STEAM engines

On building and testing the machines in our students' minds

Jon Dron, January 2021
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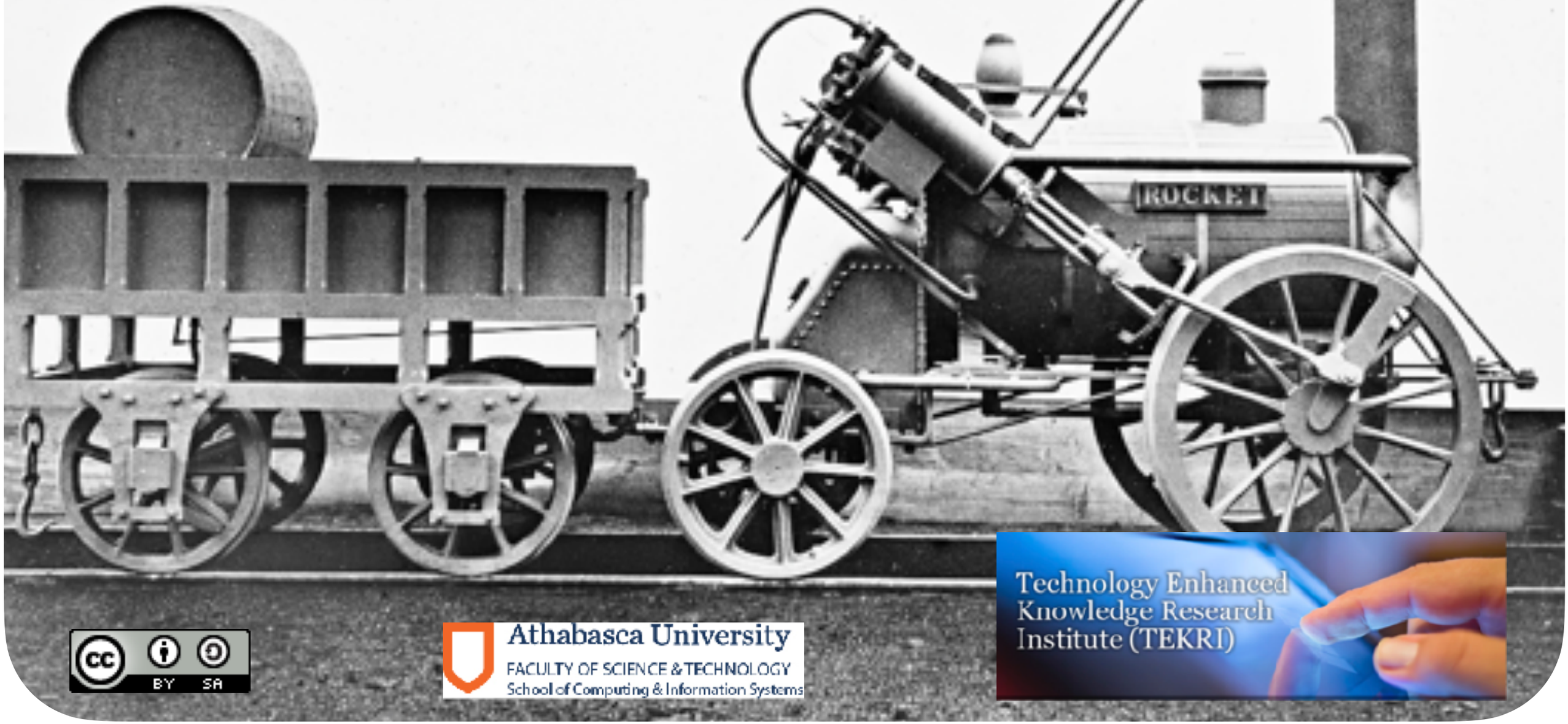
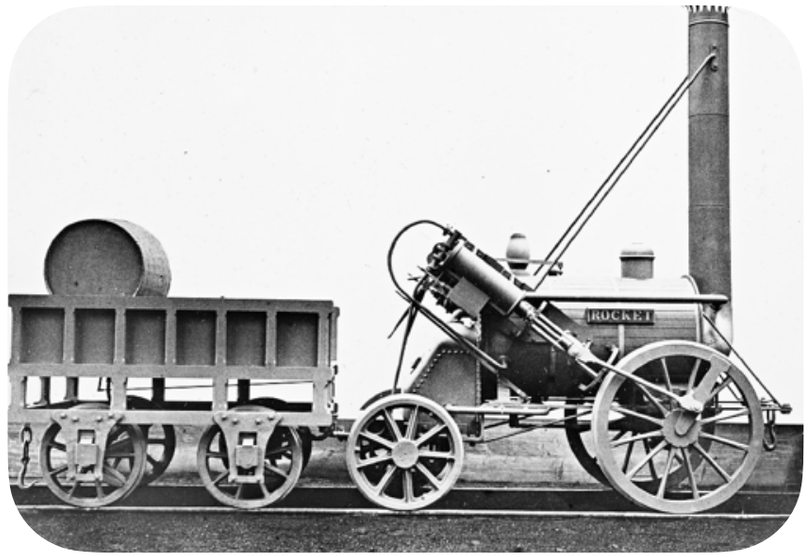
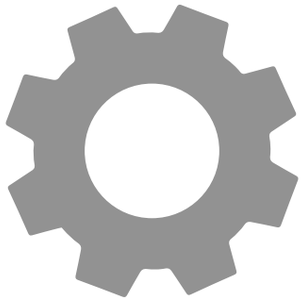


Athabasca University
FACULTY OF SCIENCE & TECHNOLOGY
School of Computing & Information Systems

