



HIER SIND SIE RICHTIG

(Fachgruppe Physik)

“Bildung wird in Österreich vererbt.”

“Bildung wird von Bildungsinstitutionen weitergereicht.”

“Manchmal wird pädagogisches (Pseudo-)Wissen von Bildungsinstitutionen weitergereicht.”

Rundgang ...





Institute of
Science and
Technology
Austria

RESEARCH

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May 22, 2024

Nurturing Curiosity From the Start

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Front-loading the means of participation



Unterricht?

Jean Piaget?





Lerntypen?

John Dewey?



A thick red vertical bar is positioned on the left side of the slide.

Mini-Whiteboard?

Lernpyramide?





Cold Call?

Jonathan Osborne

Cold Call

Mini-Whiteboard



Mythen ...

Flat Earth

...

...



Mythen ...

Lerntypen

Lernpyramide

Mythen ...

“Schüler:innen lernen am besten, wenn sie etwas selbst entdecken können.”

... Wegnehmen von Lernchancen

Discovery Teaching

1762, Jean-Jacques Rousseau in *Émile*

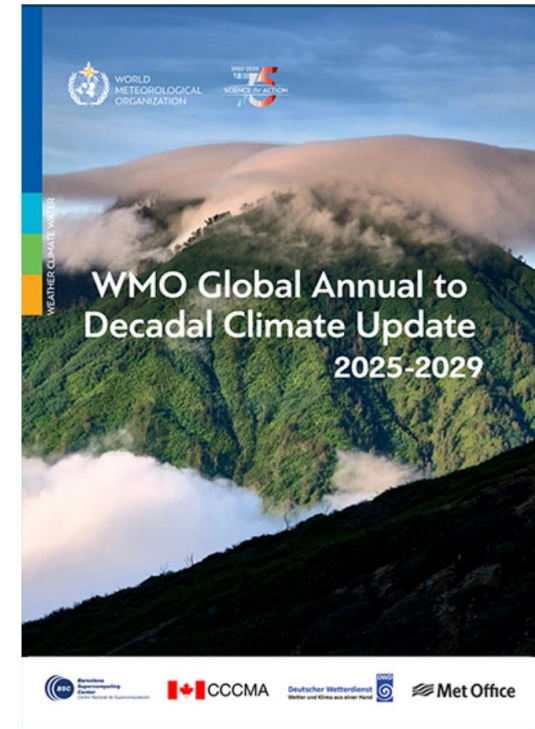
„Man soll ihm die Wissenschaft nicht beibringen, sondern er soll sie selbst entdecken!“

Das bringt uns zurück ...

“Manchmal wird pädagogisches (Pseudo-)Wissen von Bildungsinstitutionen weitergereicht.”

Sich informieren ...

Klima-Report



Sich informieren ... hilft

<https://educationendowmentfoundation.org.uk/>



Guidance report

Improving Secondary Science

First Edition • Published 21/09/2018

Who it is for

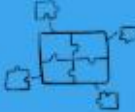
Secondary science teachers, Heads of science departments, Senior leaders

Secondary

Praxisorientiert ...

Craig Barton

<https://tipsforteachers.co.uk/>

THE TIPS FOR TEACHERS GUIDE TO Cold Call  CRAIG BARTON	THE TIPS FOR TEACHERS GUIDE TO Mini Whiteboards  CRAIG BARTON	THE TIPS FOR TEACHERS GUIDE TO Call and Respond  CRAIG BARTON	THE TIPS FOR TEACHERS GUIDE TO Turn and Talk  CRAIG BARTON
THE TIPS FOR TEACHERS GUIDE TO Checking for Listening  CRAIG BARTON	THE TIPS FOR TEACHERS GUIDE TO Checking for Understanding  CRAIG BARTON	THE TIPS FOR TEACHERS GUIDE TO Responsive Teaching  CRAIG BARTON	THE TIPS FOR TEACHERS GUIDE TO Diagnostic Questions  CRAIG BARTON
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THE TIPS FOR TEACHERS GUIDE TO Independent Practice  CRAIG BARTON	THE TIPS FOR TEACHERS GUIDE TO Purposeful Practice and Problem-Solving  CRAIG BARTON	THE TIPS FOR TEACHERS GUIDE TO Low-Stakes Quizzes  CRAIG BARTON	THE TIPS FOR TEACHERS GUIDE TO Observing Lessons and Coaching  CRAIG BARTON

Ein drittes Mal kehren wir zurück ...

“Manchmal wird pädagogisches (Pseudo-)Wissen von Bildungsinstitutionen weitergereicht.”

Auf das Wesentlichste heruntergebrochen ...

Behauptung:

In der Physik geht es nicht darum, etwas auswendig zu lernen!

In der Physik geht es darum, etwas zu verstehen!

Diese starkste Behauptung führt uns leider in ein kleines Problem ...

Welche physikalische Größe hat die Einheit **Joule pro Kelvin**?

Ähh ... Kevin wer???

Joule ???

Was Bro ???

Joule ...

Dimensionsanalyse ohne Basiswissen?

Auswendig gelerntes Wissen

oder

Inflexibles Wissen

Zuerst brauche ich ein paar Bausteine,
damit ich mir überhaupt etwas
“zusammendenken” kann.

Jonathan Osborne

Critical Thinking

I can't think critically about something if I don't have something to think about.

Habe ich aber ein paar Bausteine, **dann** ...

kann ich lernen diese zu verknüpfen.

(nicht alleine, aber unter guter Anleitung sehr wohl).

Beispiele ...

Atome ...

(Ch / Ph)

Hauptstadt von Italien - Rom ...

Römisches Reich

You can't connect the dots
if you don't have any!

