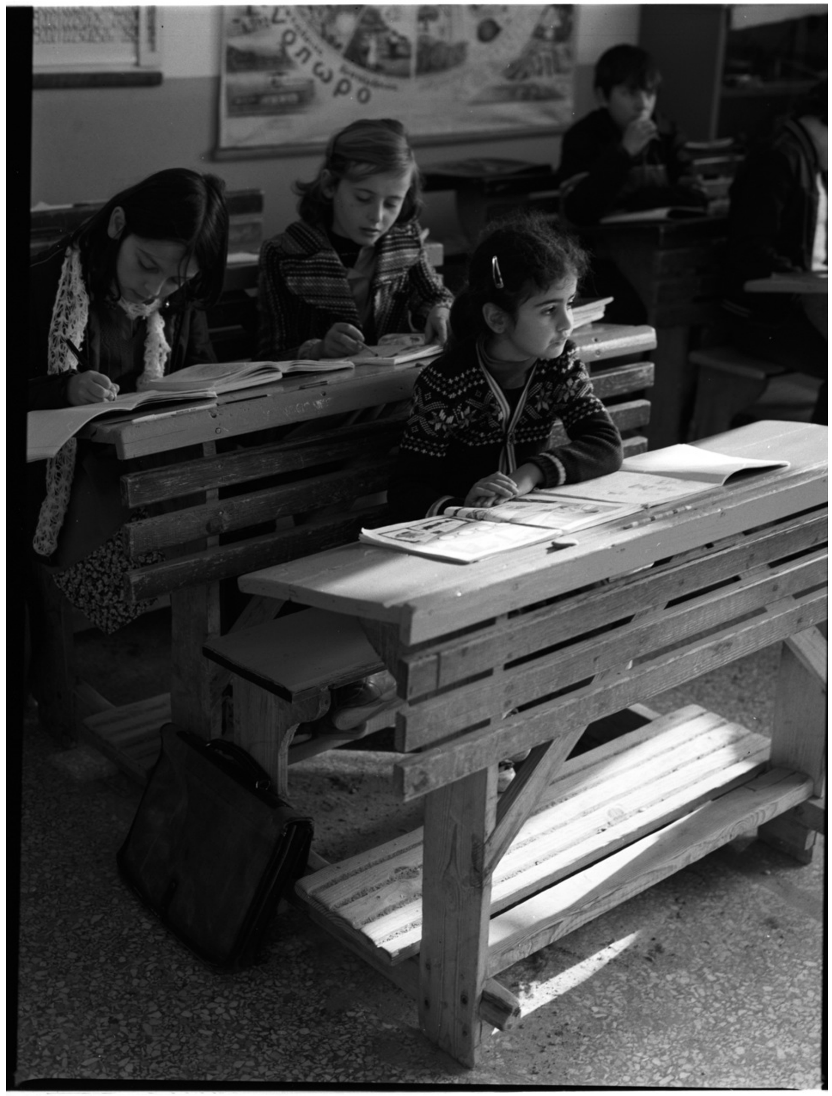
‘Look this way’, the teacher says.
‘Listen to what I tell you about … . Answer my questions, hands up, only one person may speak at a time.’

‘Now, everyone read chapter 7—carefully, and silence, please …’



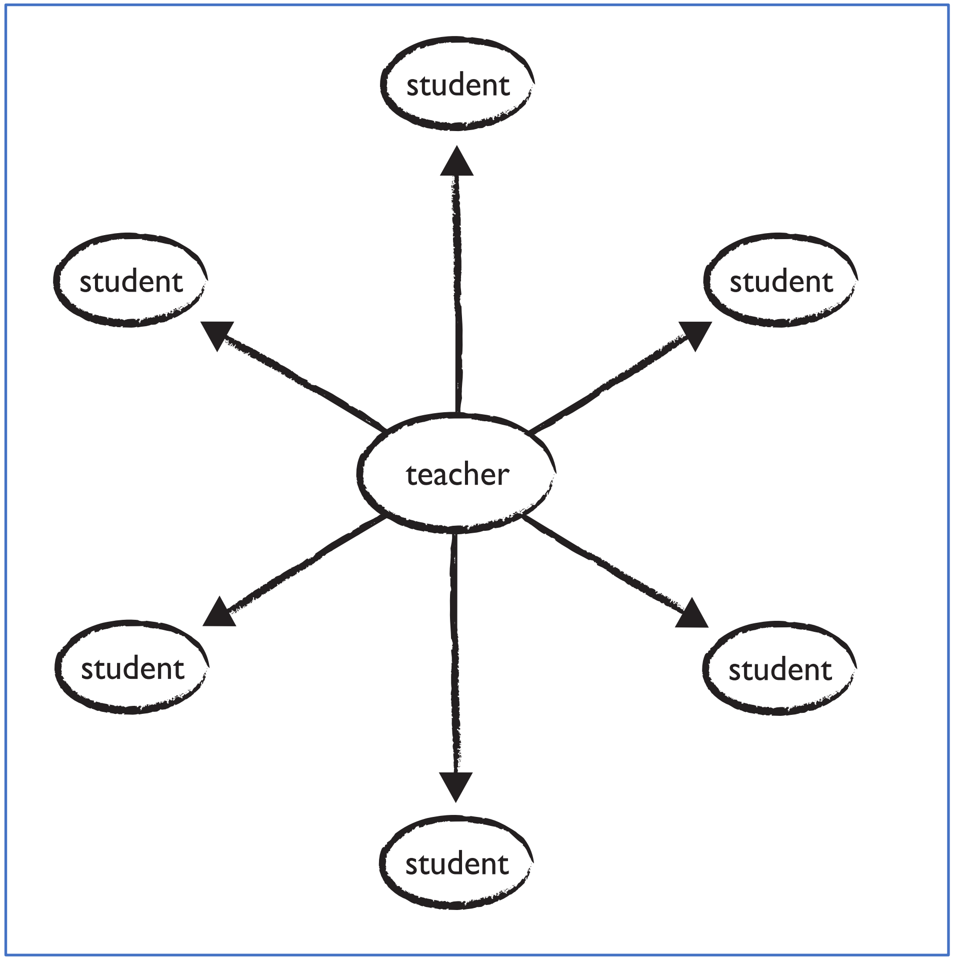
'… and now, answer the questions at the end of the chapter. No talking.'

Soula looks up for a moment. Is she thinking about her work? Or is she daydreaming?



Then, something terrible happens …

‘Turn around, Soula,’ says the teacher. ‘Don’t disturb the girls behind you.’



The Old School

Then, computers come,

… and what changes?

User Name student
Password kids
Log On To RCS
KNOW Your Keyboard
Ctrl-A - SELECT ALL
Ctrl-C - COPY
Ctrl-V - PASTE
Ctrl-S - SAVE
Ctrl-P - PRINT
Ctrl-Z - UNDO
Ctrl-X - DELETE
Entire Network
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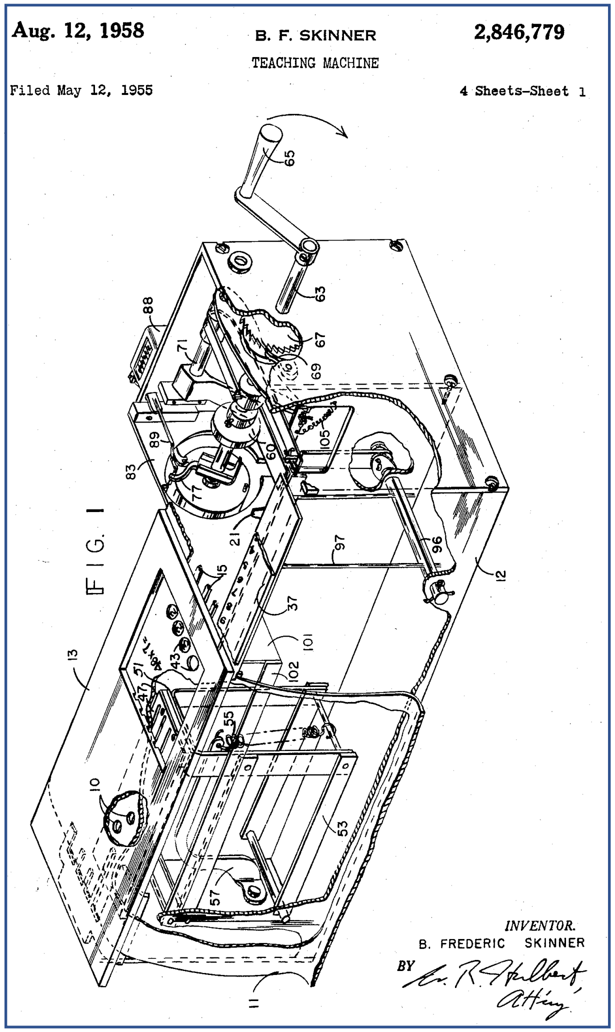
Martha
Mary
Eve
Hannah
Esther



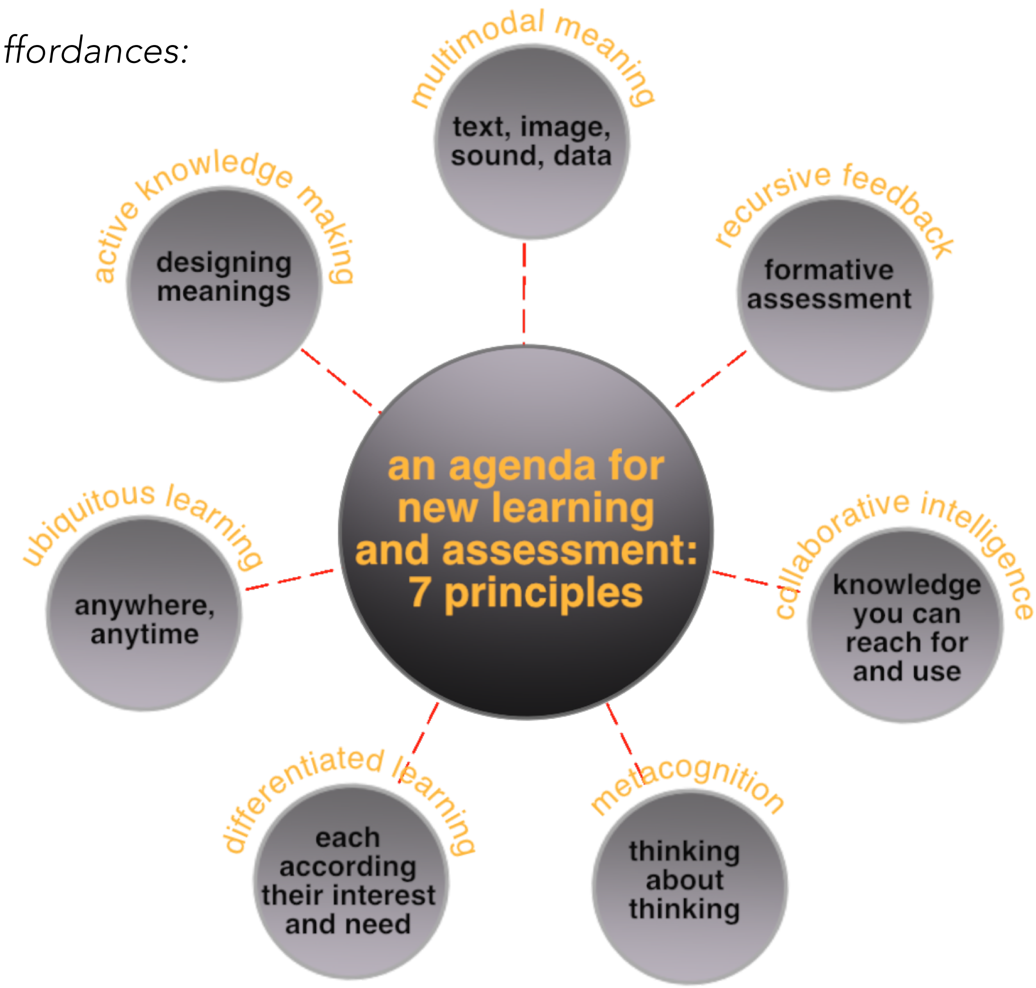
B.F. Skinner's Teaching Machine

FIG. I. A recent model of a teaching machine for the lower grades. The machine operates on the principles described in the accompanying article. Material is presented in a window with a few letters or figures missing. The pupil moves sliders which cause letters or figures to appear. When an answer has been composed, the pupil turns a crank. If the answer was right, a new frame of material moves into the window and the sliders return to their home position. If the answer was wrong, the sliders return but the frame remains and must be completed again. (This is a later version of the device described in Skinner's 1954 paper.)