STE(A)M

Science
Technology
Engineering
(Liberal **A**rts)
Mathematics

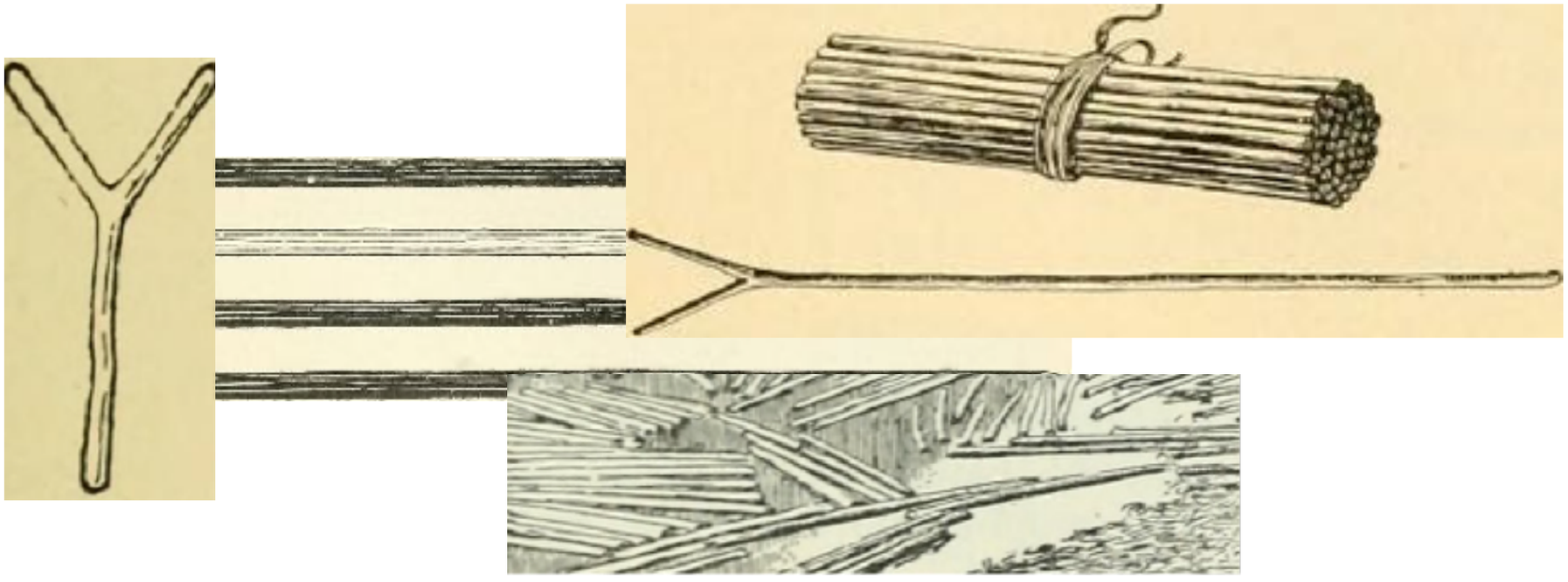


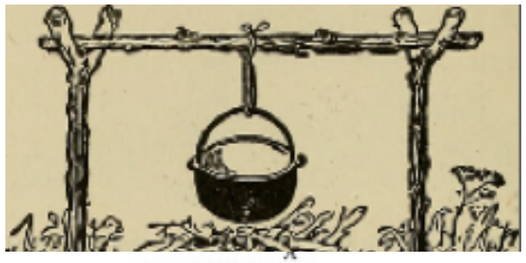


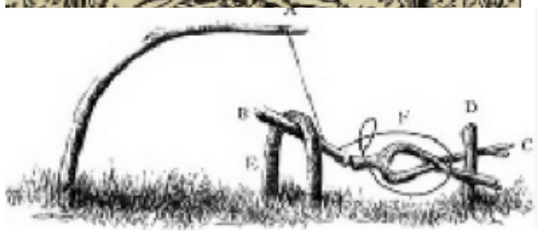
Machines in our minds

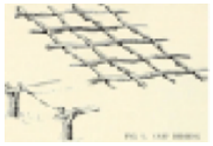
Add 23+21
Remember a line from a poem
Remember a piece of music
Think about how to turn on your computer
Invent a password
Turn on a light
Draw a picture
Write your name
Unlock your phone
Write some software
Design a robot

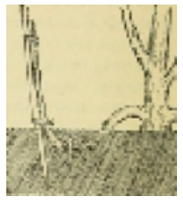
What are some educational uses for a stick?



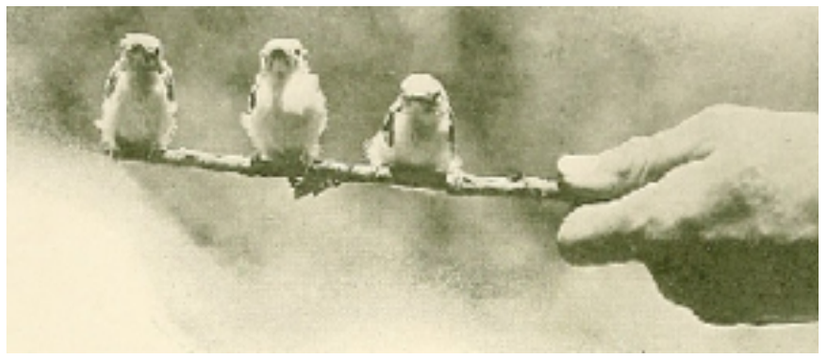


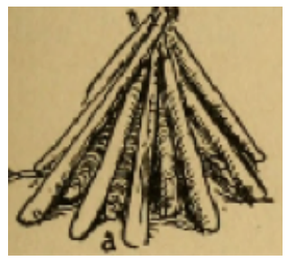






The stick becomes a technology when we add methods (and maybe other stuff)





So these are stupid questions

Does *the use of screws in classrooms improve learning*?

Does *the use of computers in classrooms improve learning*?

Does *the use of <insert preferred teaching method here> in classrooms improve learning*?

Formally…

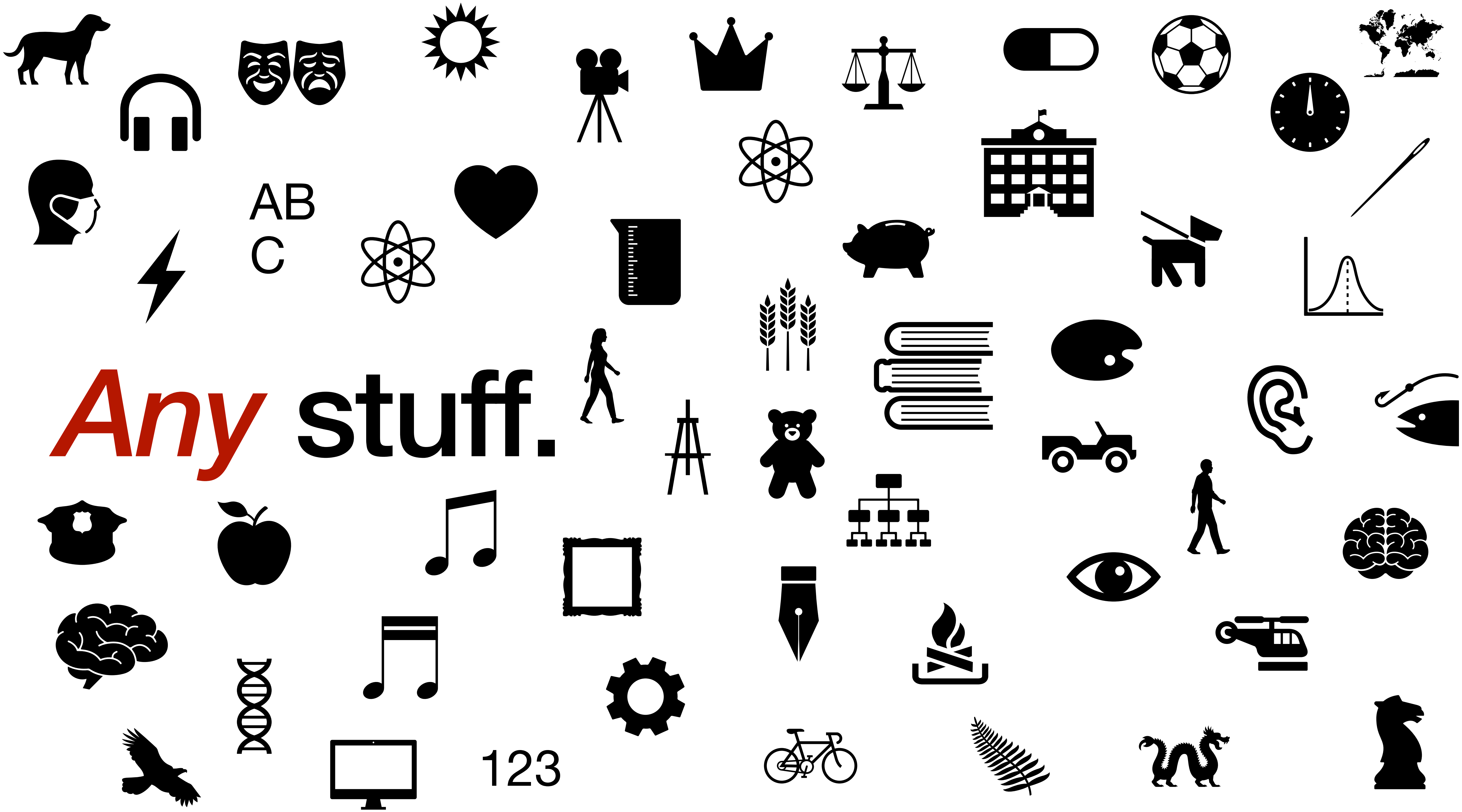
Technology:

The orchestration of phenomena to some use
(W.Brian Arthur)

Essentially…

Organizing stuff to do stuff

Arthur, W. B. (2009). *The Nature of Technology: what it is and how it evolves* (Kindle ed.). New York, USA: Free Press.


Any stuff.
AB
C
123

A noun and a verb

I am using writing to write something written

Painters paint paintings

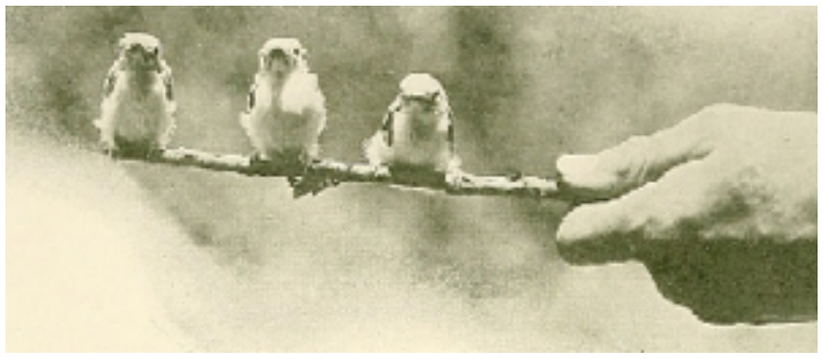
Production lines produce productions

Teaching methods teach

Kelly, K. (2010). *What Technology Wants* (Kindle ed.). New York: Viking.

All technologies are assemblies

Almost all technologies are assemblies of and with *other* technologies



We don’t just *use* technologies.
We *participate* in them.

Hard technologies

We are part of the orchestration

Soft technologies

We are active orchestrators of phenomena

Softness is an absence.

A space for us to fill.

An adjacent possible.

Kauffman, S. A. (2019). *A World Beyond Physics: The Emergence and Evolution of Life*. Oxford University Press.

Nearly all technologies are assemblies of soft and hard.

Softness and hardness depend upon your point of view.

Image by Jules Feiffer, from The Phantom Tollbooth, by Norton Juster

It’s the total assembly that matters.

You can add methods/tools to hard technologies to make them softer

Richard Dean Anderson as MacGyver

You can add constraints/rules to soft technologies to make them harder

Teaching *is* technology

Pedagogical methods combined with other tools (usually at least language) and structures intended to bring about learning.

Teaching *creates* technology

Teaching builds machines (methods, tools, components) in learners' minds

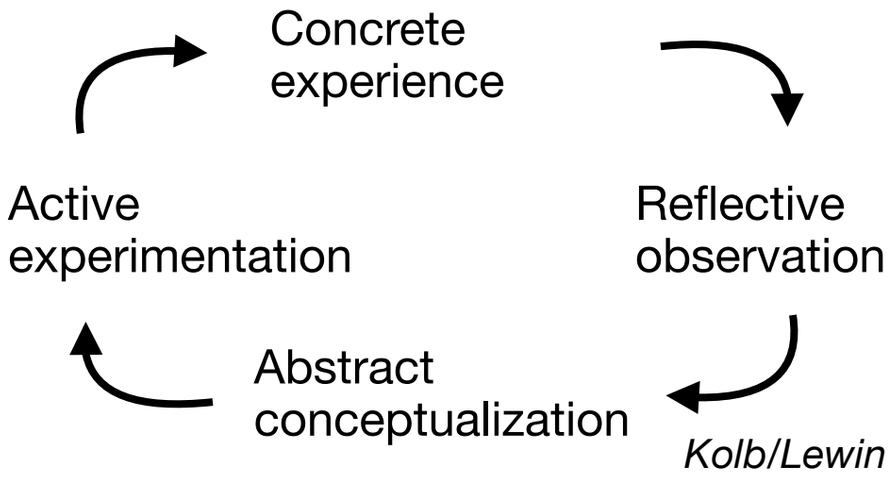
Technologies to build machines in minds

Tell me and I forget, teach me and I may remember, involve me and I learn.

Benjamin Franklin

Criticize the work, not the student

The compliment sandwich



Kolb/Lewin

Don't punish or reward

Alfie Kohn

1. Encourage contact between students and faculty
2. Develop reciprocity and cooperation among students
3. Encourage active learning
4. Give prompt feedback
5. Emphasize time on task
6. Communicate high expectations
7. Respect diverse talents and ways of learning

Chickering and Gamson

1. Gaining attention
2. Informing participants of objectives
3. Stimulating recall of prior learning
4. Presenting the content
5. Providing learning guidance
6. Eliciting performance
7. Providing feedback
8. Assessing performance
9. Enhancing retention and transfer

Gagne

Repeat after me…

Tell 'em what you are going to tell 'em, tell 'em, tell 'em what you told 'em

Learning technology

/ˈlərniNG/ /tekˈnäləjē/

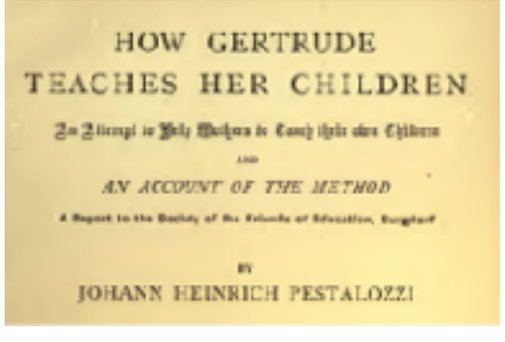
noun and verb

A technology which includes one or more pedagogies as part of its assembly

Harder pedagogies

1894

“I believe it is not possible for common popular instruction to advance a step, so long as formulas of instruction are not found which make the teacher… merely the mechanical tool of a method.”