Paul Kirschner



Paul A. Kirschner

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Emeritus Professor (Educational Psychology), [Open University of the Netherlands](#)
Verified email at ou.nl - [Homepage](#)

[Instructional Design](#) [Educational Psychology](#) [Educational Technology](#) [Computer Supported Colla...](#)

John Sweller



J. Sweller

Publications 293

h-index 97

Citations 79,331

Highly Influential Citations 5,253

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Efrat Furst



EfratFurst

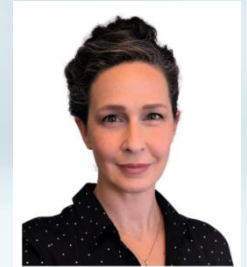
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Bridging Cognitive Science & Education



Epistemology or Pedagogy, That Is the Question

Paul A. Kirschner Utrecht University

Cognitive Architecture and Instructional Design

**John Sweller,^{1,4} Jeroen J. G. van Merriënboer,² and
Fred G. W. C. Paas³**

Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching

Paul A. Kirschner

*Educational Technology Expertise Center
Open University of the Netherlands
Research Centre Learning in Interaction
Utrecht University, The Netherlands*

John Sweller

*School of Education
University of New South Wales*

Richard E. Clark

*Rossier School of Education
University of Southern California*

Why cognitive science matters in education: three reasons

My perspective on why the science of learning is important for teachers



EFRAT FURST

JAN 31, 2026



Retrieval Practice

Explicit Instruction

Interleaving

Spaced Learning

Desirable Difficulties

Retrieval Practice

Reaktion in Österreich ...

Unverständnis

“Kleinschrittiger Unterricht”

“Sinnloses Auswendig lernen”

Erneuter Erklärungsversuch ...

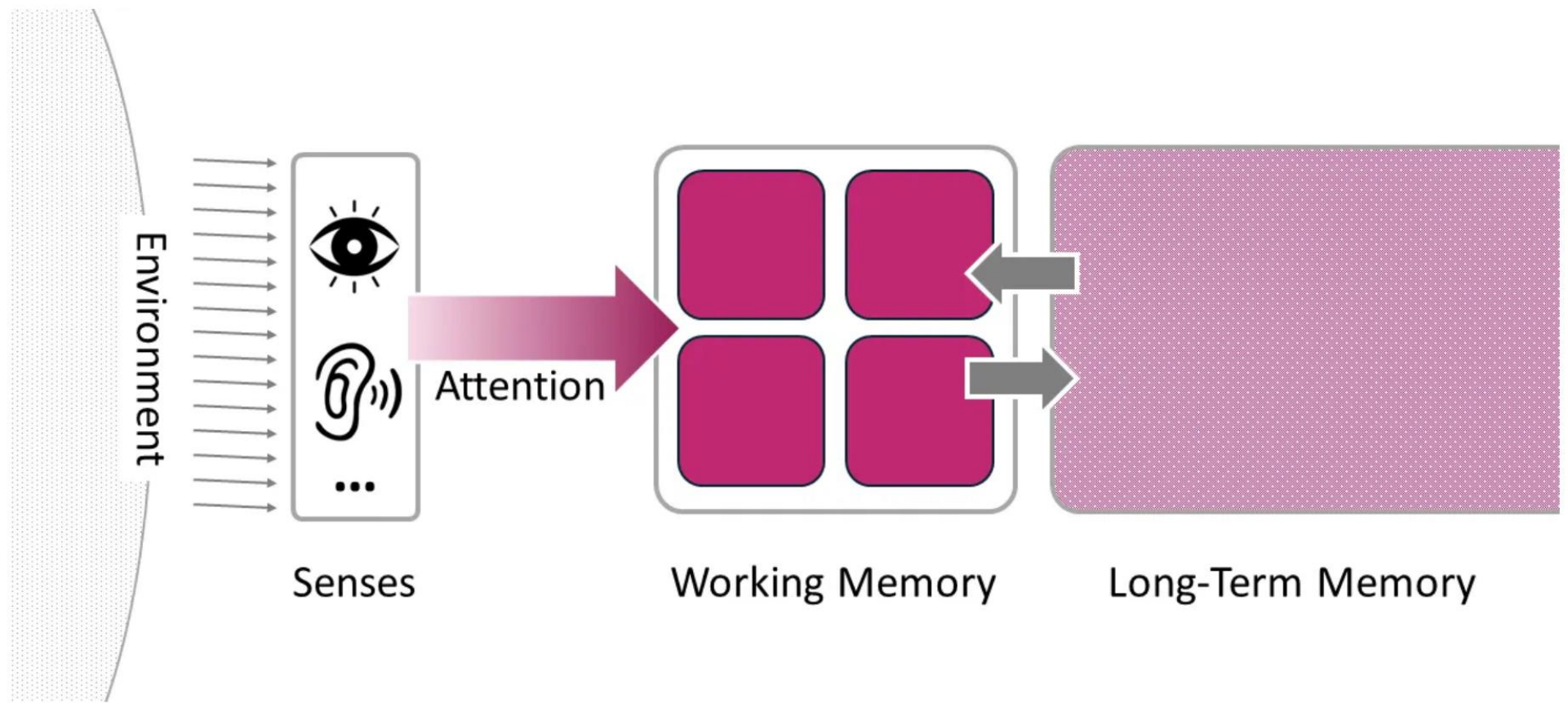
Learning is, by its nature, a constructive cognitive process.

Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching

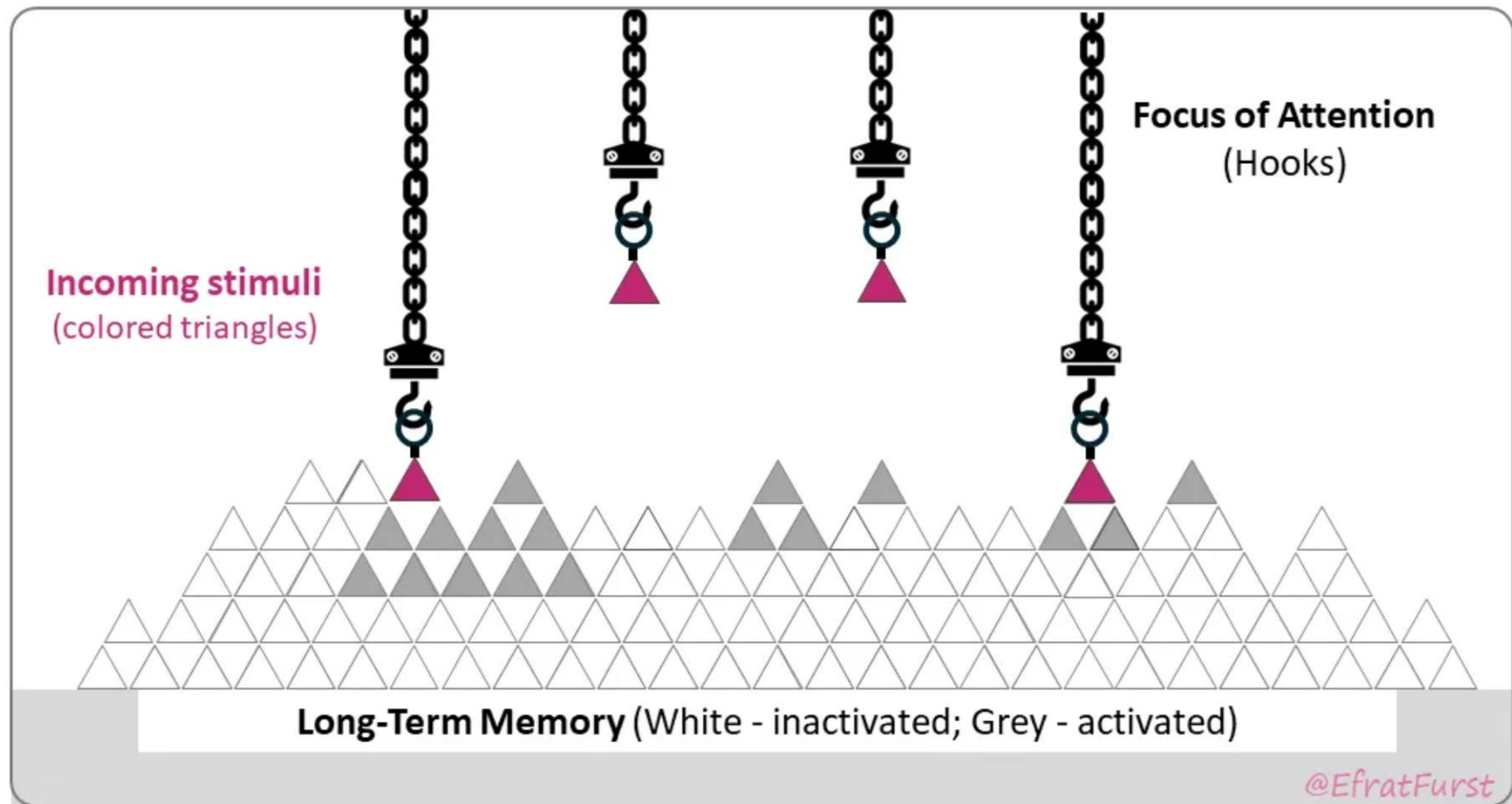
“Aus der Echokammer” ...

- Learning is constructive.
- Therefore, knowledge cannot be transmitted.
- Therefore, **explicit instruction is ineffective.**
- Therefore **should** teachers minimise or even avoid explicit/direct instruction.
- Therefore **should** teachers should not teach, but merely facilitate and let students create their “own” knowledge.

“Constructivism is a learning theory that explains how learners ***actively*** construct mental representations (schemas) by integrating new information with their existing knowledge.”
(Some definitions add to this: through personal experience and interaction with the environment.)



Atkinson and Shiffrin in 1968



Working Memory = everything that currently works

You can't connect the dots if you don't
have any!

Ein viertes Mal kehren wir zurück ...

“Aus der Echokammer” ...

“Manchmal wird pädagogisches (Pseudo-)Wissen von Bildungsinstitutionen weitergereicht.”

INVESTIGATIVE SCIENCE LEARNING ENVIRONMENT

Helping students learn physics by thinking and acting like scientists.

The ISLE Approach

E. Etkina, D. T. Brookes, G. Planinsic

Man wird nicht MedizinerIn, nur weil man einen weißen Mantel anzieht.

(... oder die professionelle Arbeitsweise von MedizinerInnen nachahmt)

INVESTIGATIVE SCIENCE LEARNING ENVIRONMENT

Helping students learn physics by thinking and acting like scientists.

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E. Etkina, D. T. Brookes, G. Planinsic

Epistemology or Pedagogy, That Is the Question

Paul A. Kirschner Utrecht University



Marco Odermatt, fährt Ski der Schweizer Marke Stöckli

“Constructivism is a learning theory that explains how learners ***actively*** construct mental representations (schemas) by integrating new information with their existing knowledge.”

So ...

Do pupils construct their own knowledge?

NEIN.

SchülerInnen konstruieren **NICHT** Gasgesetze, Fallgesetze oder das Wechselwirkungsgesetz.

Dies sind die Ergebnisse jahrhundertelanger gemeinsamer Forschung und einer immensen gemeinsamen Wissensbasis und gemeinsamer Anstrengung.

(... und folglich auch Grund dafür, dass es Schulen gibt).

Do students construct mental schemas?

Natürlich!

Pupils construct **no** public knowledge. They construct **private understanding of public knowledge**.

(Paul Kirschner)

One of the most persistent myths in education is the assumption that explicit instruction somehow prevents learning from being constructive.

Well, it doesn't.

(Paul Kirschner)

For students to learn, teachers must teach.