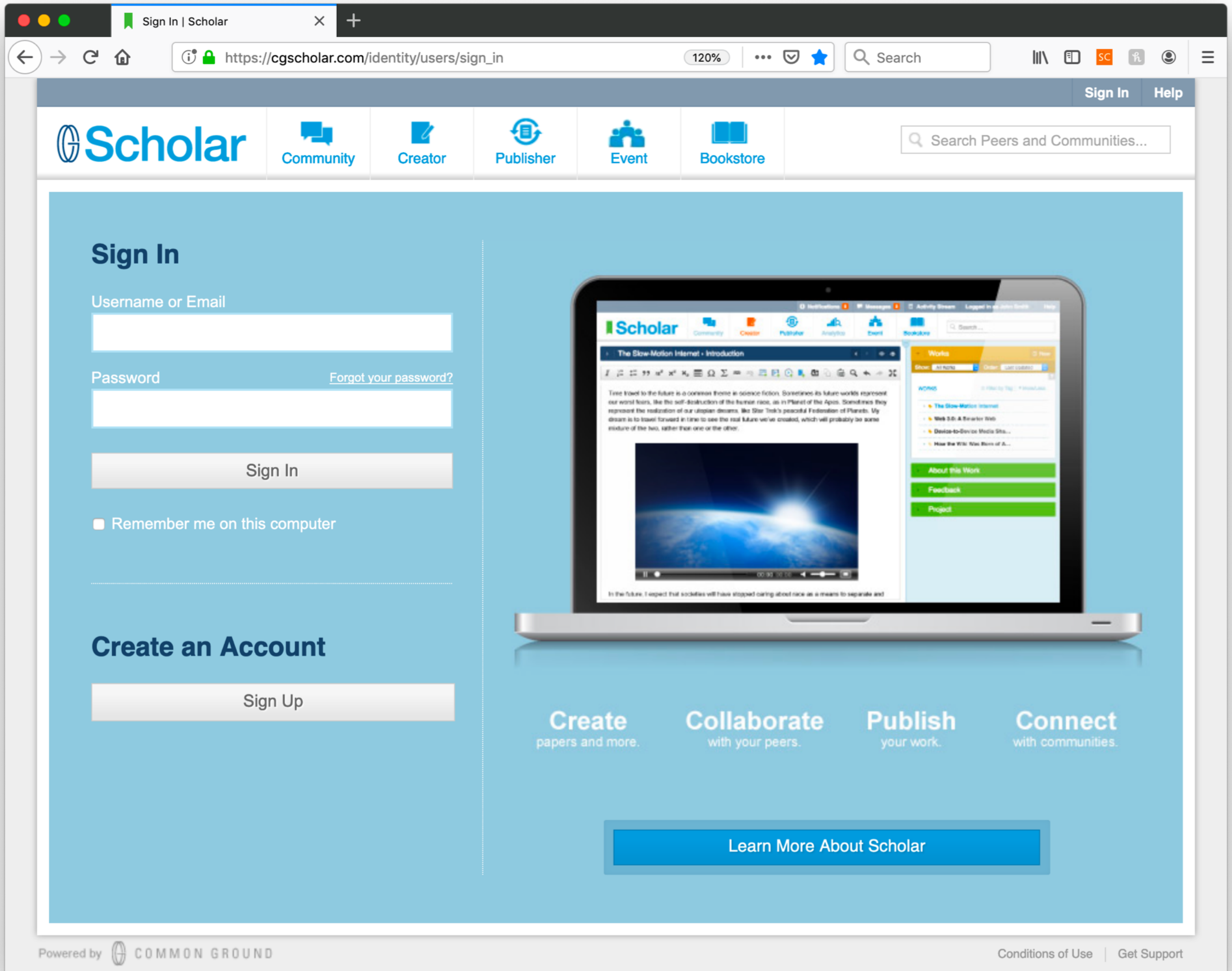
Skinner invented a "teaching machine," also neatly contained in a box, even if this time the child being conditioned was outside the box, literally though perhaps not metaphorically. A lone child was presented material, a question was posed by the machine as substitute teacher, the student gave an answer, and then she was judged right or wrong. If right, she could move on; if wrong she must answer again. This was behaviorism translated into in mechanized practice.

The New School

Seven affordances:



Kalantzis, Mary and Bill Cope. 2015. "Learning and New Media." in *The Sage Handbook of Learning*, edited by D. Scott and E. Hargreaves. Thousand Oaks CA: Sage.



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Help
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Community
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Publisher
Event
Bookstore
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Sign In
Username or Email
Password
Forgot your password?
Sign In
Remember me on this computer
Create an Account
Sign Up
Create
papers and more.
Collaborate
with your peers.
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BILL & MELINDA GATES foundation

NSF

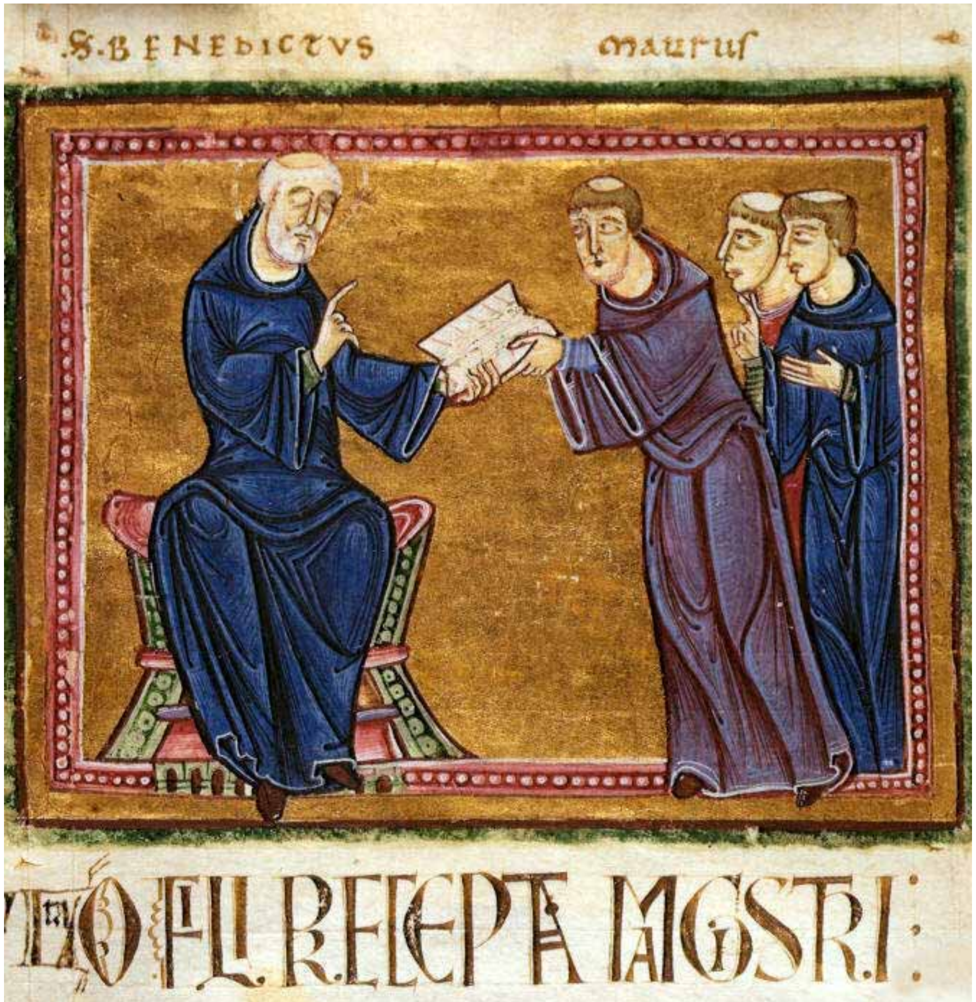
Three Pivotal Artifacts

1. Classroom Discourse

2. The Textbook

3. The Test

Artifact 1: Classroom Discourse



The Rule of St Benedict

“For it belongeth to the master to speak and to teach; it becometh the disciple to be silent and to listen. If, therefore, anything must be asked of the Superior, let it be asked with all humility and respectful submission.”

St Benedict. c.530 [1949]. *The Holy Rule of St. Benedict.* Translated by O. Rev. Boniface Verheyen. Chapter 1.

Daphne Kohler on MOOCs

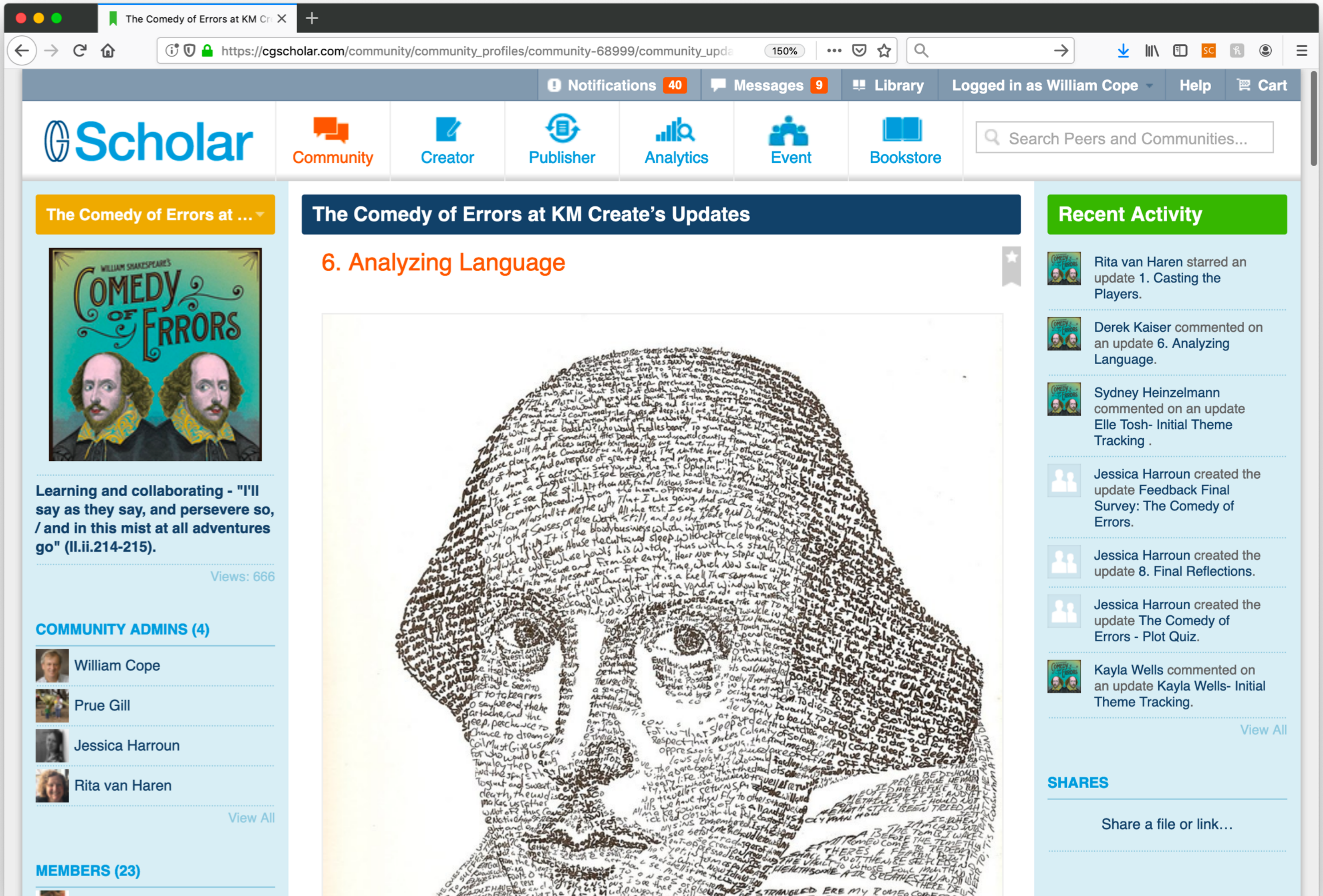
"Of course, we all know as educators that students don't learn by sitting and passively watching videos. Perhaps one of the biggest components of this effort is that we need to have students who practice with the material in order to really understand it… even simple retrieval practice, where students are just supposed to repeat what they already learned gives considerably improved results on various achievement tests down the line than many other educational interventions. We've tried to build in retrieval practice into the platform… For example, even our videos are not just videos. Every few minutes, the video pauses and the students get asked a question."

"Hands up!"

Teacher initiates: 'What's the furthest planet from the sun in the Solar System?'

Students respond: (Members of the class shoot up their hands, and one responds, a proxy for all the others:) 'Pluto.'

Teacher evaluates: 'Yes, that's correct!' (Or an alternative ending: 'No, that's wrong, does someone else know the answer?')