HOW GERTRUDE
TEACHES HER CHILDREN

AN ACCOUNT OF THE METHOD

BY
JOHANN HEINRICH PESTALOZZI

https://openlibrary.org/books/OL7244777M/How_Gertrude_teaches_her_children

2010

Script for Day: 053

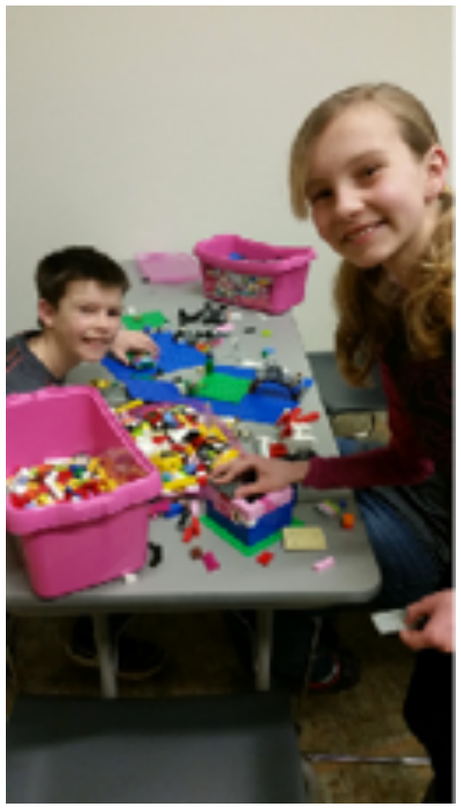
TITLE: Reading and enjoying literature/ words with “b”

TEXT: The Bath

LECTURE: Assemble students on the rug or reading area. . . . Give students a warning about the dangers of hot water. . . . Say, “Listen very quietly as I read the story.” . . . Say, “Think of other pictures that make the same sound as the sound bath begins with.”

Schwartz, B. (2015). *Why We Work*. Simon & Schuster/ TED.

Softer pedagogies



https://flic.kr/p/Er4hEx

https://flic.kr/p/iRBaxm

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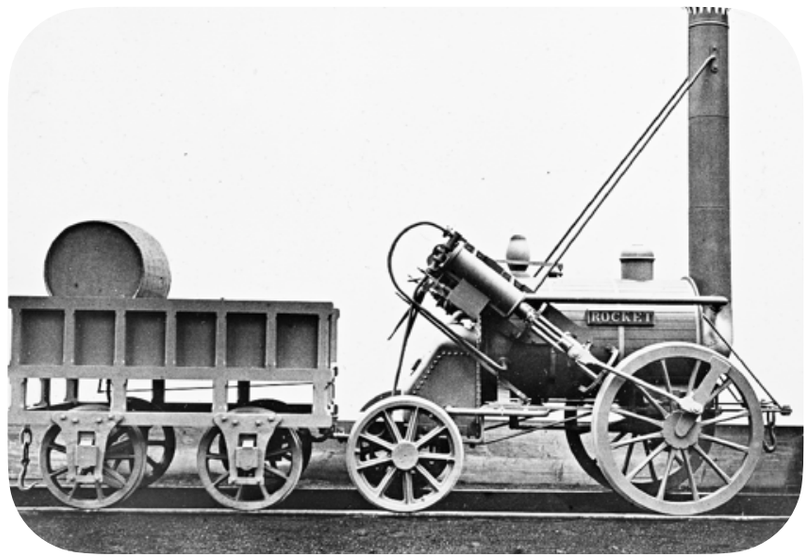
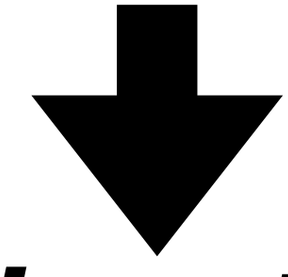
STEAM = T

Science
Technology
Engineering
Liberal **A**rts
Mathematics

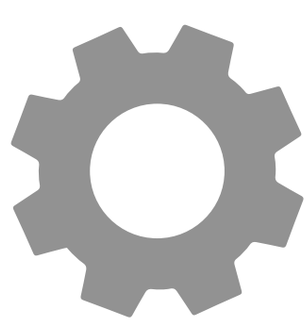


…all are technology



Organizing stuff to do stuff

Traditionally, STEM teaching tends to focus first on the **hard** components (prerequisite facts, theories, and methods) and tends to use harder pedagogies to achieve that