(... and not only facilitate – as it often happens)

INSTRUCTIONAL ILLUSIONS

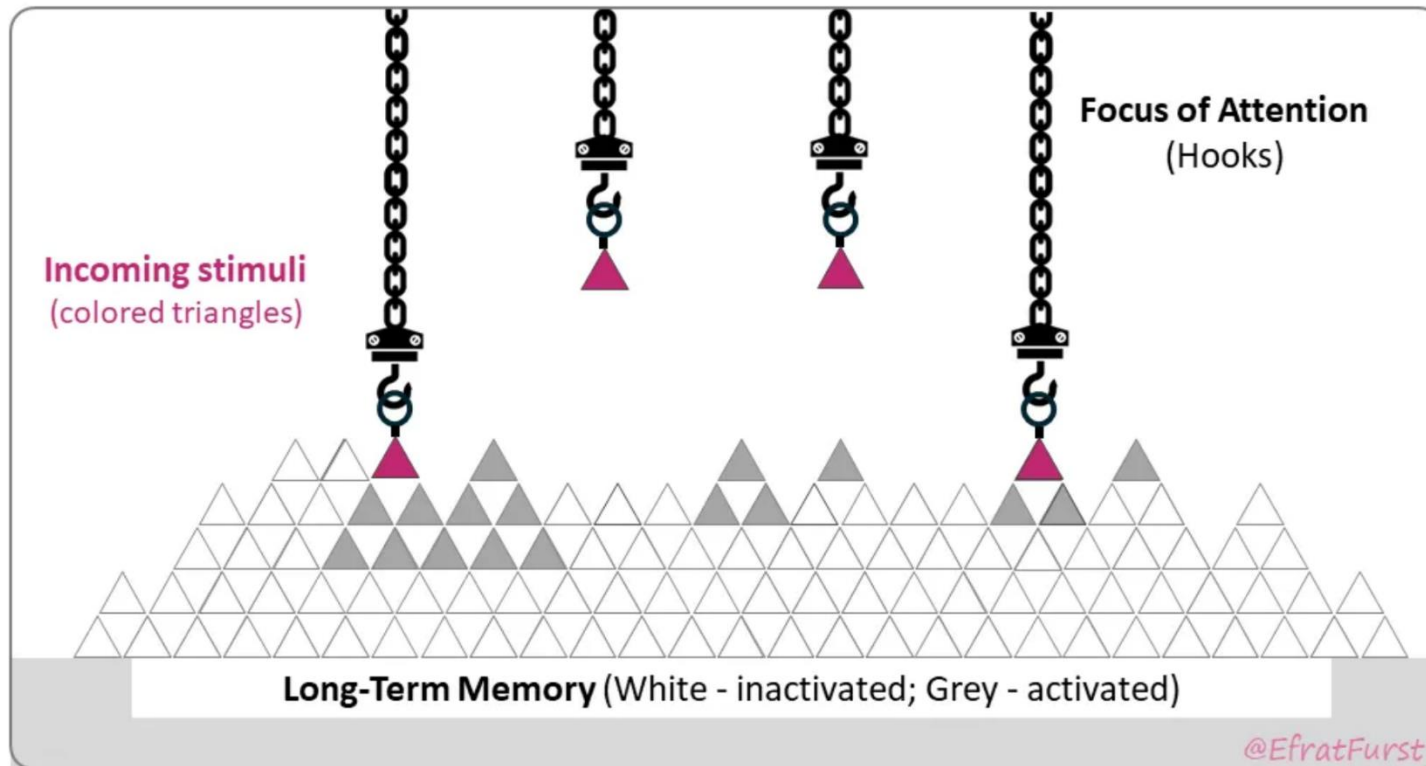
Things that look like learning often aren't.

Was wir sehen $\neq$ was SchülerInnen lernen

Visible

- . Activity**
- . Engagement**
- . Confidence**
- . Correct answers**
- . Enjoyment**
- . Performance**

Erfolgreiches Lernen = Aufbau einer stark vernetzen Wissensbasis



Working Memory = everything that currently works

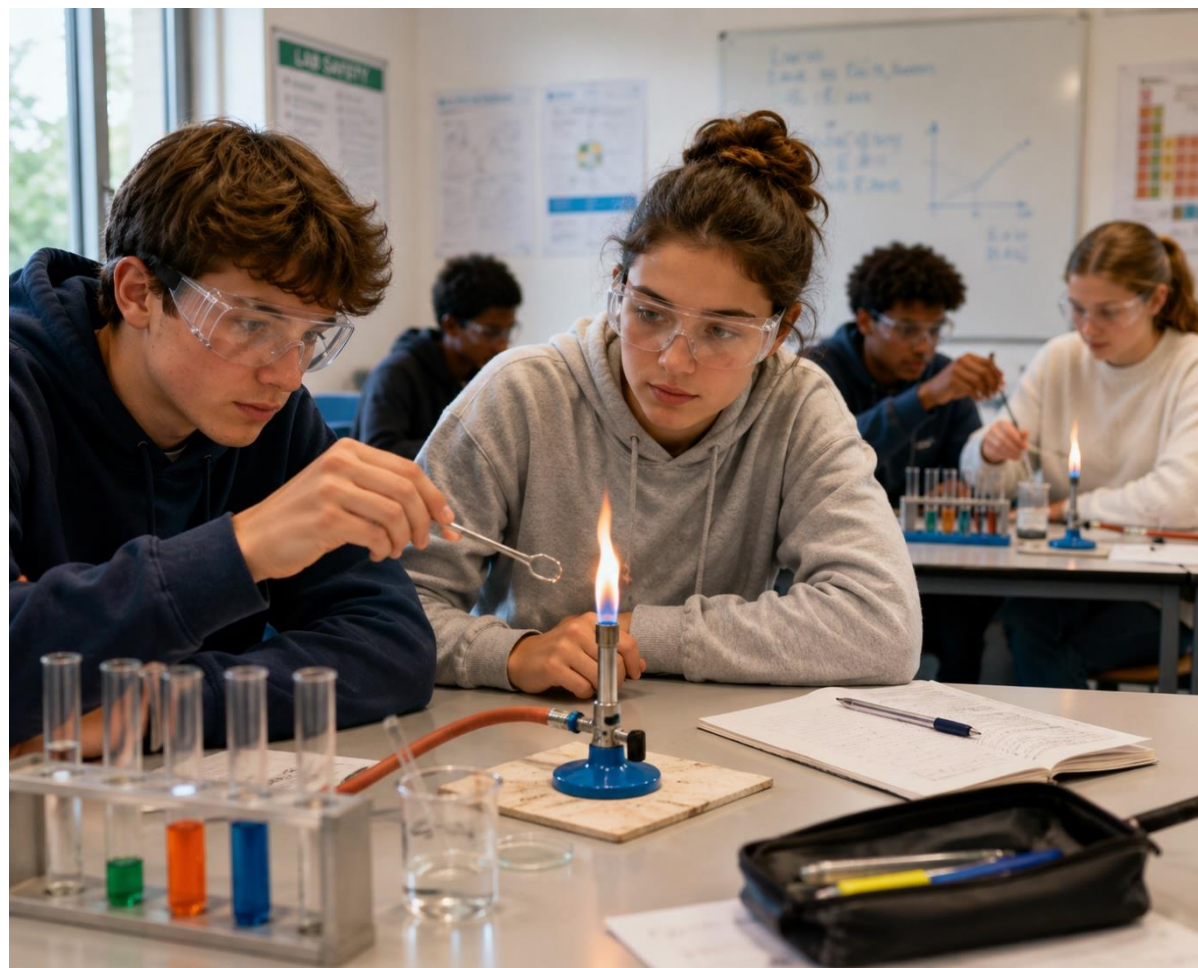
Der sichtbare Teil des Unterrichts ...