The Comedy of Errors at KM Cr
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Messages 9
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Logged in as William Cope
Help
Cart
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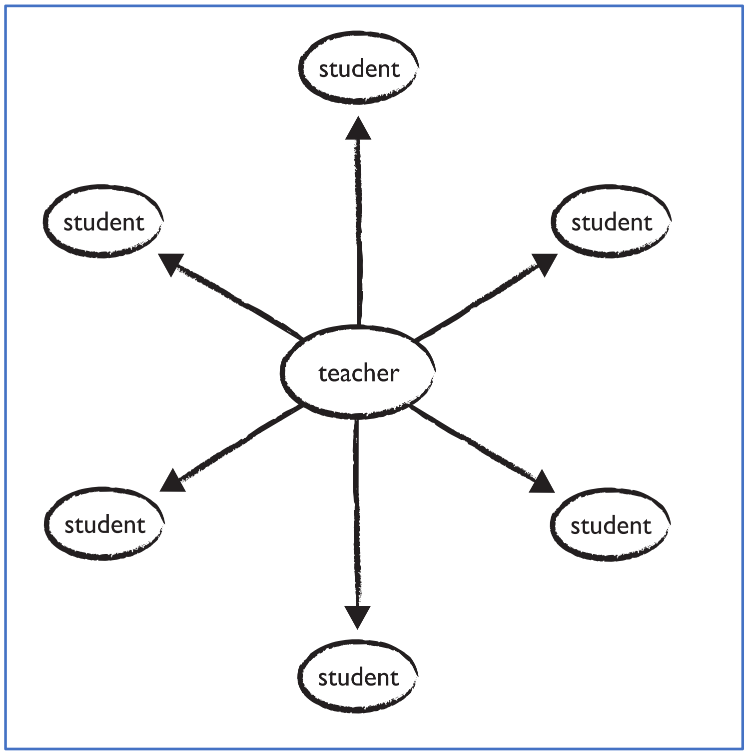
Community
Creator
Publisher
Analytics
Event
Bookstore
Search Peers and Communities...
The Comedy of Errors at ...
WILLIAM SHAKESPEARE'S COMEDY OF ERRORS
Learning and collaborating - "I'll say as they say, and persevere so, / and in this mist at all adventures go" (II.ii.214-215).
Views: 666
COMMUNITY ADMINS (4)
William Cope
Prue Gill
Jessica Harroun
Rita van Haren
View All
MEMBERS (23)
The Comedy of Errors at KM Create's Updates
6. Analyzing Language
Recent Activity
Rita van Haren starred an update 1. Casting the Players.
Derek Kaiser commented on an update 6. Analyzing Language.
Sydney Heinzelmann commented on an update Elle Tosh- Initial Theme Tracking .
Jessica Harroun created the update Feedback Final Survey: The Comedy of Errors.
Jessica Harroun created the update 8. Final Reflections.
Jessica Harroun created the update The Comedy of Errors - Plot Quiz.
Kayla Wells commented on an update Kayla Wells- Initial Theme Tracking.
View All
SHARES
Share a file or link...


504
Laser
Lounge

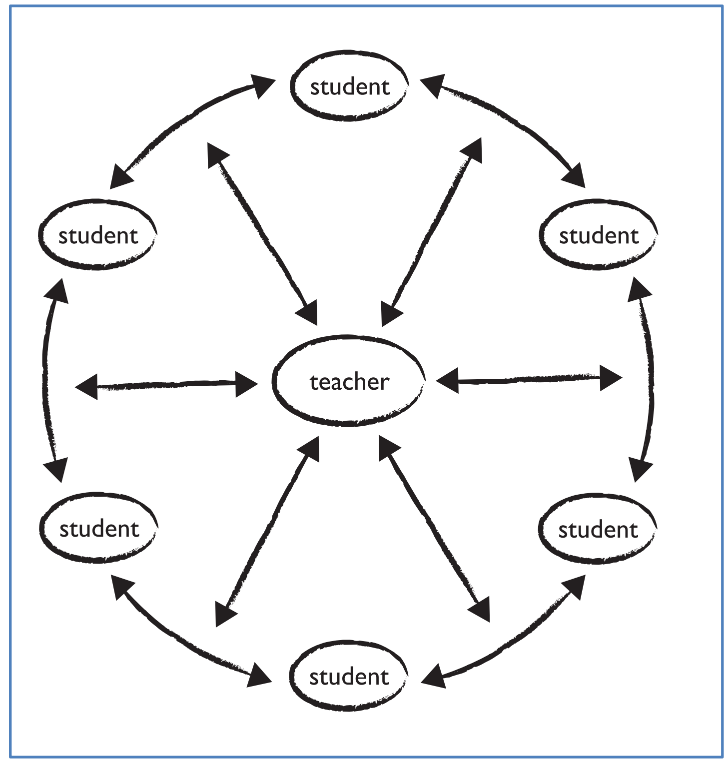

THE WOLF


Laser
Lounge

Changing the Relationships between Learners



The Old School



The New School

Classroom Discourse (still … and utterly transformed)

1. Everyone responds

2. Lowered barriers to response

3. From oral and written

4. When everyone responds, learner differences become visible and valuable

5. This is highly engaging

6. The read/write mix and the participation mix is about right

7. We can break out of the four walls of the classroom and the cells of the timetable

8. Anyone can be an initiator

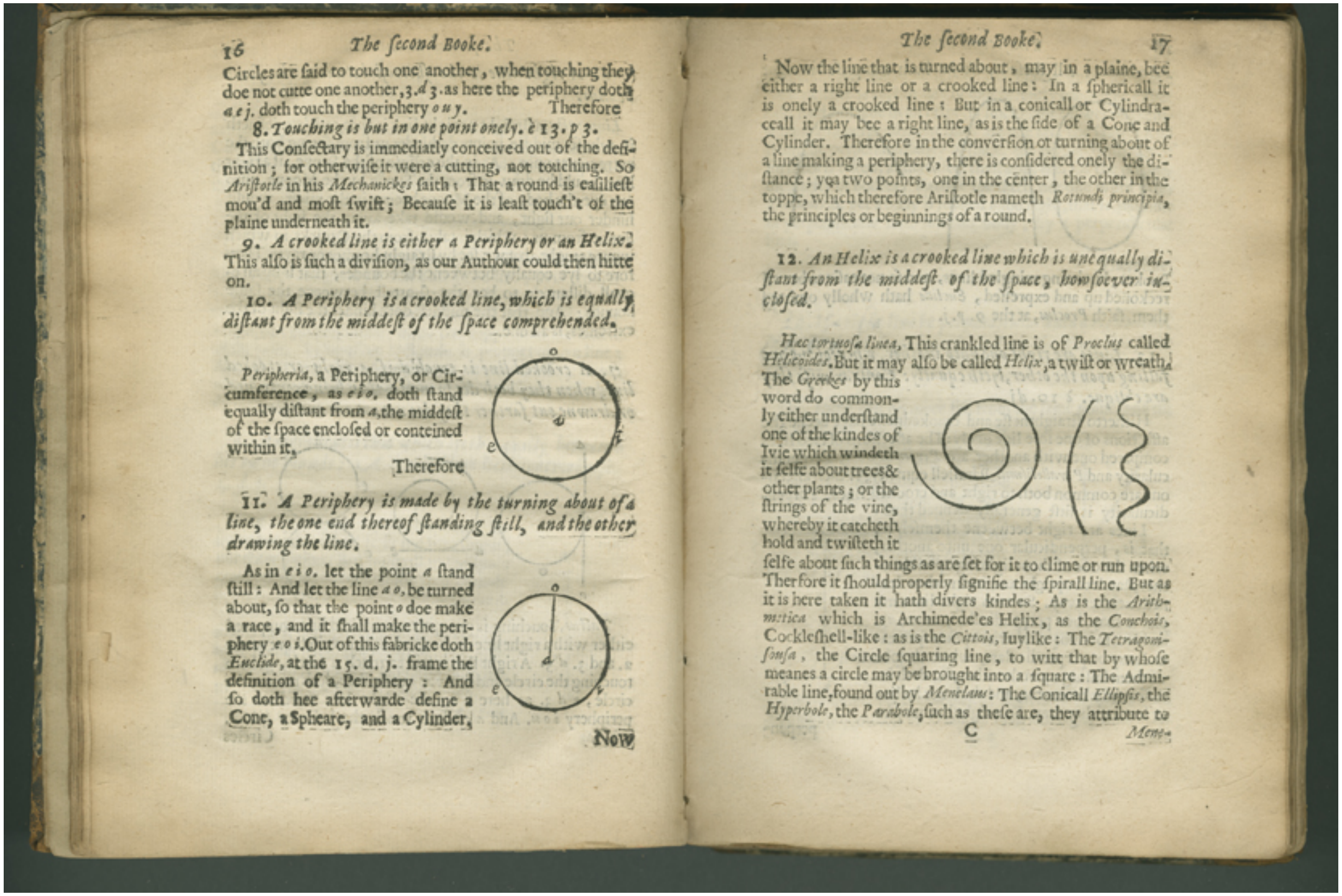
9. A new transparency, learning analytics and assessment

Artifact 2. The Textbook

Petrus Ramus' Textbook

Perhaps the most prolific of all early modern authors, Petrus Ramus, comes to prominence in print in the century after Gutenberg. Appointed professor at the University of Paris in 1551, Ramus was a prolific writer of textbooks. Walter Ong, exhaustive chronicler and analyst of Ramus's legacy, has identified 750 separately published editions in 1100 separate printings between 1550 and 1650.

Ong, Walter J. 1958 [1983]. *Ramus, Method and the Decay of Dialogue*. Cambridge MA: Harvard University Press.



Circles are ſaid to touch one another, when touching they doe not cutte one another, 3.*d* 3. as here the periphery doth *a e j.* doth touch the periphery *o u y.* Therefore

8. *Touching is but in one point onely.* e 13. p 3.

This Conſectary is immediatly conceived out of the definition; for otherwiſe it were a cutting, not touching. So *Ariſtotle* in his *Mechanickes* ſaith: That a round is eaſilieſt mou'd and moſt ſwift; Becauſe it is leaſt touch't of the plaine underneath it.

9. *A crooked line is either a Periphery or an Helix.*

This alſo is ſuch a diviſion, as our Authour could then hitte on.

10. *A Periphery is a crooked line, which is equally diſtant from the middeſt of the ſpace comprehended.*

Peripheria, a Periphery, or Circumference, as *e i o.* doth ſtand equally diſtant from *a*, the middeſt of the ſpace encloſed or conteined within it.

Therefore

11. *A Periphery is made by the turning about of a line, the one end thereof ſtanding ſtill, and the other drawing the line.*

As in *e i o.* let the point *a* ſtand ſtill: And let the line *a o*, be turned about, ſo that the point *o* doe make a race, and it ſhall make the periphery *e o i.* Out of this fabricke doth *Euclide*, at the 15. d. j. frame the definition of a Periphery: And ſo doth hee afterwarde define a Cone, a Spheare, and a Cylinder,

Now

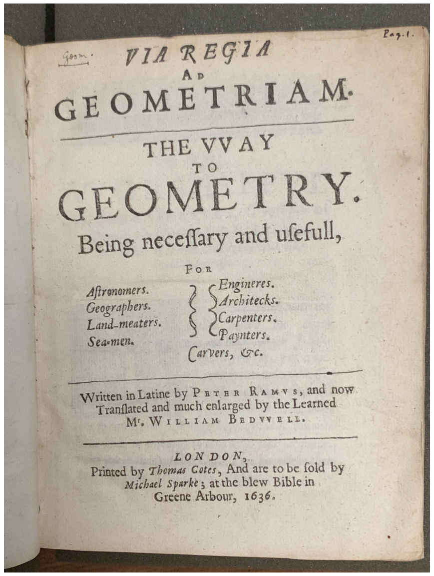
Now the line that is turned about, may in a plaine, bee either a right line or a crooked line: In a ſphericall it is onely a crooked line: But in a conicall or Cylindraceall it may bee a right line, as is the ſide of a Cone and Cylinder. Therefore in the converſion or turning about of a line making a periphery, there is conſidered onely the diſtance; yea two points, one in the center, the other in the toppe, which therefore Ariſtotle nameth *Rotundi principia*, the principles or beginnings of a round.

12. *An Helix is a crooked line which is unequally diſtant from the middeſt of the ſpace, howſoever incloſed.*

Hæc tortuoſa linea, This crankled line is of *Proclus* called *Helicoides*. But it may alſo be called *Helix*, a twiſt or wreath. The *Greekes* by this word do commonly either underſtand one of the kindes of Ivie which windeth it ſelfe about trees & other plants; or the ſtrings of the vine, whereby it catcheth hold and twiſteth it ſelfe about ſuch things as are ſet for it to clime or run upon. Therfore it ſhould properly ſignifie the ſpirall line. But as it is here taken it hath divers kindes; As is the *Arithmetica* which is Archimede'es Helix, as the *Conchois*, Cockleſhell-like: as is the *Cittois*, Iuylike: The *Tetragoniſonſa*, the Circle ſquaring line, to witt that by whoſe meanes a circle may be brought into a ſquare: The Admirable line, found out by *Menelaus*: The Conicall *Ellipſis*, the *Hyperbole*, the *Parabole*, ſuch as theſe are, they attribute to

C *Mene-*

Petrus Ramus, *Euclid's Elements (1569, English Translation 1636)*



VIA REGIA AD GEOMETRIAM.

THE VVAY TO GEOMETRY.