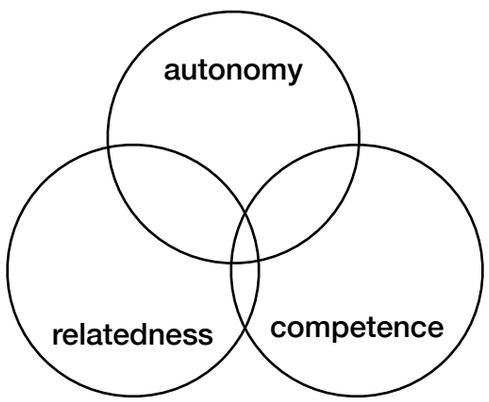


But learning facts, theories and methods is useless in itself

STEM fields, to practitioners, are soft

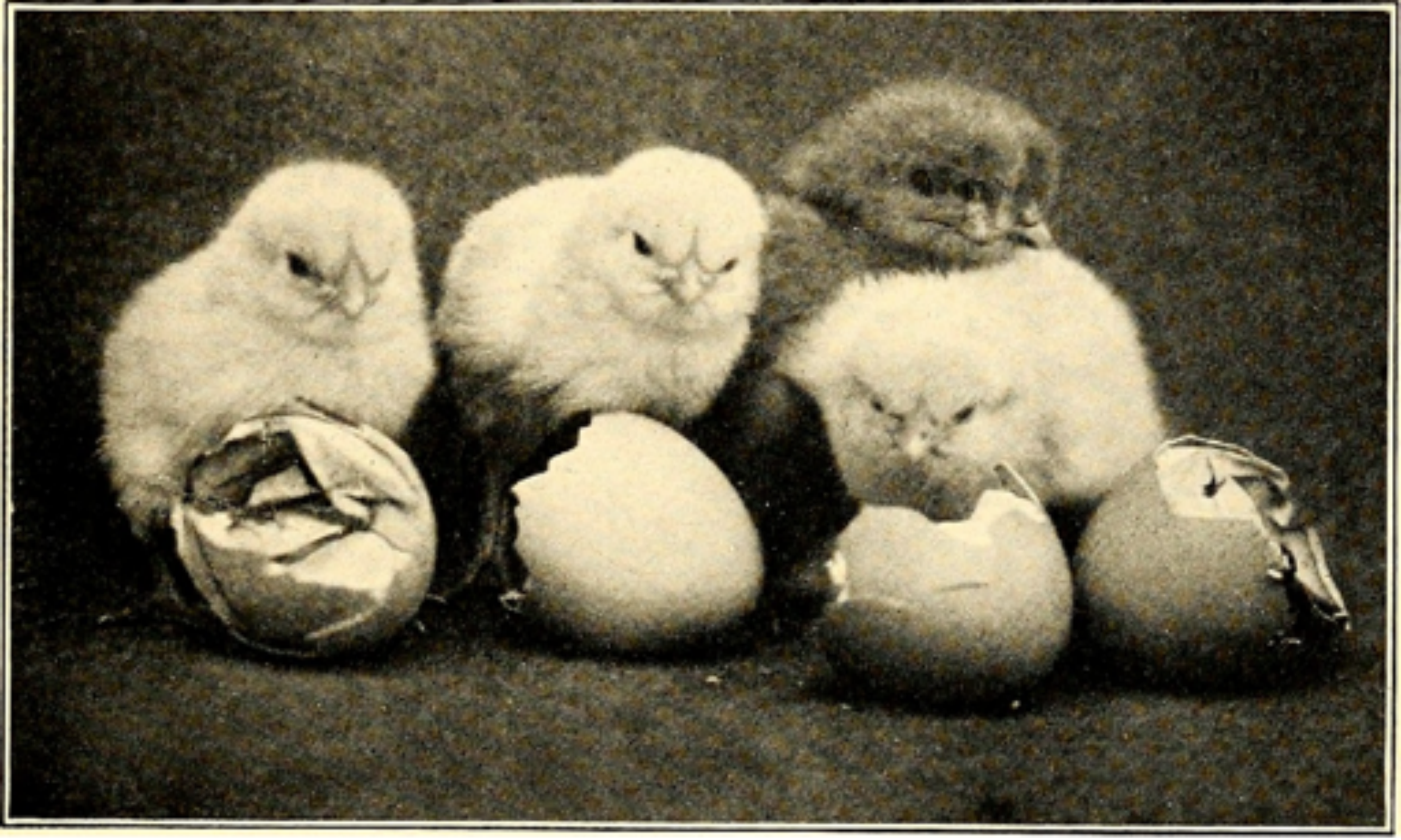
and

we learn best by *doing* things that *matter* to us, with or for *other people*, when we feel in *control*, and when it is not too difficult and not too easy (achievable *challenge*)



http://selfdeterminationtheory.org

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publications.



Chickens and eggs

Who is doing the building?

We don’t just *participate* in learning technologies.

We *co*-participate.

Not just designated teachers…

Textbook authors

Graphic designers

Institutional regulators

Application developers

Tech support staff

Curriculum designers

Learning designers

Editors

Course/ program boards

Administrators

Other students

…and, most of all,

the learners themselves

The online teaching environment

The online learning environment

The distributed teacher

Legislators

Exam boards

Architects

Universities

Amazon recommends

Semesters

Programmers

Illustrators

LMSs

Teachers

Social media

System admins

Website builders

Timetables

Computers

Textbook authors

Stack Exchange

Desks

Lecture theatres

The learner

Committees

Friends and families

People on buses

Classmates

News sources

Laboratories

Books

Cleaners

Google search

Wikipedia

Learning designers

Administrators

Teachers in classrooms *can* dictate much (but **never** all) of the technology of learning.

Teachers online *cannot.*

We must acknowledge the distributed teacher.

We *must* let go

It's not *just* about hard methods

"Everything works" (Hattie, 2013)

Equally true:

"Nothing works" (Dron, just now)

It ain't what you do, it's the way that you do it, **plus** the way everyone else does it.

Hattie, J. (2013). *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. Taylor & Francis.

Predicting learning

Being a good teacher (online or not)

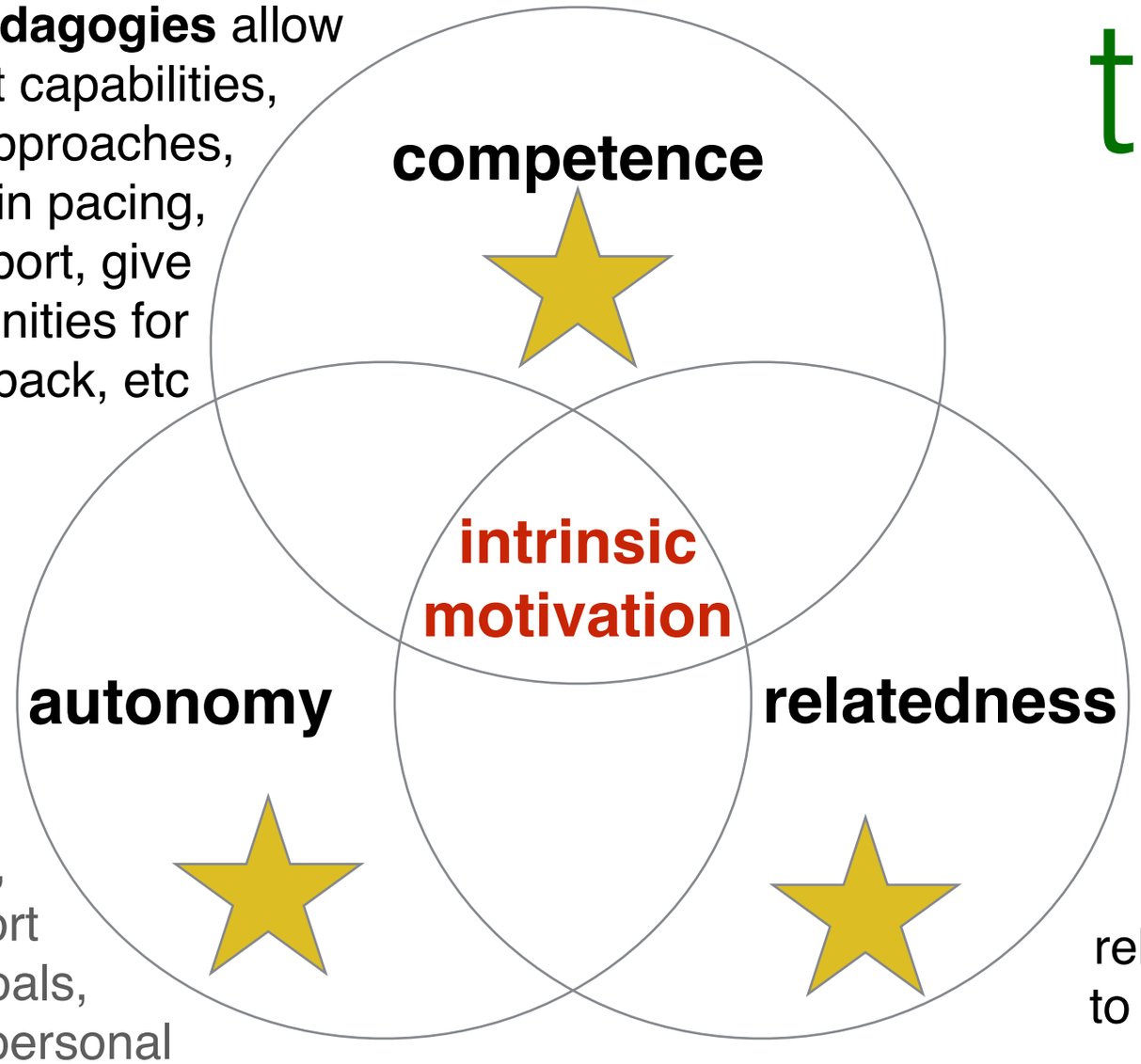
- **Caring about (and knowing about) the learners**
- **Caring about (and knowing about) learning & teaching**
- **Caring about (and knowing about) the subject you teach**

Making learning visible*
Letting go but staying close

* Hattie, J. (2013). *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. Taylor & Francis.