*kann durchaus schlechte Indizien für das
Lernen der SchülerInnen liefern.*

“poor proxies of learning” (Robert Coe)

Poor Proxies for Learning

- Students are busy: lots of work is done (especially written work)
- Students are engaged, interested, motivated
- Students are getting attention: feedback, explanations
- Classroom is ordered, calm, under control
- Curriculum has been 'covered' (ie presented to students in some form)
- (At least some) students have supplied correct answers, even if they
 - Have not really understood them
 - Could not reproduce them independently
 - Will have forgotten it by next week (tomorrow?)
 - Already knew how to do this anyway



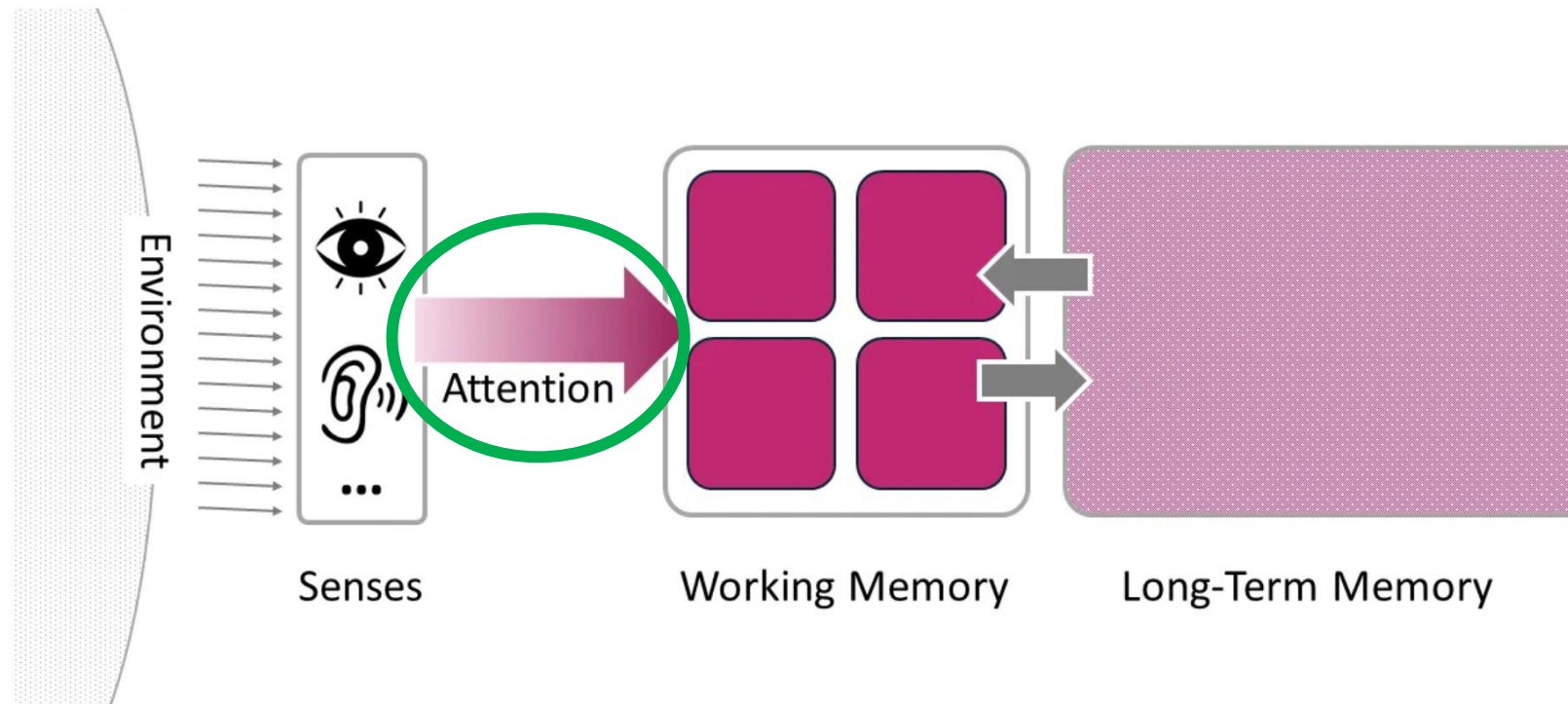
Idealisiertes Bild vs. reale Klassenraumsituation

- **“stinkt!”**
- **“mein Kugelschreiber!”**
- **“Fenster auf!”**
- **Lehrer: Feuermelder?**

Wo sind die Gedanken (sowohl Lehrperson als auch SchülerInnen)?