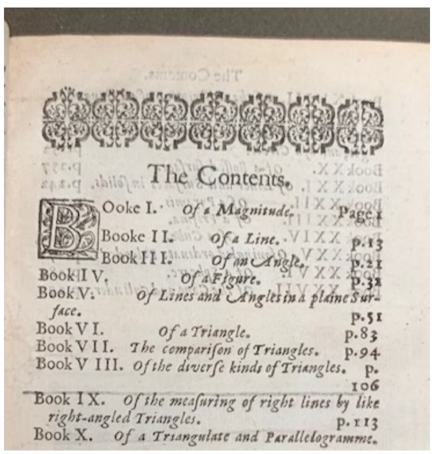
Being necessary and usefull,

For

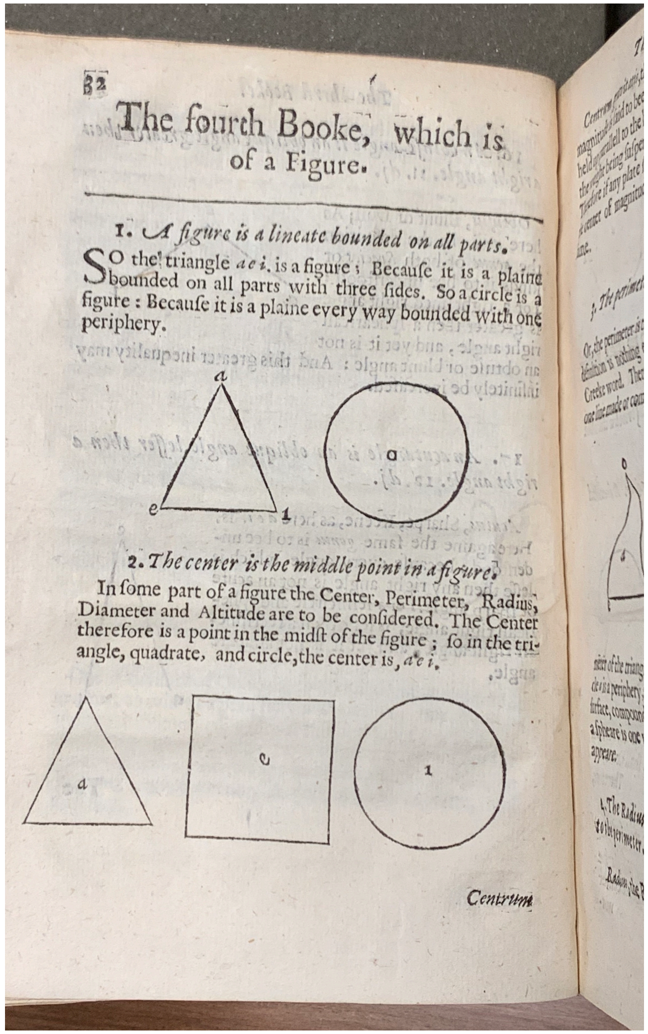
Astronomers. Geographers. Land-meaters. Sea-men. Engineres. Architecks. Carpenters. Paynters. Carvers, &c.

Written in Latine by PETER RAMUS, and now Translated and much enlarged by the Learned Mr. WILLIAM BEDWELL.

LONDON, Printed by Thomas Cotes, And are to be sold by Michael Sparke, at the blew Bible in Greene Arbour, 1636.



The Contents.



32

The fourth Booke, which is of a Figure.

1. *A figure is a lineate bounded on all parts.*

So the triangle *aei*, is a figure; Because it is a plaine bounded on all parts with three sides. So a circle is a figure: Because it is a plaine every way bounded with one periphery.

2. *The center is the middle point in a figure.*

In some part of a figure the Center, Perimeter, Radius, Diameter and Altitude are to be considered. The Center therefore is a point in the midst of the figure; so in the triangle, quadrate, and circle, the center is, *a e i*.

Petrus Ramus, Way to Geometry (1636 English Translation)

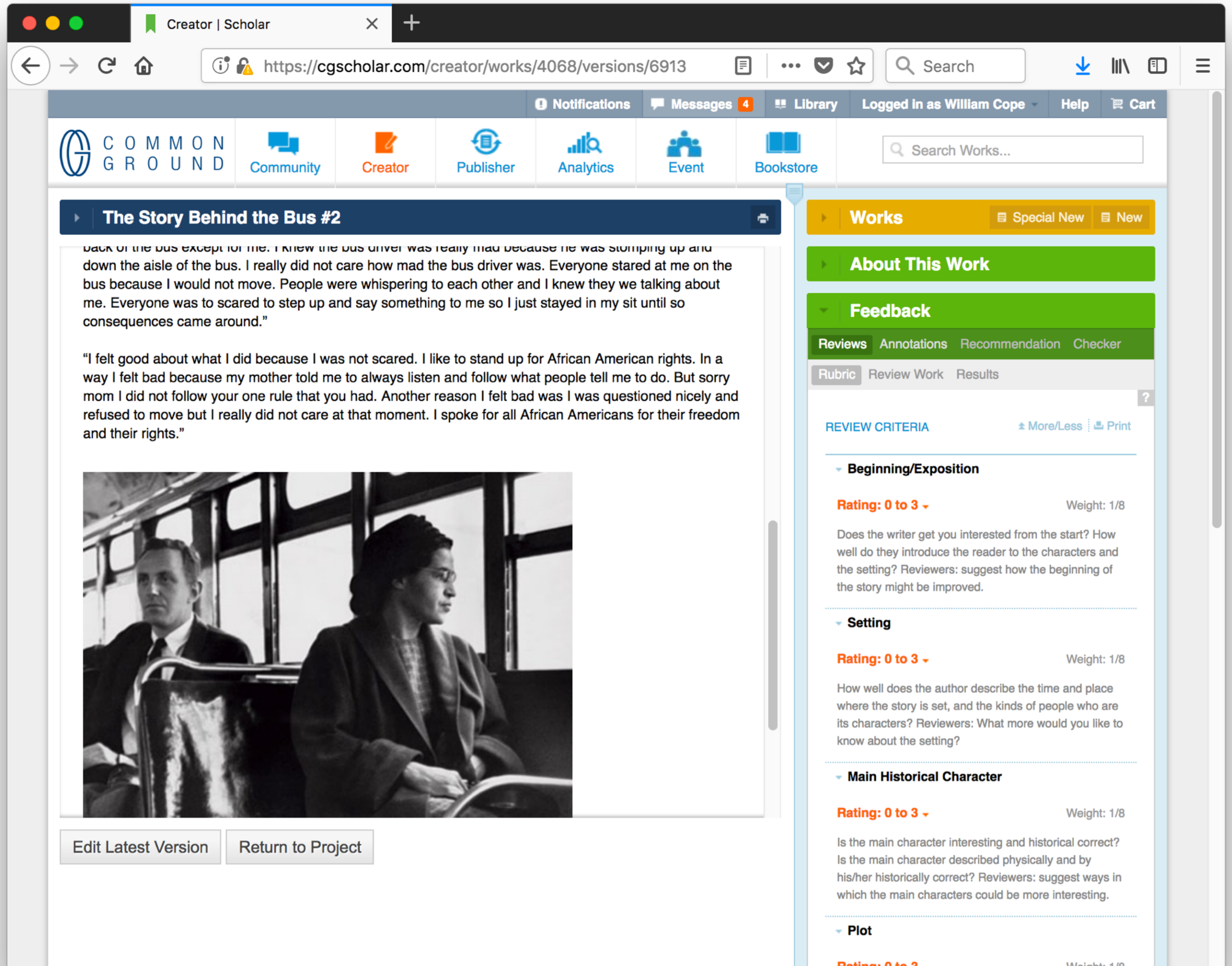
A table of contents points to a Book IV, "Of A Figure," commencing on page 32. Arriving at this page we find a section numbered and named, "1. A figure is a lineate bounded on all parts." Then, "So the triangle is a e 1…" and below that, I drawing of a triangle with its three corners labeled a, e, and 1.

Ramus relies on the visual in ways the Gutenberg in his Bible did not. He creates a spatialized architectonics of decomposition, from one visually compartmentalized cell of knowledge to the next, ordered from the simpler ideas to the more complex, and the diagrammed taxonomic relationships of main and subsidiary concepts. There is also the multimodal integration of text with image using labels and figure references.

Walter Ong on Petrus Ramus

Walter Ong, Jesuit priest, does not hide his dislike of Petrus Ramus, Protestant convert. "The Ramist arts of discourse are monologue arts. They develop the didactic, schoolroom outlook which... tends finally even to lose the sense of monologue in pure diagrammatics." Ramism "crowds spatial models into the universe of the mind," a precursor, for better or for worse of "the Newtonian revolution, with its stress on visually controlled observation of mathematics, and its curiously silent, nonrhetorical universe."

Ong, Walter J. 1958 [1983]. *Ramus, Method and the Decay of Dialogue.* Cambridge MA: Harvard University Press. Pp. 287, 318.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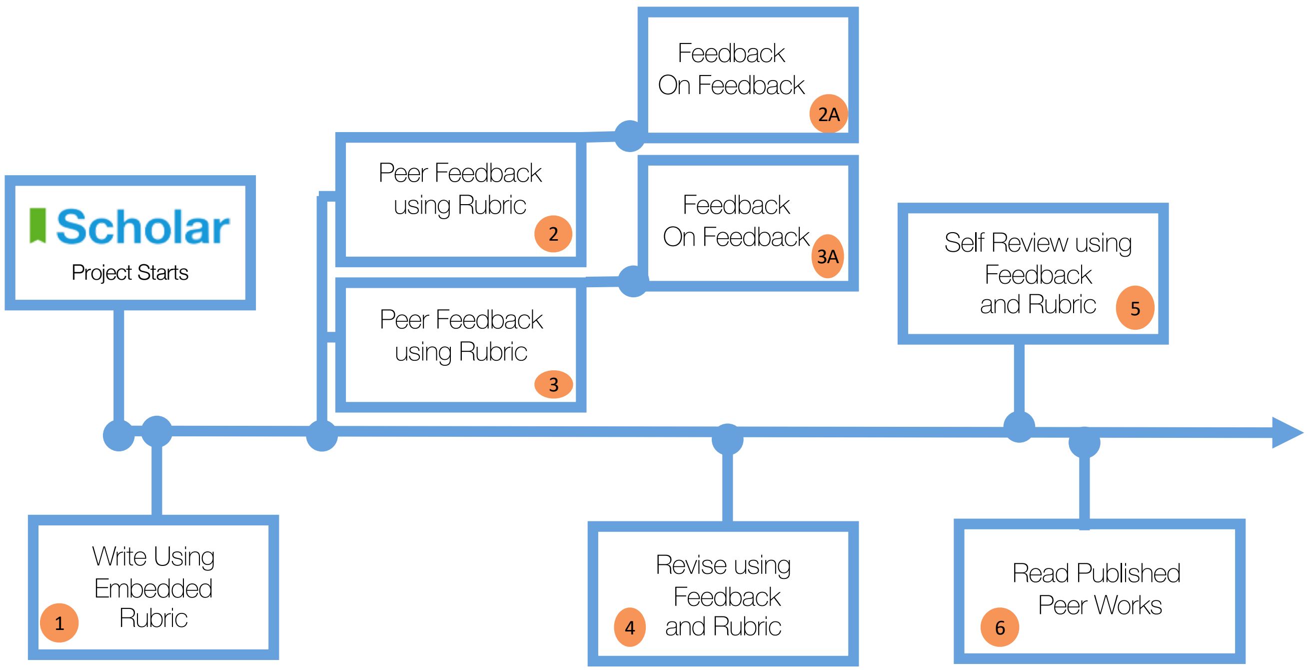
The Story Behind the Bus #2
down the aisle of the bus. I really did not care how mad the bus driver was. Everyone stared at me on the bus because I would not move. People were whispering to each other and I knew they we talking about me. Everyone was to scared to step up and say something to me so I just stayed in my sit until so consequences came around."
"I felt good about what I did because I was not scared. I like to stand up for African American rights. In a way I felt bad because my mother told me to always listen and follow what people tell me to do. But sorry mom I did not follow your one rule that you had. Another reason I felt bad was I was questioned nicely and refused to move but I really did not care at that moment. I spoke for all African Americans for their freedom and their rights."
Edit Latest Version
Return to Project
Works
Special New
New
About This Work
Feedback
Reviews
Annotations
Recommendation
Checker
Rubric
Review Work
Results
REVIEW CRITERIA
More/Less
Print
Beginning/Exposition
Rating: 0 to 3
Weight: 1/8
Does the writer get you interested from the start? How well do they introduce the reader to the characters and the setting? Reviewers: suggest how the beginning of the story might be improved.
Setting
Rating: 0 to 3
Weight: 1/8
How well does the author describe the time and place where the story is set, and the kinds of people who are its characters? Reviewers: What more would you like to know about the setting?
Main Historical Character
Rating: 0 to 3
Weight: 1/8
Is the main character interesting and historical correct? Is the main character described physically and by his/her historically correct? Reviewers: suggest ways in which the main characters could be more interesting.
Plot
Rating: 0 to 3
Weight: 1/8

Social Learning, Collaborative Intelligence



COGNITION	*METACOGNITION*
Learning Activity: a focus on representation of specific content knowledge	*Self-regulation of Learning:* project objectives, phase outline; ongoing dialogue around processes
Disciplinary Practice: thinking about a specific topic, its facts and arguments	*Disciplinary Thinking:* a focus on the general conditions of insightful work in this discipline; epistemological reflection
Empirical Work: outlining specific content, applying disciplinary reasoning to that content	*Theoretical Work*: thinking based on the general theoretical precepts of the discipline; a play/dialogue between the particular (thinking about specific details of knowledge), and the general (thinking about conceptual concepts and frameworks that tie this knowledge together).
Individual Intelligence: the activity of representing knowledge (including contribution to jointly created works)	*Collaborative Intelligence:* structured feedback; productive diversity in learning from varied perspectives
Learning: the knowledge representation made by the student	*Assessment*: formative assessments by peers, teachers and self; retrospective data analytics