Effective teaching

Effective pedagogies allow for different capabilities, interests, approaches, differences in pacing, foster peer support, give opportunities for feedback, etc



Effective pedagogies let teachers show they care, help students to support one another, work together, see relevance to their communities, etc

Effective pedagogies give learners autonomy, support personal goals, show personal relevance, incorporate existing skills, etc

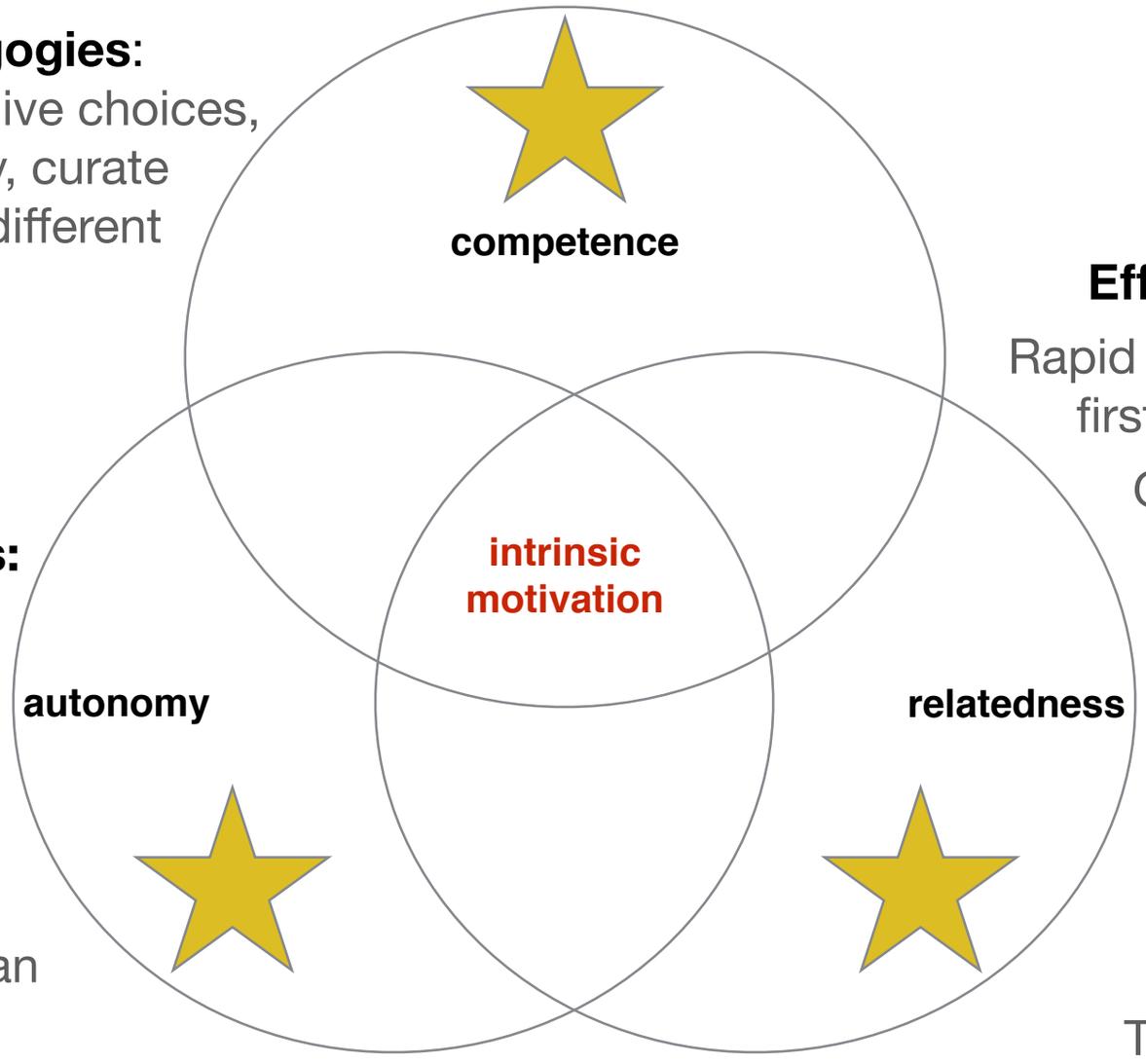
http://selfdeterminationtheory.org

Deci, E.L., & Ryan, R.M. (2000). The “What” and “Why” of goal pursuits: Human needs and the self-determination of behaviour. Psychological Inquiry, 11, 227-268

Effective online teaching

Effective pedagogies:
do not dictate, give choices, support diversity, curate resources from different sources

Effective pedagogies:
let learners use their interests and environments, allow students to help define goals, respect diversity, focus on outcomes more than process



Effective pedagogies:

Rapid response times (especially the first time)

Giving (time, attention, praise for work, responsibility)

Designs that mean students must share

Designs that make observation easier

Shared activities

Online discussions

Trust building

Personal profiles

Active online presence

http://selfdeterminationtheory.org

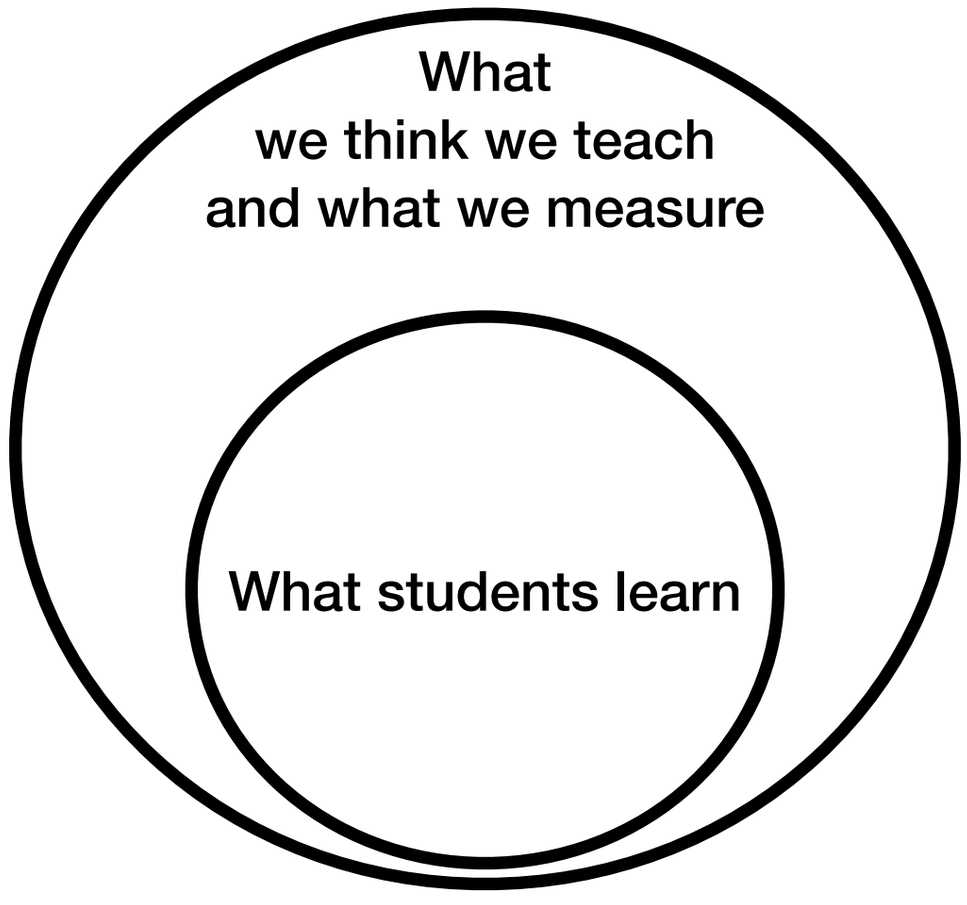
Deci, E.L., & Ryan, R.M. (2000). The “What” and “Why” of goal pursuits: Human needs and the self-determination of behaviour. Psychological Inquiry, 11, 227-268