Begeisterte SchülerInnen überzeugen auch ihre Eltern ...

Aktiv $\neq$ kognitive aktiv



Don't confuse an active classroom with an active mind.

Students may be:

- active and busy
- discussing and collaborating
- enjoying the activity
- producing data from measurements

...but still **not thinking deeply about the knowledge or concepts they are supposed to learn.**

“When performing a cognitive task requiring domain-specific knowledge, **the presence or absence of knowledge** is the best predictor of performance.”

(John Sweller)

“A knowledge-rich curriculum, explicit instruction, retrieval practice and spacing, and with honest training about the gap between how learning feels and how learning works, and you might have something.”

(Carl Hendrick)



Retrieval Practice

Explicit Instruction

Interleaving

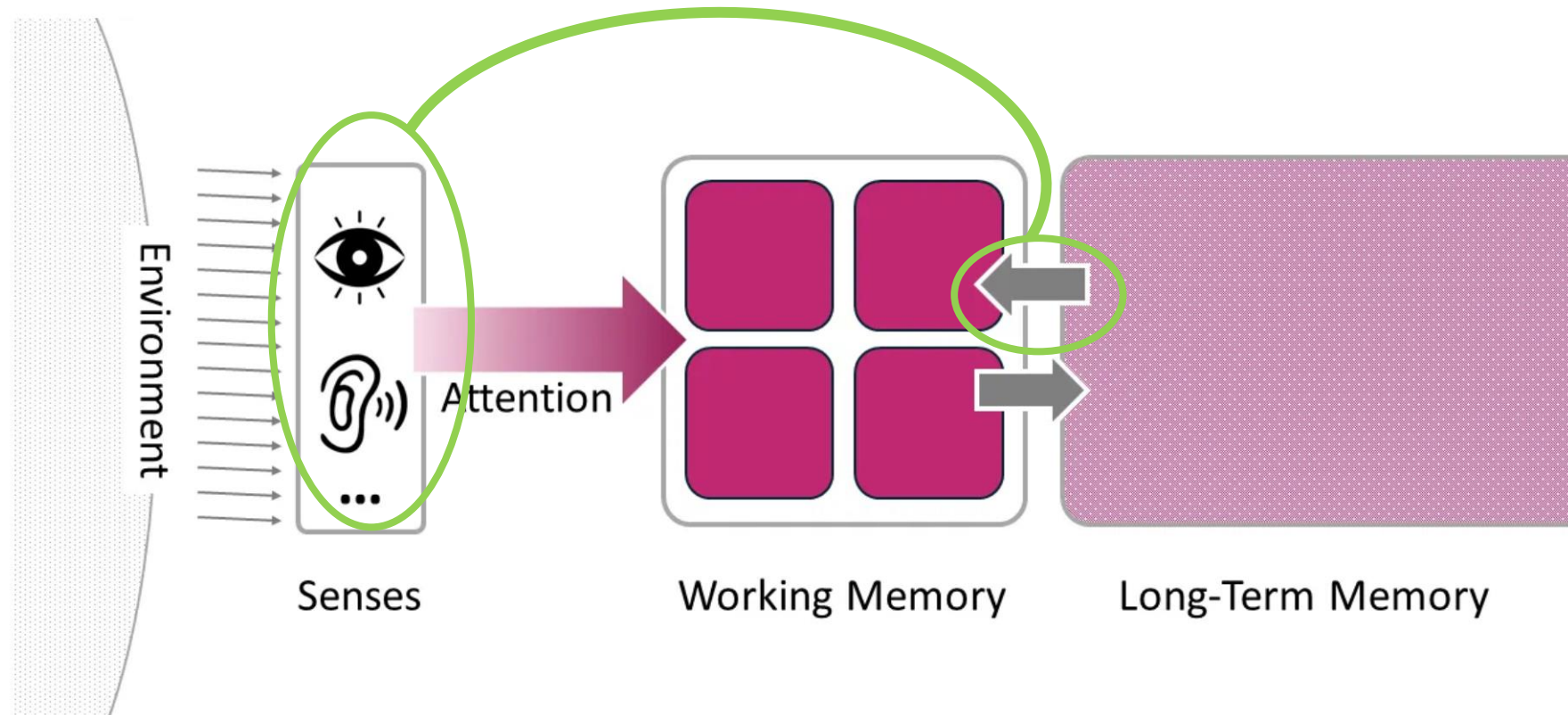
Spaced Learning

Desirable Difficulties

Students need to **retrieve, think & explain their learning**, but these capacities develop through knowledge, guidance and practice.