Knowledge Representations

Learners as knowledge producers,
not (just) knowledge consumers

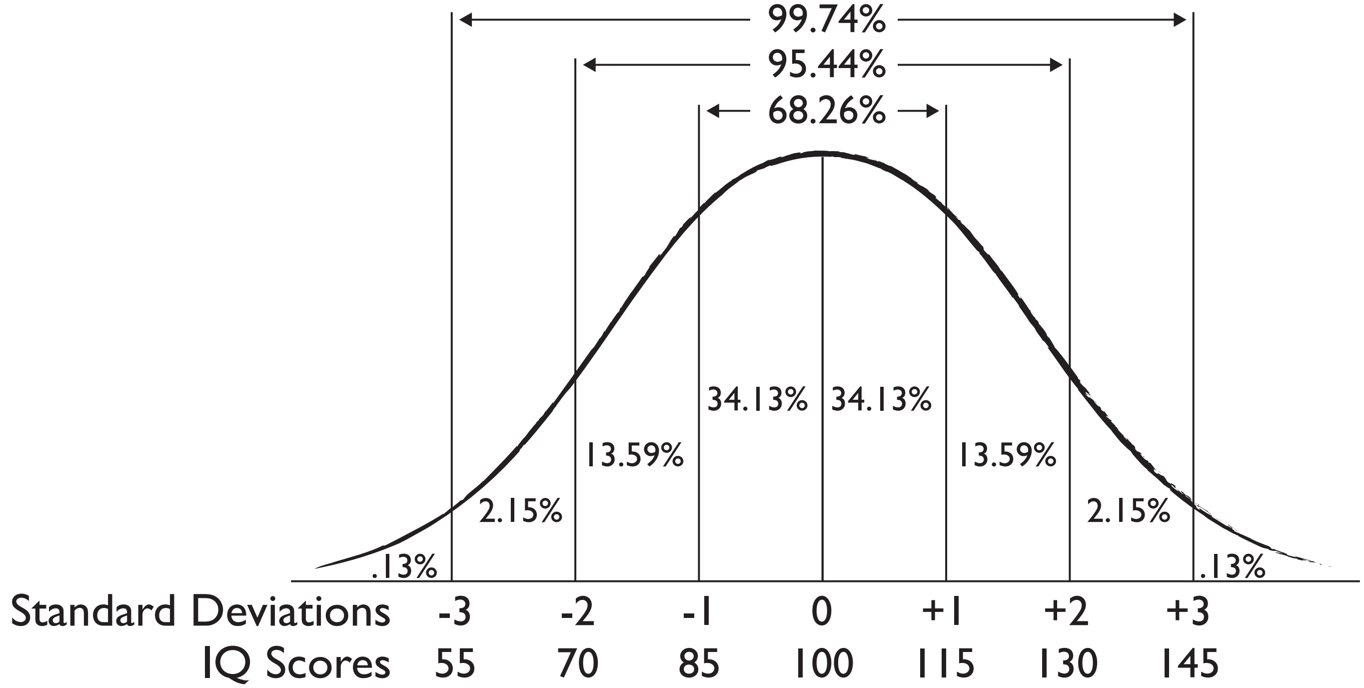
Multimodal knowledge artifacts

Complex epistemic performance

There is no scale

Artifact 3: The Test

Traditional Assessment



KEY:

0 and 25: idiot
26 and 50: imbecile
51 and 70: moron

115-124: above average
125-134: gifted
140-145: genius

Goddard, Henry H. 1920.*Human Efficiency and Levels of Intelligence*
Princeton NJ: Princeton University Press

Traditional Tests

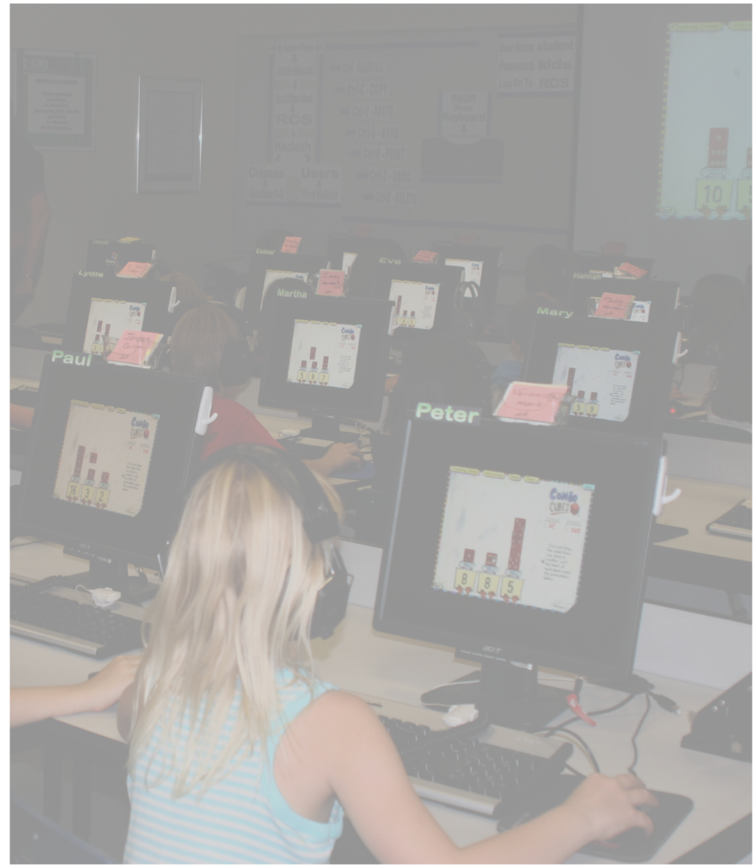
1. Measure long-term memory
2. Address a narrow cognitive range: facts and procedures
3. A peculiar test logic, unlike other places of knowledge activity
4. Limited sampling
5. Disturbing experiences
6. A linear process: backward looking and judgmental by nature
7. Individualized, isolating
8. Insist on inequality

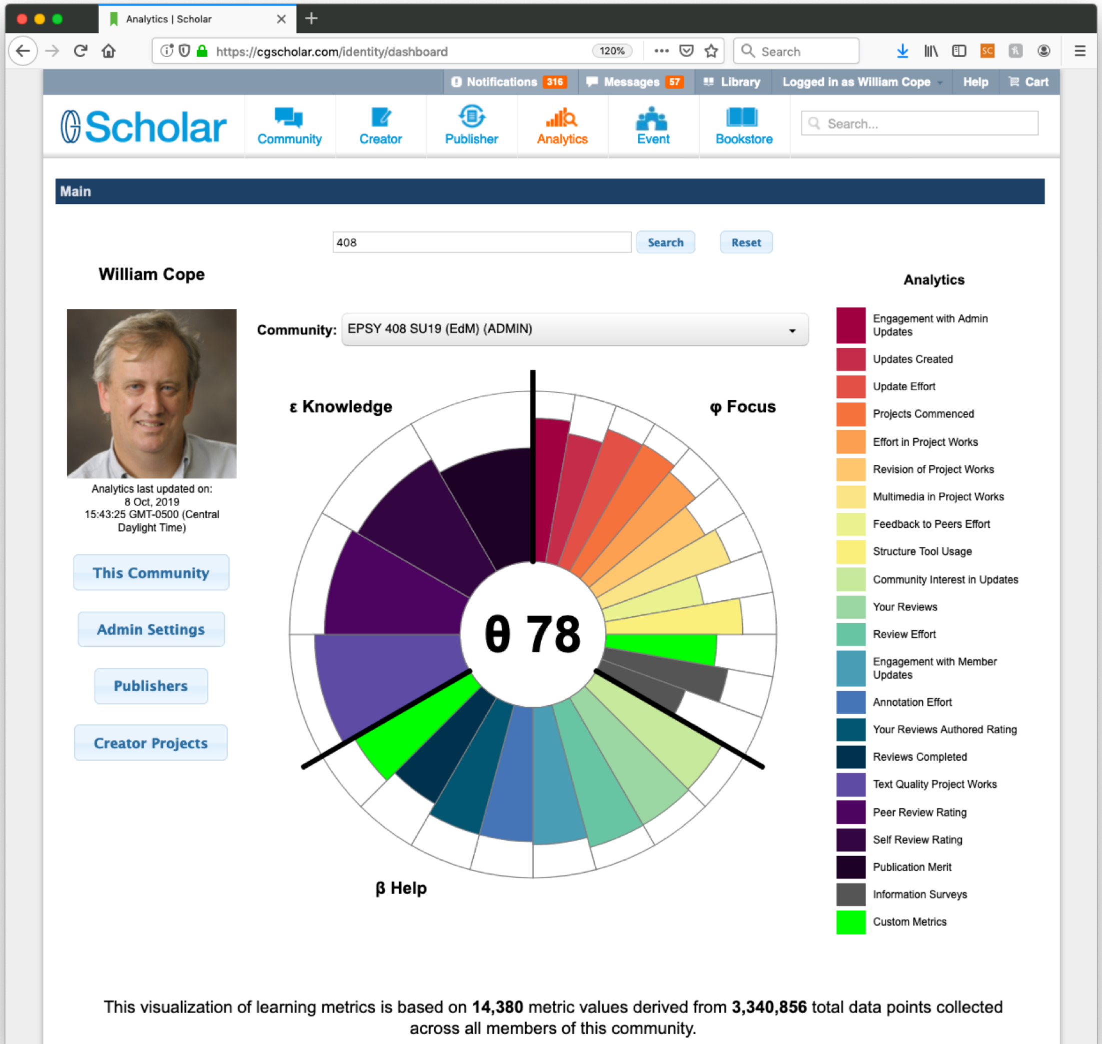
Then computers come…

… and nothing (really) changes.

Education 1.0

1. Teacher-centered
2. Learner as knowledge consumer
3. Knowledge transmission and replication
4. Long term memory
5. Knowledge as fact, correctly executable theorem, definition
6. Cognitive focus
7. Individual minds
8. Long cycle feedback, retrospective and judgmental (summative assessment)

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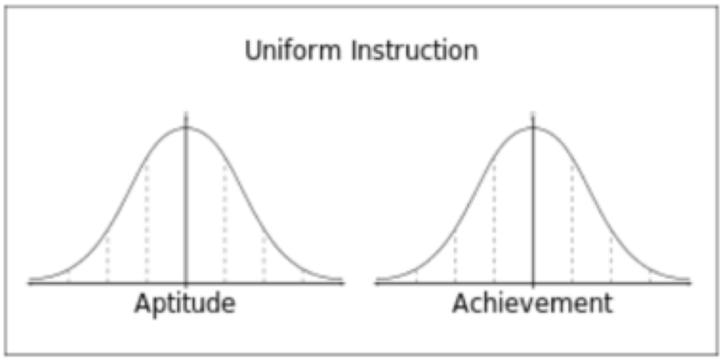
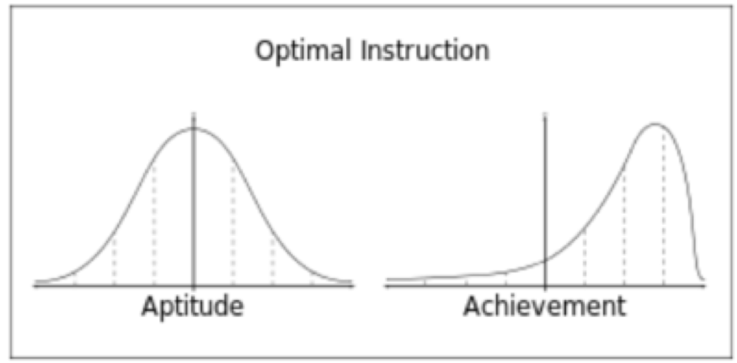
Projects Commenced
Effort in Project Works
Revision of Project Works
Multimedia in Project Works
Feedback to Peers Effort
Structure Tool Usage
Community Interest in Updates
Your Reviews
Review Effort
Engagement with Member Updates
Annotation Effort
Your Reviews Authored Rating
Reviews Completed
Text Quality Project Works
Peer Review Rating
Self Review Rating
Publication Merit
Information Surveys
Custom Metrics
This visualization of learning metrics is based on 14,380 metric values derived from 3,340,856 total data points collected across all members of this community.

From Mastery Learning to Reflexive Pedagogy





Optimal instruction: regular, formative assessment that directs teachers to intervene in the case of students who are falling behind, allowing students to work at their own pace, group work, and intensive tutoring.

Bloom, Benjamin S. 1968. "Learning for Mastery." *Evaluation Comment* 1(2):1-2.