Design to make learning visible

- shared learning diaries
- conversation
- direct observation
- learning analytics
- assignments
- etc

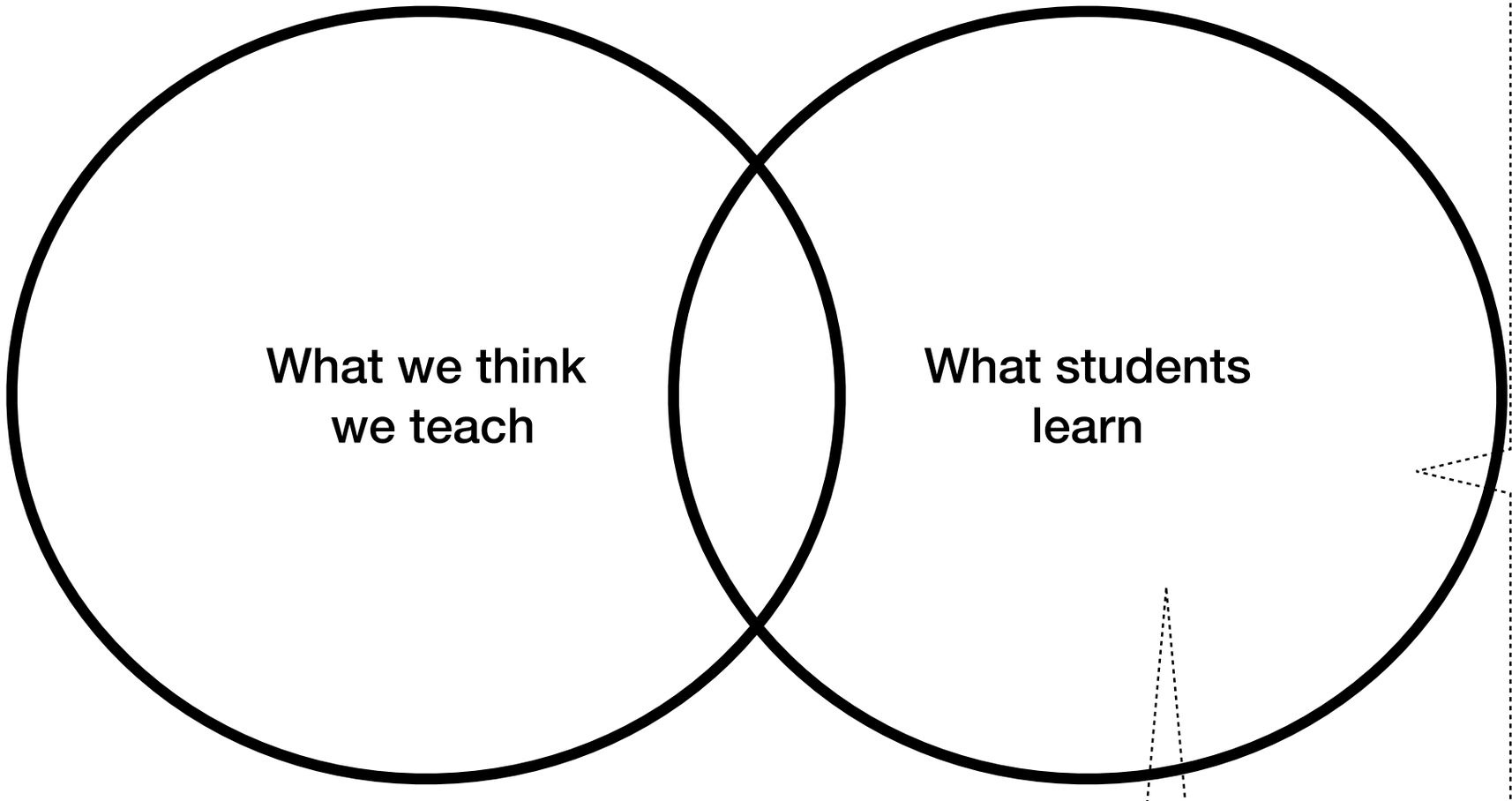
Assessing STEM subjects

The hard traditional view



Assessing STEM subjects

The soft reality



soft technologies: approaches, ways of learning, ways of thinking, ways of doing, technique, other stuff we do not explicitly teach

How should we assess this?

Generative assessment methods

e.g.

Appreciative inquiry

Outcomes harvesting

Design-based/action/participative research

Evidence, not compliance

https://appreciativeinquiry.champlain.edu/

https://www.annmurraybrown.com/post/2019/01/21/outcomes-harvesting-a-different-type-of-evaluation-method