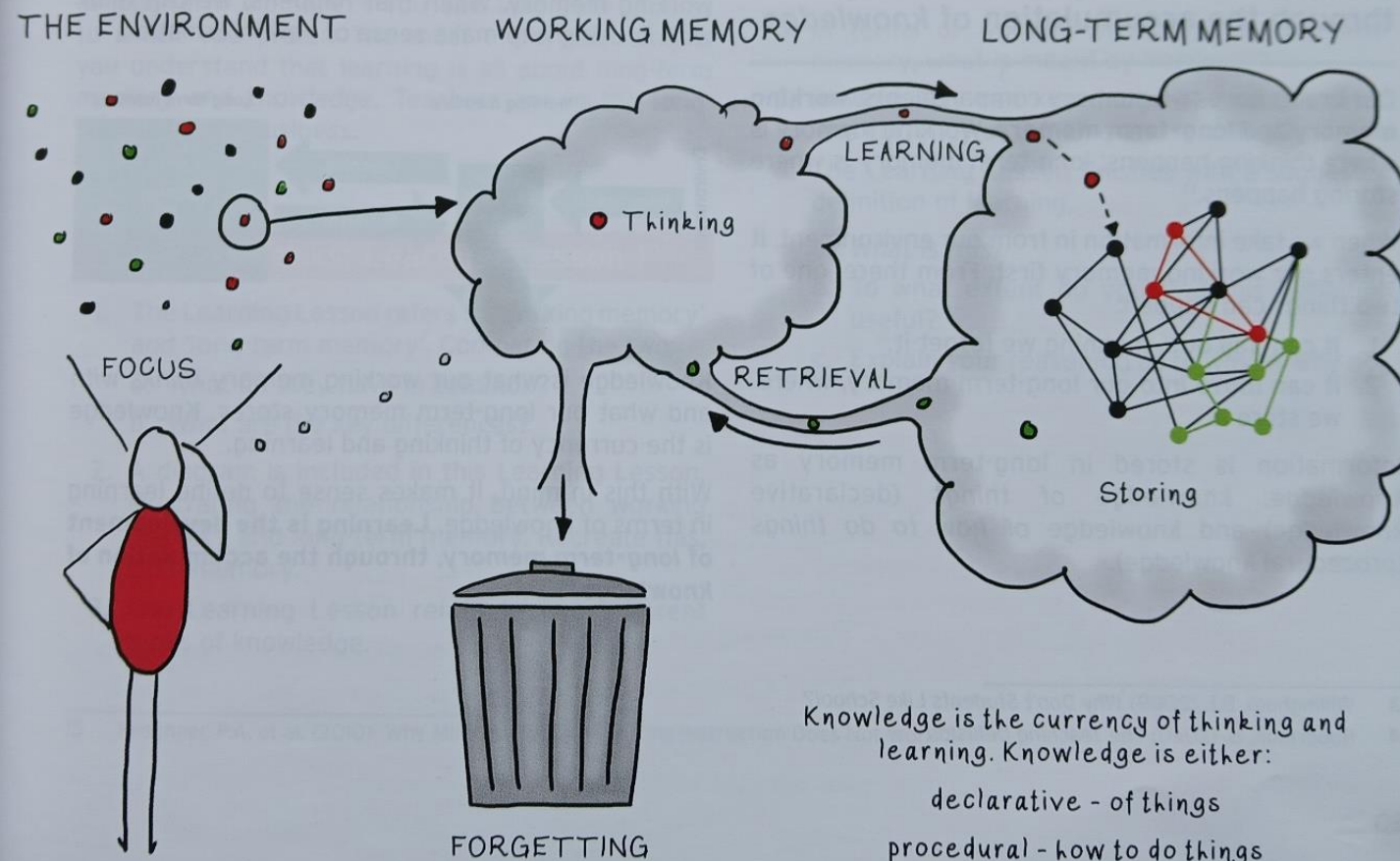
Lehrerrolle:

Connect new information to students' prior knowledge.



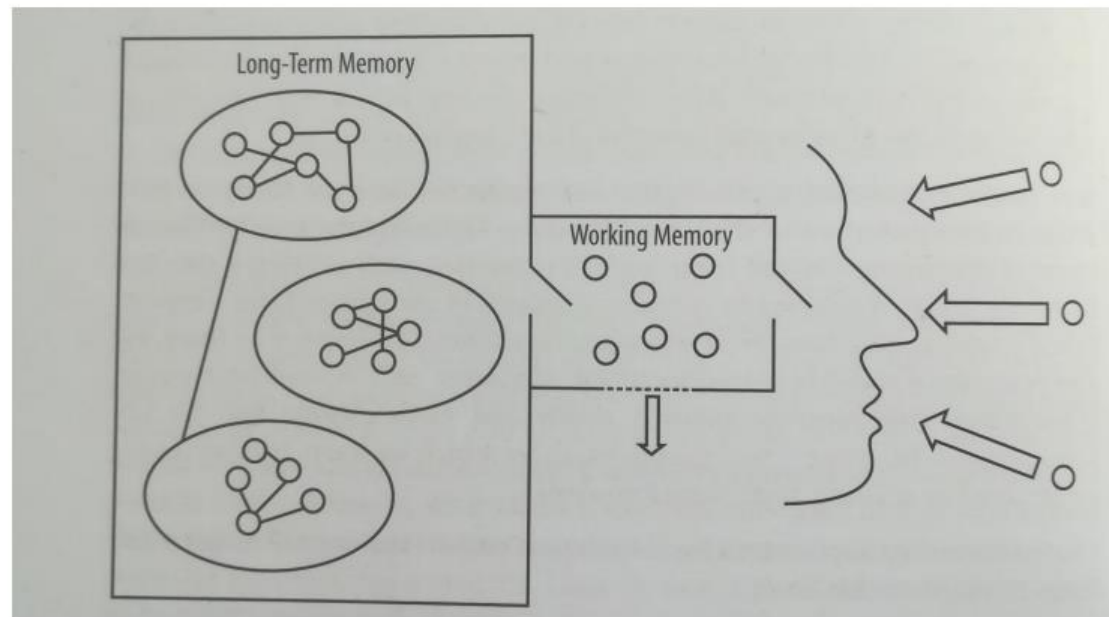
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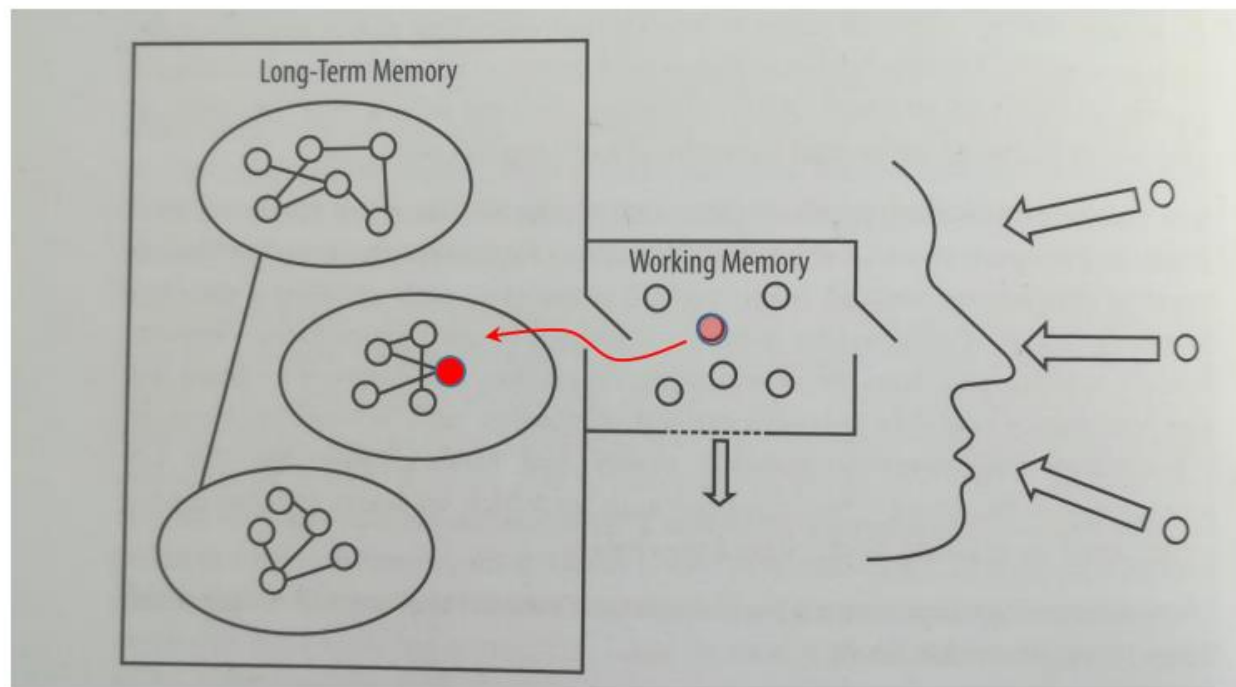
LEARNING IS THE DEVELOPMENT OF LONG-TERM MEMORY
THROUGH THE ACCUMULATION OF KNOWLEDGE.