Definition

'Big data' and 'artificial intelligence' in education are:

1. the ***purposeful or incidental recording*** of activity and interactions in digitally-mediated, network-interconnected learning environments—the volume of which is unprecedented in large part because the datapoints are smaller and the recording is continuous;

2. the ***varied types of data*** that are recordable and analyzable;

3. the ***accessibility and durability*** of these data, with potentials to be: a) immediately available for formative assessment or adaptive instructional recalibration, and b) persistent for the purposes of developing learner profiles and longitudinal analyses;

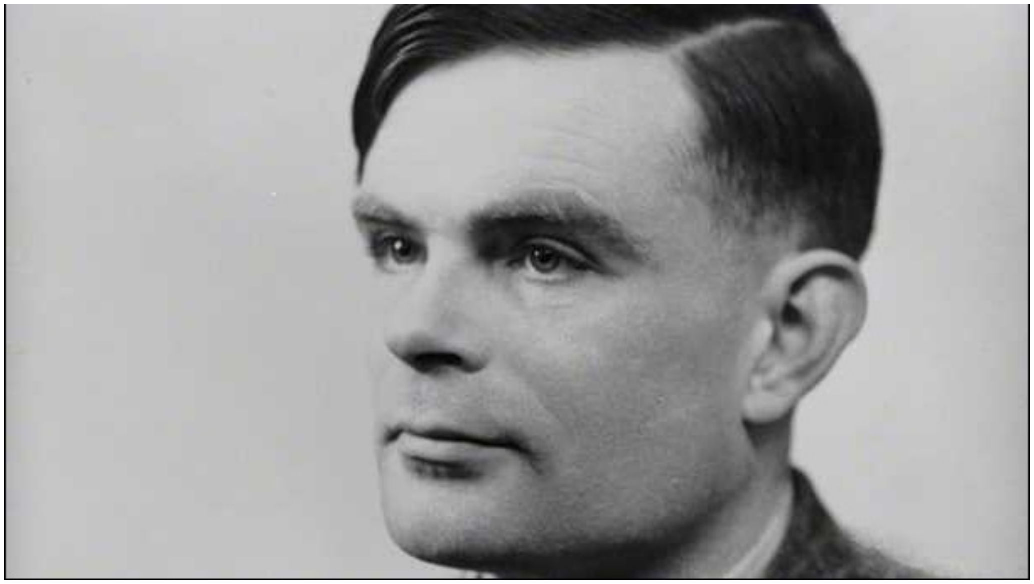
4. the application of ***machine learning and artificial intelligence*** where the machine learns from patterns of student interaction;

5. presentations of ***data analytics***—syntheses based on the particular characteristics of these data, for learner and teacher feedback, institutional accountability, educational software design, learning resource development, and educational research.

Cope, Bill and Mary Kalantzis. 2016. "Big Data Comes to School: Implications for Learning, Assessment and Research." *AERA Open* 2(2):1-19.

The question of Artificial Intelligence

Alan Turing's "On Computable Numbers"



"Can machines think?" asked Alan Turing… His answer was that, some day in the not-too-distant future, in a certain sense they might. "Lady Lovelace's Objection: …she states, 'The Analytical Engine has no pretensions to originate anything. It can do whatever we know how to order it to perform'." But perhaps, says Turing, the Analytical Engine had the potential to "think for itself" to the extent that it could come up with surprising answers to mathematical problems… in this sense Lovelace was not so wrong. "At my present rate of working I produce about a thousand digits of programme a day… Meanwhile, "[p]arts of modern machines which can be regarded as analogues of nerve cells work about a thousand times faster than the latter… Machines take me by surprise with great frequency…, largely because I do not do sufficient calculation."

Turing, A.M. 1950. "Computing Machinery and Intelligence." *Mind* 59:433-60. Pp 450, 455, 459.

Electric Adder to the Base Two

A circuit is to be designed that will automatically add two numbers, using only relays and switches. Although any numbering base could be used the circuit is greatly simplified by using the scale of two. Each digit is thus either 0 or 1; the number whose digits in order are $a_k, a_{k-1}, a_{k-2}, \ldots a_2, a_1, a_0$ has the value $\sum_{j=0}^{k} a_j 2^j$.

Using the method of symmetric functions, and shifting down for s_j gives the circuits of Figure 35. Eliminating superfluous elements we arrive at Figure 36.

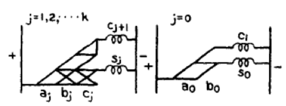


Figure 35. Circuits for electric adder

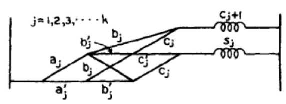


Figure 36. Simplification of figure 35

Table I. Analogue Between the Calculus of Propositions and the Symbolic Relay Analysis

Symbol	Interpretation in Relay Circuits	Interpretation in the Calculus of Propositions
X	The circuit X	The proposition X
0	The circuit is closed	The proposition is false
1	The circuit is open	The proposition is true
$X + Y$	The series connection of circuits X and Y	The proposition which is true if either X or Y is true
$X\,Y$	The parallel connection of circuits X and Y	The proposition which is true if both X and Y are true
X'	The circuit which is open when X is closed and closed when X is open	The contradictory of proposition X
=	The circuits open and close simultaneously	Each proposition implies the other

Claude Shannon's Relay Circuits

In 1938 Shannon come up with the idea that, instead of paper tape, relay circuits or on/off switches could represent mathematical symbols as zeros and ones, and doing the work of calculation electrically. Applying the elementary logic of nineteenth century mathematical philosopher, George Boole, he suggested that when the circuit is closed a proposition could be considered false, and when it is open, it could be considered true: "any circuit is represented by a set of equations, the terms of the equations corresponding to the various relays and switches in the circuit. A calculus is developed for manipulating these equations by simple mathematical processes." Such an electronic machine would work sequentially through a series of yes/no binaries.

Shannon, Claude E. 1938. "A Symbolic Analysis of Relay and Switching Circuits." *Transactions American Institute of Electrical Engineers* 57:471-95. P. 471.

"Intelligent Machinery".

I propose to investigate the question as to whether it is possible for machinery to show intelligent behaviour. It is usually assumed without argument that it is not possible. Common catch phrases such as 'acting like a machine', 'purely mechanical behaviour' reveal this common attitude. It is not difficult to see why such an attitude should have arisen. Some of the reasons are

(a) An unwillingness to admit the possibility that mankind can have any rivals in intellectual power. This occurs as much amongst intellectual people as amongst others: they have more to lose. Those who admit the possibility all agree that its realization would be very disagreeable. The same situation arises in connection with the possibility of our being superseded by some other animal species. This is almost as disagreeable and its theoretical possibility is indisputable.

(b) A religious belief that any attempt to construct such machines is a sort of Promethean irreverence.

(c) The very limited character of the machinery which has been used until recent times (e.g. up to 1940). This encouraged the belief that machinery was necessarily limited to extremely straightforward, possibly even to repetitive, jobs. This attitude is very well expressed by Dorothy Sayers (The Mind of the Maker, p. 46) "... which imagines that God, having created his Universe, has now screwed the cap on His pen, put His feet on the mantelpiece and left the work to get on with itself." This, however, rather comes into St. Augustine's category of figures of speech or enigmatic sayings framed from things which do not exist at all. We simply do not know of any creation which goes on creating itself in variety when the creator has withdrawn from it. The idea is that God simply created a vast machine and has left it working until it runs down from lack of fuel. This is another of those obscure analogies, since we have no experience of machines that produce variety of their own accord; the nature of a machine is to do the same thing over and over again so long as it keeps going."

(d) Recently the theorem of Godel and related results (Godel 1, Church 1, Turing 1) have shown that if one tries to use machines for such purposes as determini[ng] the truth or falsity of mathematical theorems and one is not willing to tolerate an occasional wrong result, then any given machine will in some cases be unable to give an answer at all. On the other hand the human intelligence seems to be able to find methods of ever increasing power for dealing with such problems 'transcending' the methods available to machines.

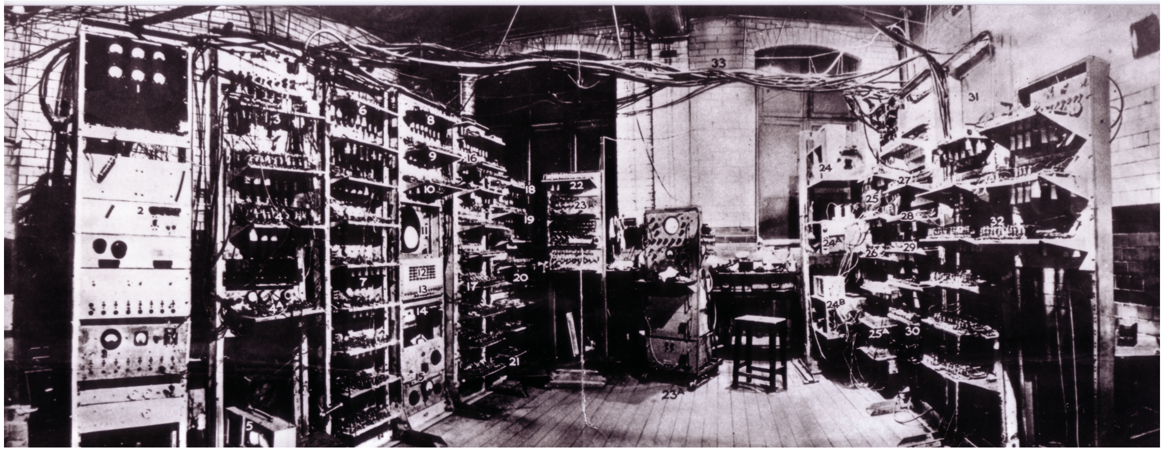
(e) In so far as a machine can show intelligence this is to be regarded as nothing but a reflection of the intelligence of its creator.

Alan Turing's "Intelligent Machinery"

Turing joined the National Physical Laboratory, whose director was Sir Charles Darwin, grandson of the natural scientist. Turing and the team to which he belonged made slow progress on the machine, the Automatic Computing Engine (a nod in the name to Babbage's Engines). In the meantime, Turing wrote a speculative report, "Intelligent Machinery."…"The electrical circuits which are used in electronic computing machinery seem to have the essential properties of nerves," Turing said. Sir Charles Darwin was not impressed, "a schoolboy's essay… not suitable for publication" was his verdict… The report was not published until after Turing's death.

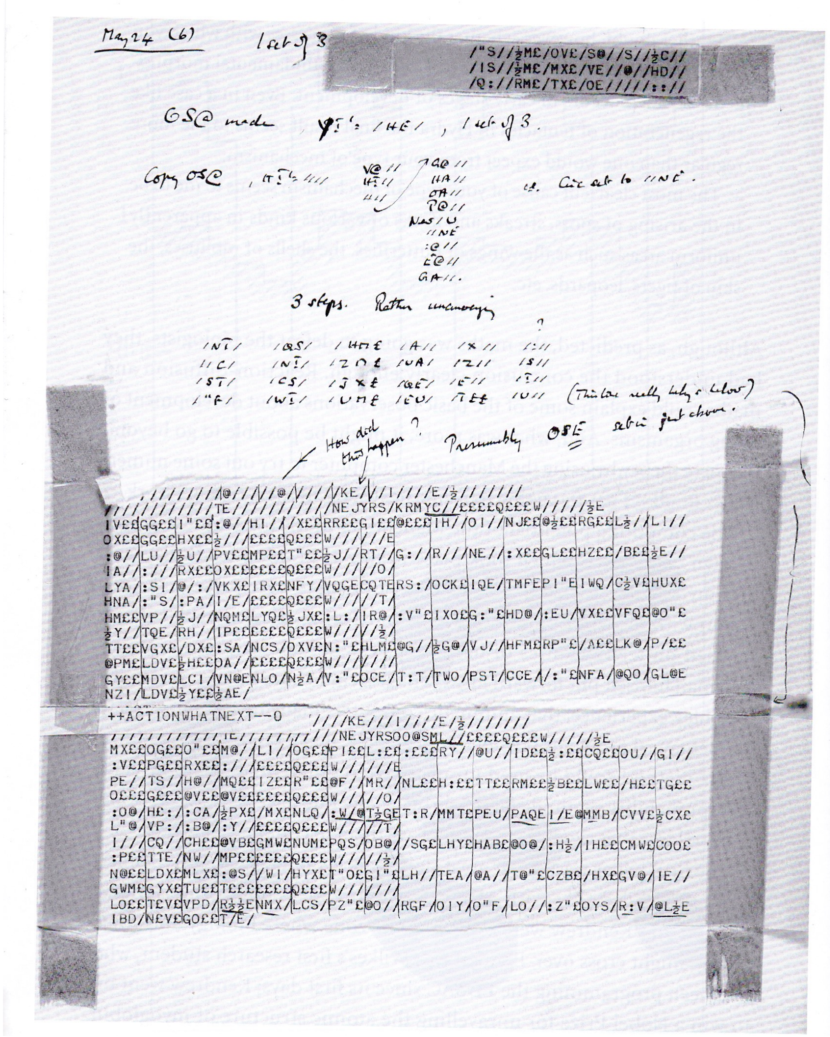
Turing, A.M. 1948. "Intelligent Machinery." A Report to the National Physical Laboratory. P.8.

The Mechanical Brain



"Manchester 1" had 1024 bits of random access memory, with paper tape input and output—this last mechanism had been Turing's suggestion. By 1949, announced The Times, "the mechanical brain" in Manchester had done something that was practically impossible to achieve in paper. It had found a some previously undiscovered, extremely large prime numbers.

Right: Alan Turing



"How did this happen?" asks Alan Turing

"Parts of modern machines which can be regarded as analogues of nerve cells work about a thousand times faster than the latter." So, the "view that machines cannot give rise to surprises is due to a fallacy…, the assumption that as soon as a fact is presented to a mind all consequences of that fact spring into the mind simultaneously with it." Things can present themselves as surprises after a lot of working over data, and some of the working over that machines can do is too laborious for manual calculation.

Turing, A.M. 1950. "Computing Machinery and Intelligence." *Mind* 59:433-60. P. 451.