How I do it

No assignments

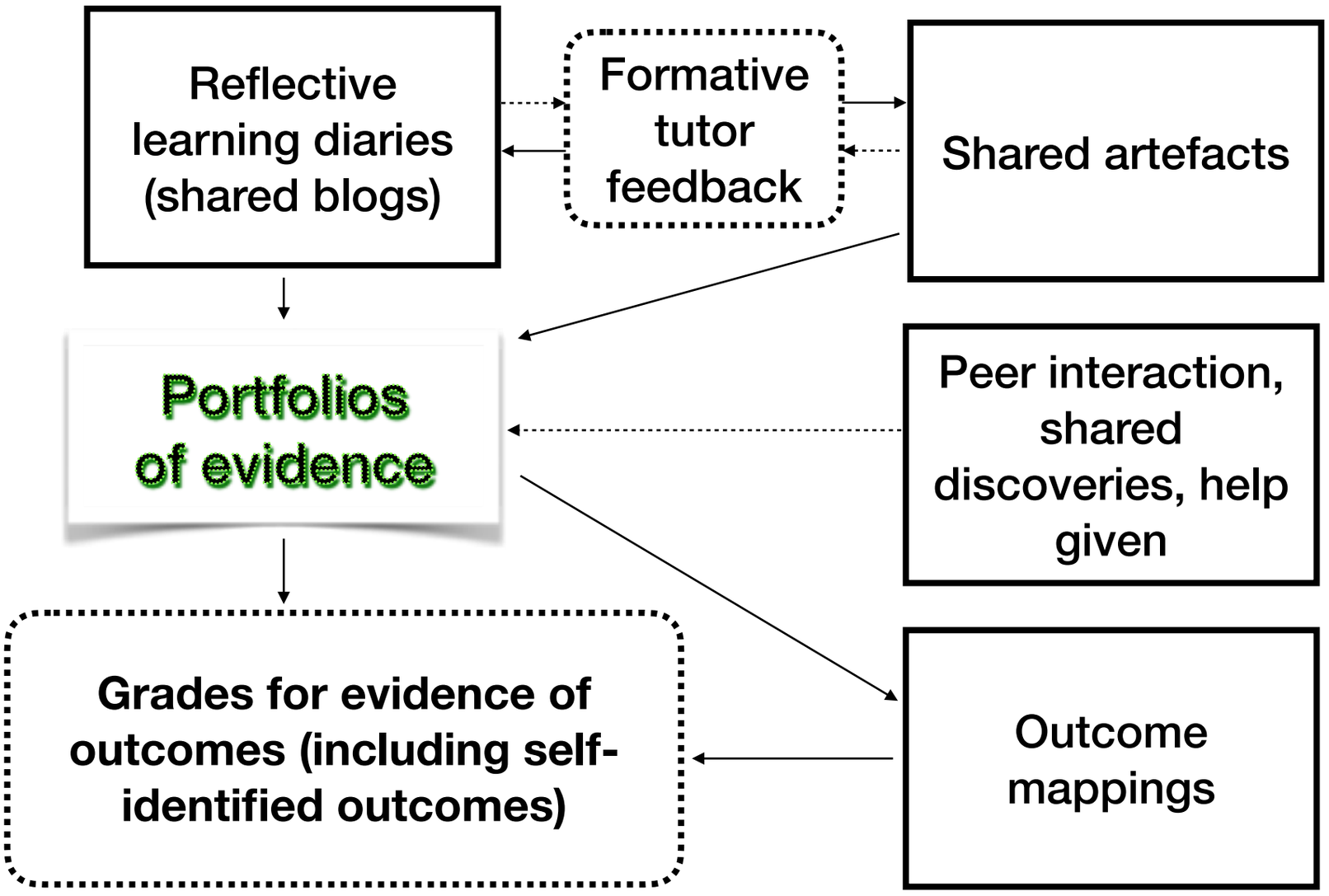
One central problem/project/ scenario, chosen by the student

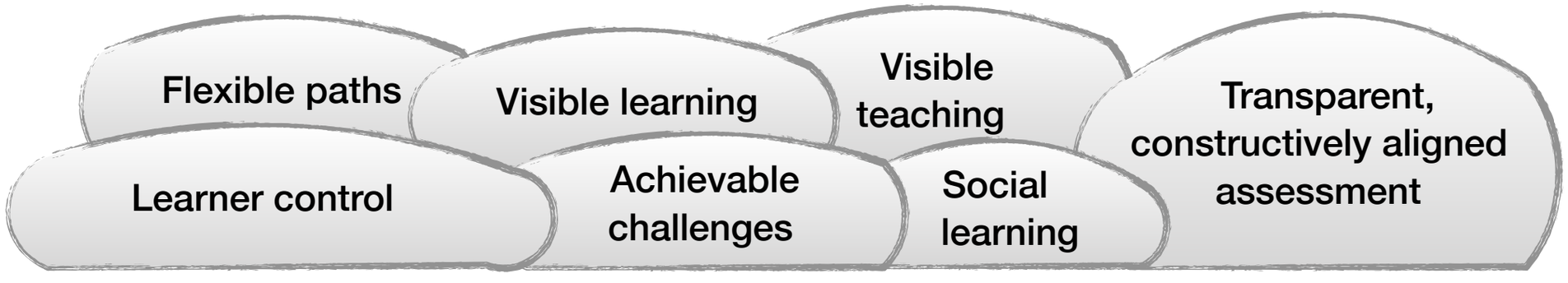
Iterative growth

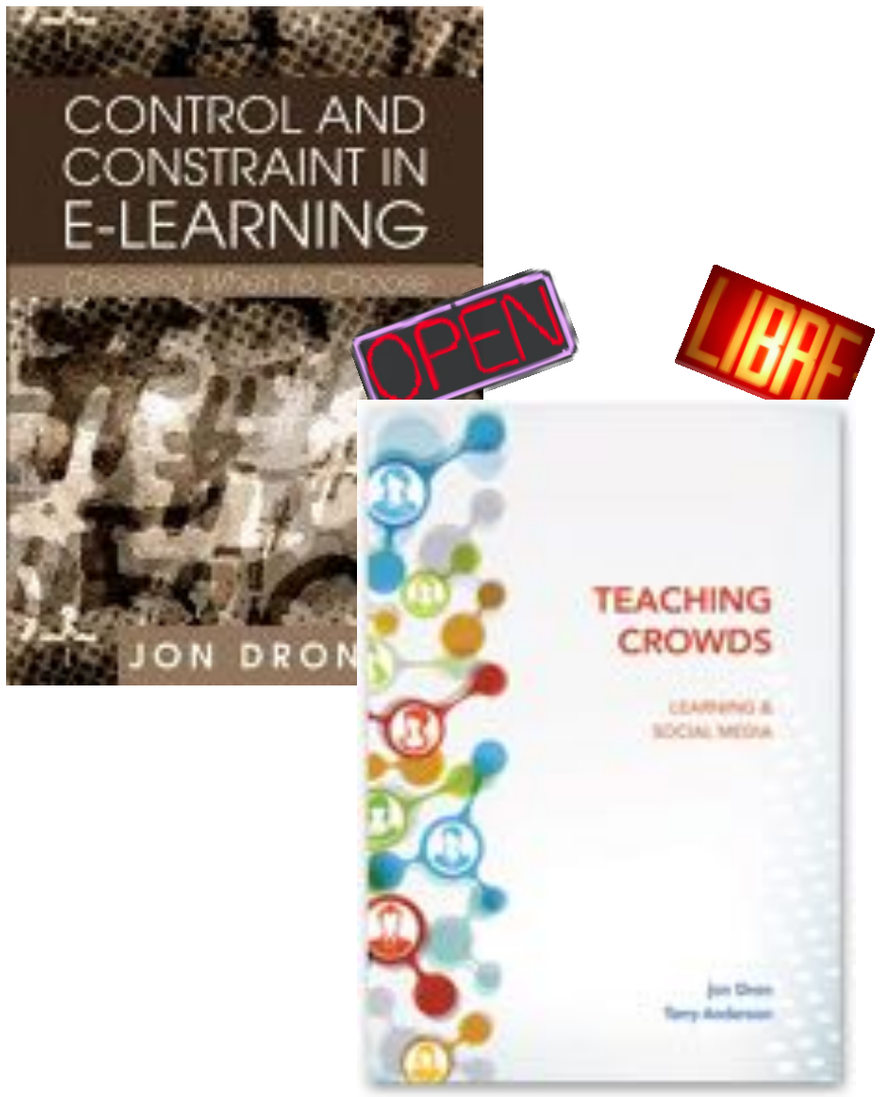
Structured process, not structured content

Choice of curated OER or Web tutorials using different pedagogies for each stage (or they find their own)

Ongoing interaction and support as needed







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https://jondron.ca

Thank you

http://teachingcrowds.ca