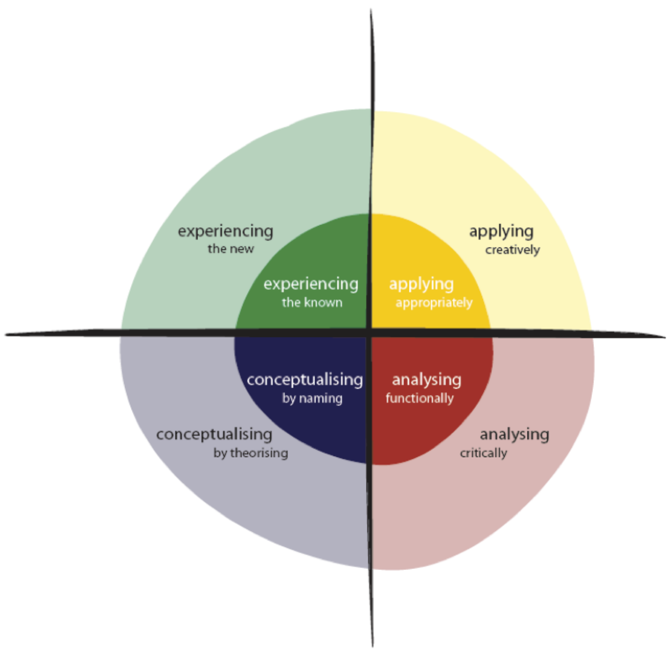
Two Definitions of AI

1. More calculation than humans can reasonably do.

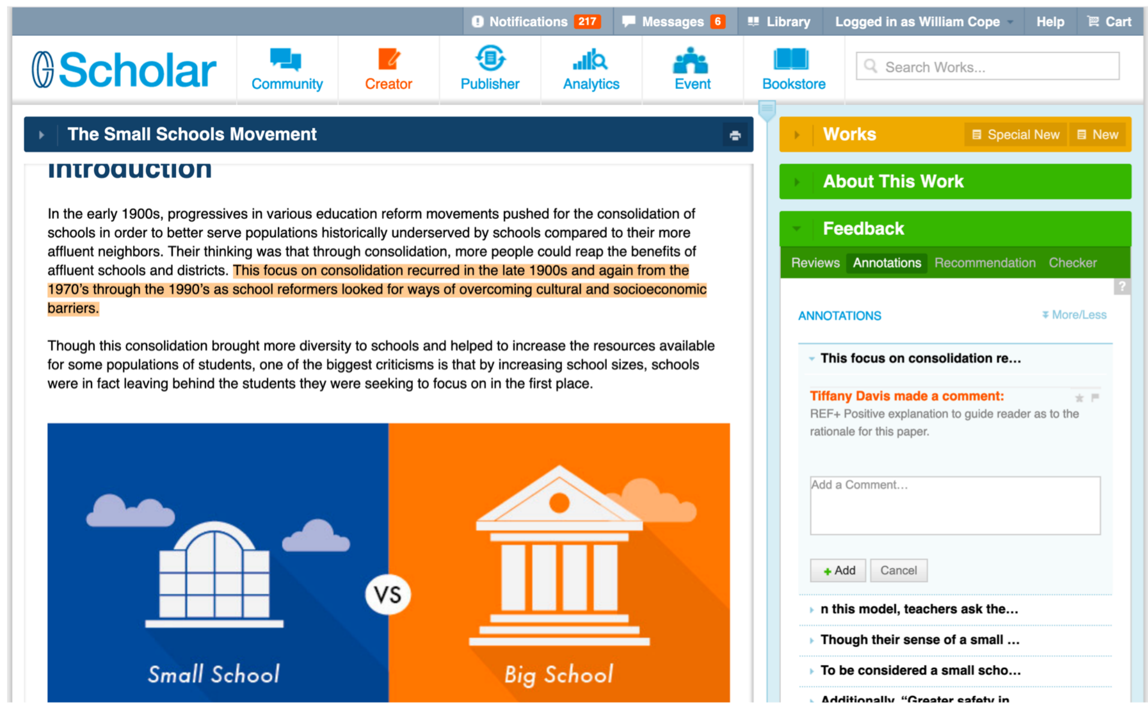
Or, more narrowly:

2. Machine learning, (and deep learning, neural nets): data that recalibrates itself as new data entered.

New Frontiers: Machine Learning



Crowdsourced, collaborative intelligence, where users train the machine to detect high order thinking.



What AI Does: Four Textualities

1. AI **names in Unicode** (graphemes: some phonemes, mostly and more importantly now, ideographs); including stuff that can now speak its name in the internet of things

2. AI **counts instances and concepts** represented in Unicode on a scale not feasible for humans

3. AI **transposes measurable qualities into quantities** (ambience … the e.g. ambient intelligent classroom)

4. AI **renders** by laborious decomposition > calculation > on-the-fly recomposition : image/text in pixels; sound/speech

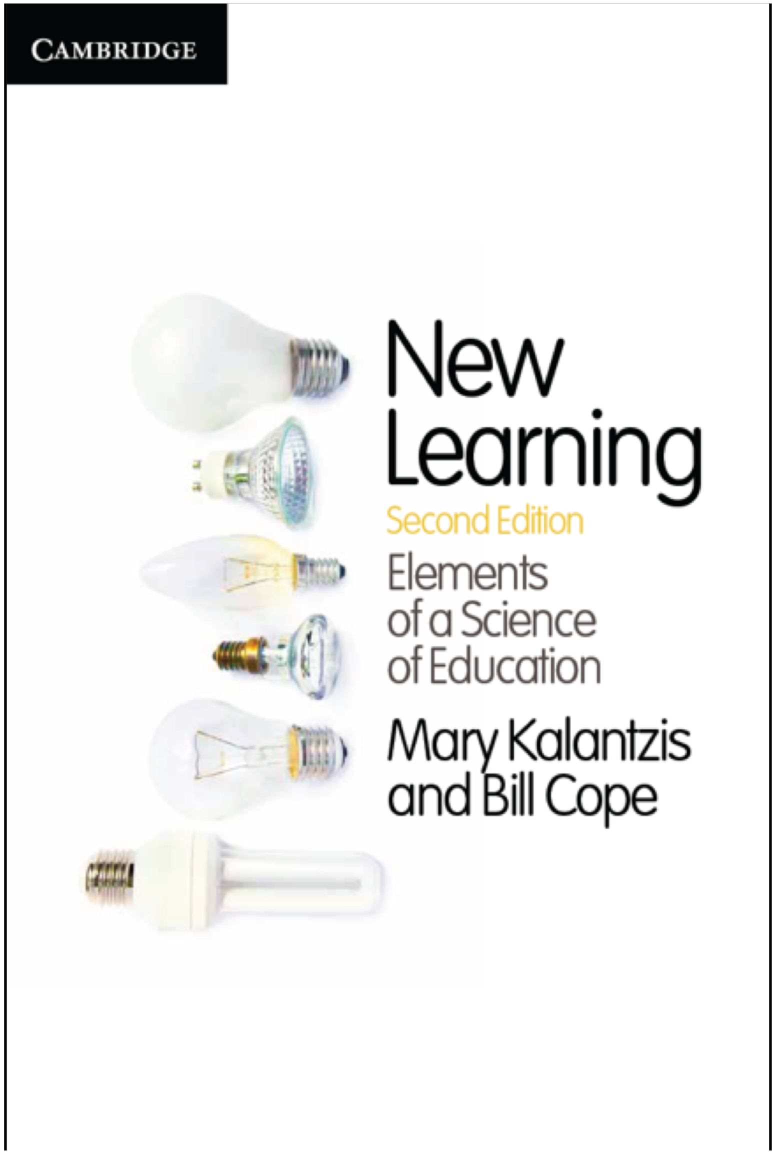
Traditional Tests	AI-supported, Embedded Assessments
1. Measure long-term memory	Assess higher-order thinking
2. Address a narrow cognitive range: facts and procedures	Address complex epistemic performance
3. A peculiar test logic, unlike other places of knowledge activity	Offer a broad range of data types and data points, authentic to knowledge work
4. Limited sampling	Big Data: n=all
5. Disturbing experiences	Embedded assessment is the learner's friend
6. A linear process: backward looking and judgmental by nature	Recursive processes: prospective and constructive by nature
7. Individualized, isolating	Assess collaborative as well as individual intelligence
8. Insist on inequality	Mastery learning, where every learner can succeed

The Test is Dead.

Long Live Assessment!

Education 1.0	Education 2.0
1. Teacher-centered	Learner as agent, participant
2. Learner as knowledge consumer	Learner as knowledge producer
3. Knowledge transmission and replication	Knowledge as discoverable, navigation, critical discernment
4. Long term memory	Devices as "cognitive prostheses"—social memory and immediate calculation
5. Knowledge as fact, correctly executable theorem, definition	Knowledge as judgment, argumentation, reasoning
6. Cognitive focus	Focus on knowledge representations, "works" (ergative)
7. Individual minds	Social, dialogical minds
8. Long cycle feedback, retrospective and judgmental (summative assessment)	Short cycle feedback, prospective and constructive (reflexivity, recursive feedback, formative assessment)

References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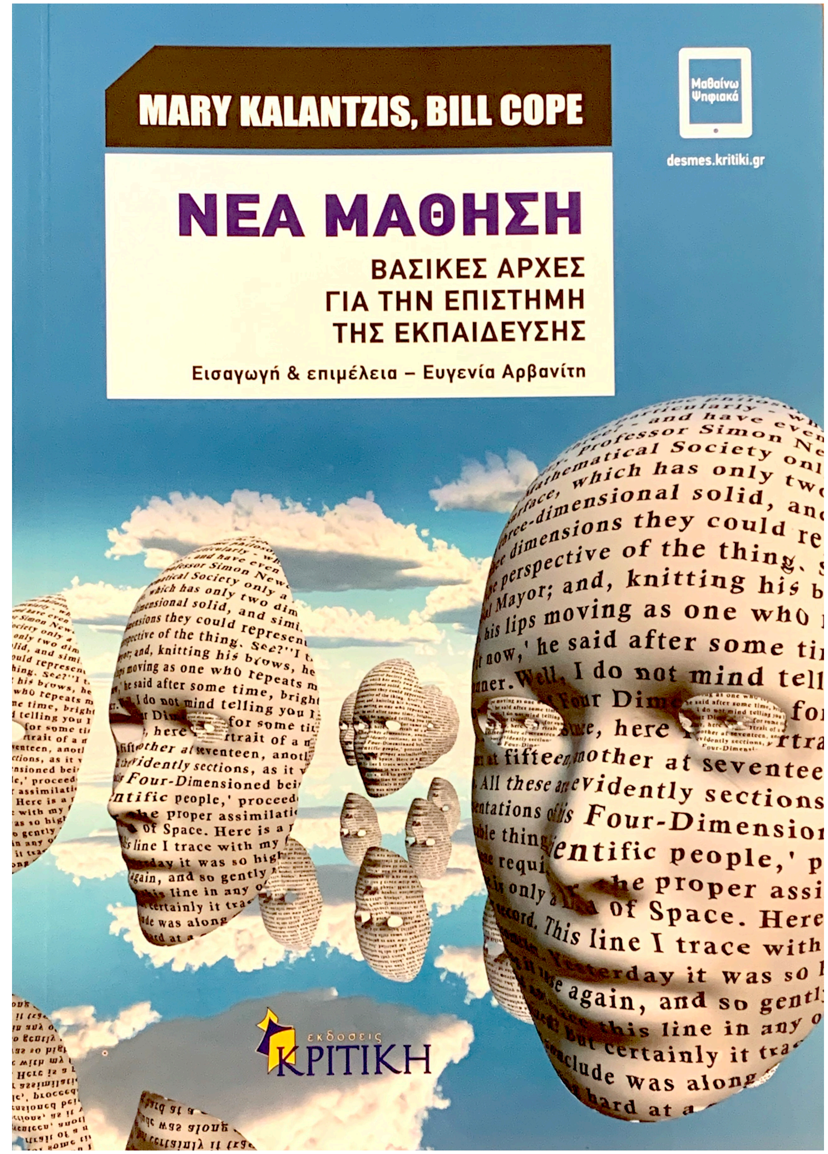
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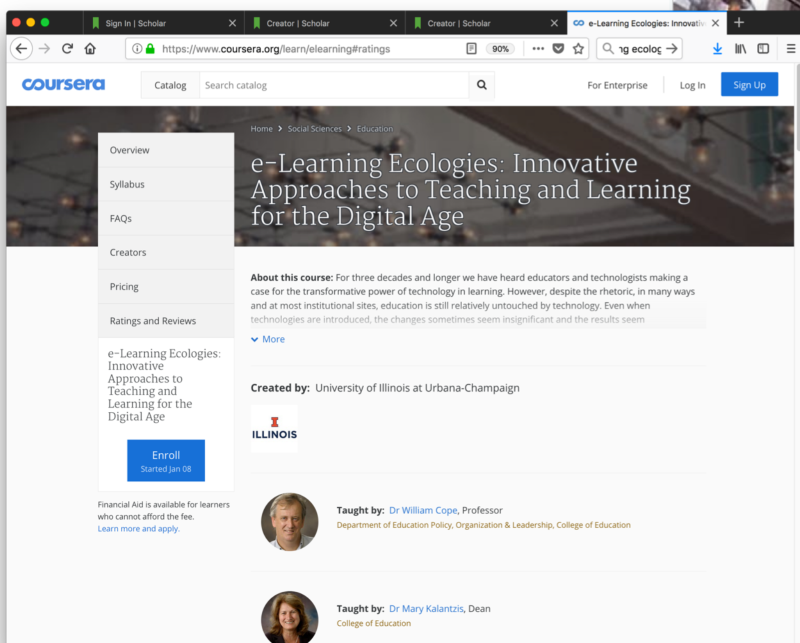
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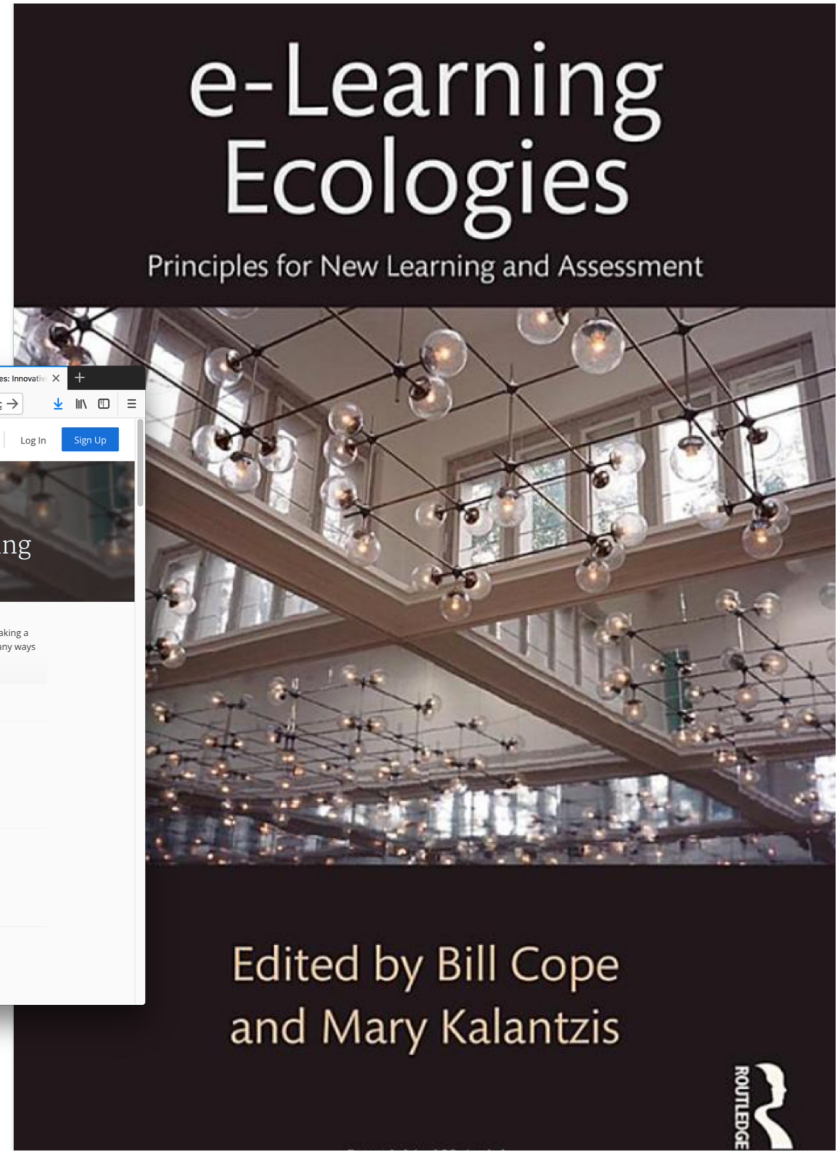
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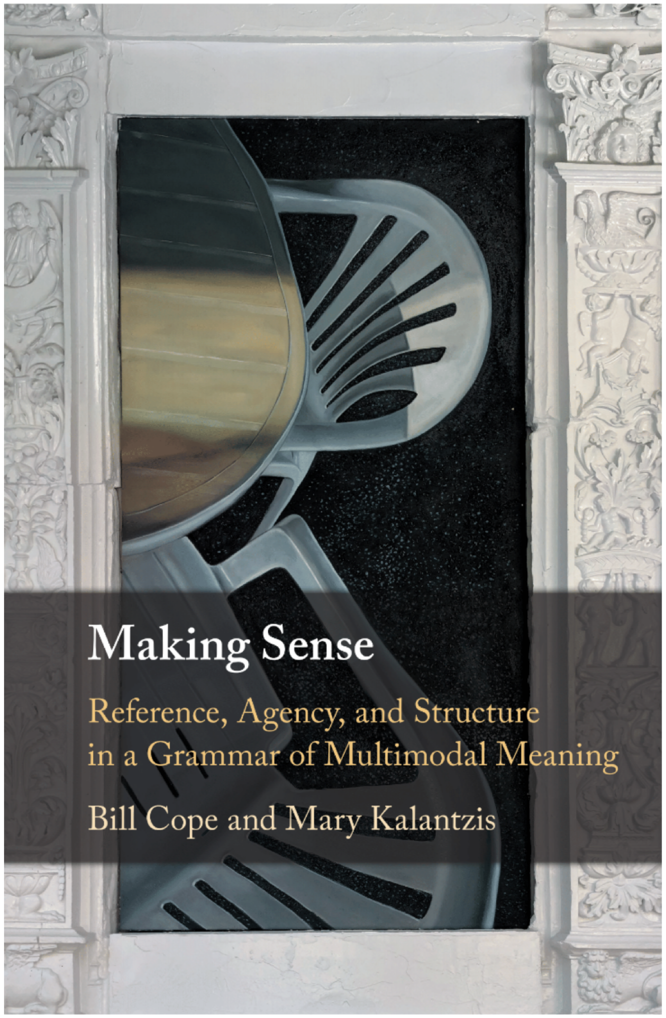
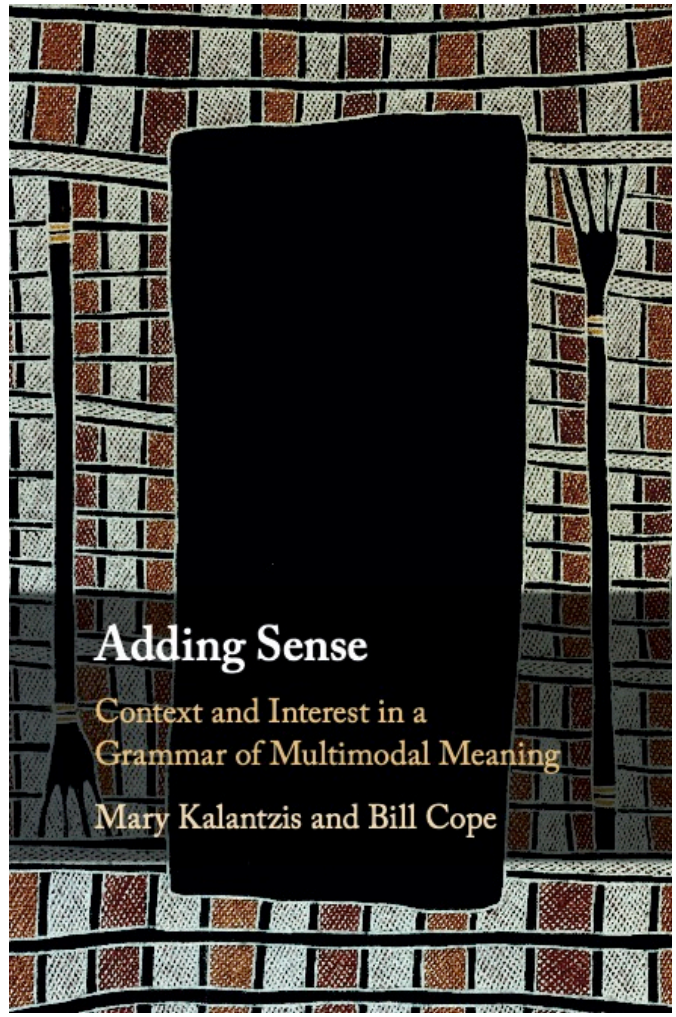
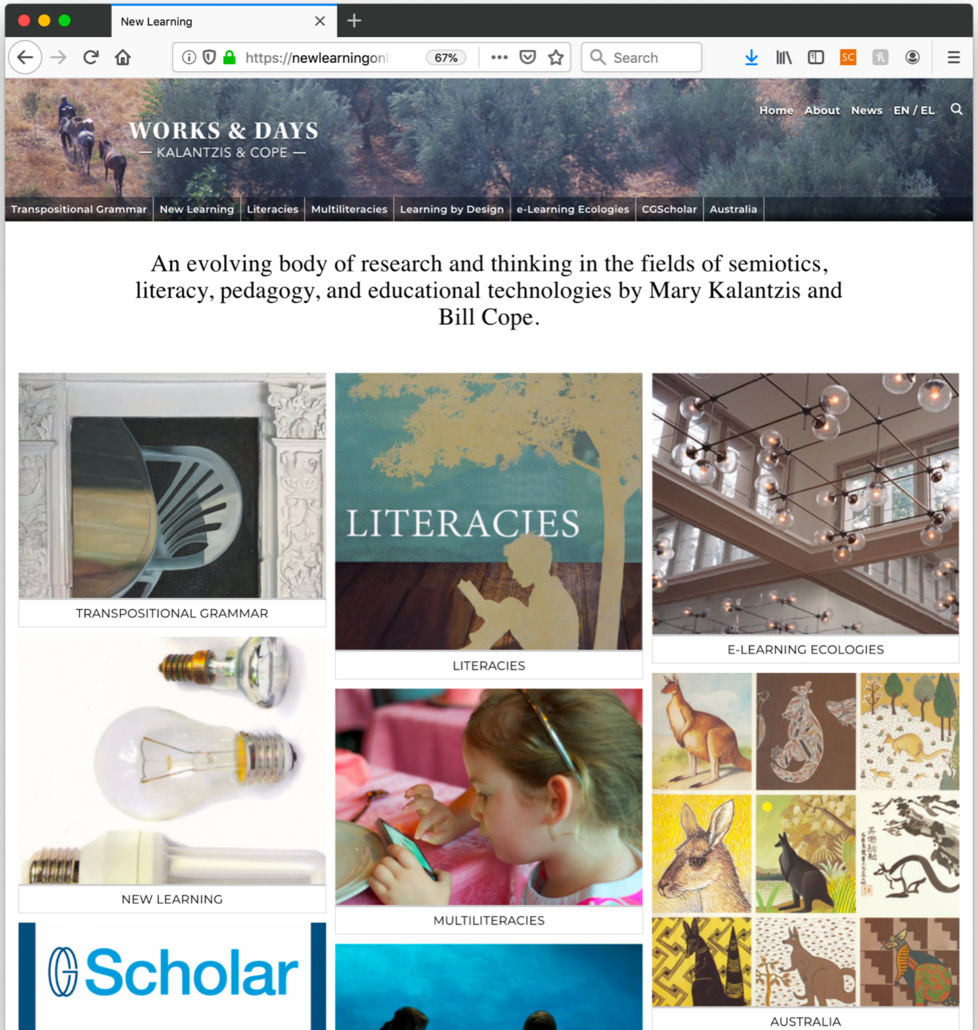




Cambridge University Press, 2019 (in press)



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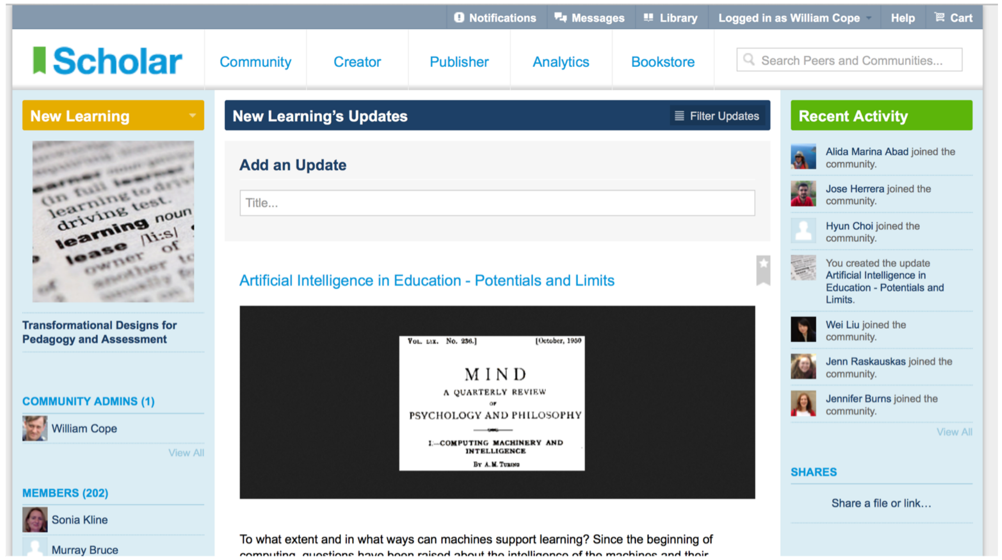

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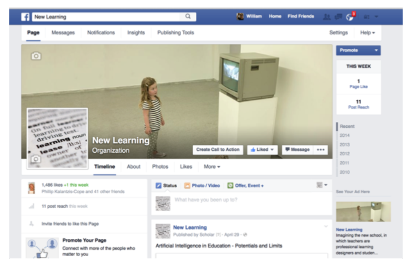

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