DAMIT das DENKEN funktioniert braucht es ...

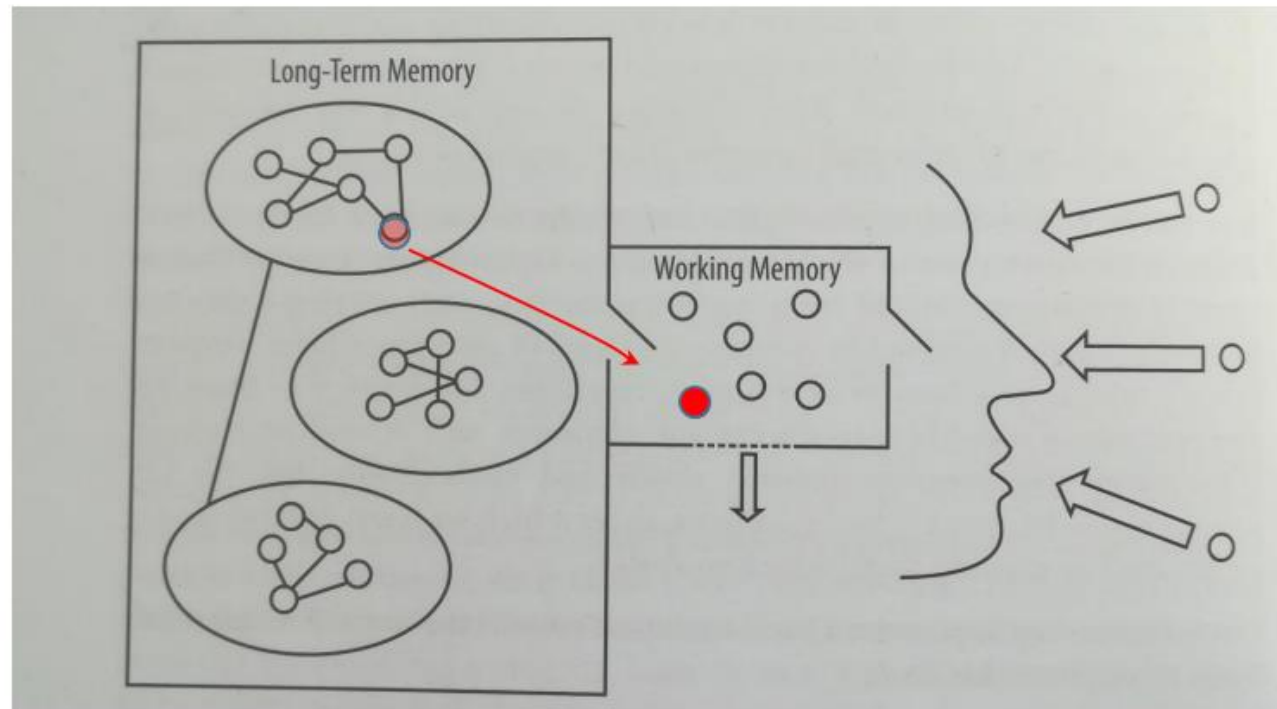
1. Die notwendigen Informationen aus der Umwelt
2. Das notwendige Hintergrundwissen aus dem „Hinterstübchen“
3. Den verfügbaren Platz im Arbeitsgedächtnis





„Einbetten in ein bereits bestehendes Schema, Beispiel
Hochzahlen“

“Understanding is remembering in disguise”



„RETRIEVAL PRACTICE“

„sich etwas – wiederholt – ins Gedächtnis rufen“

OHNE Hilfsmittel / „closed books“

So what?

“Low-stakes” Überprüfung
(“testing – effect | retrieval practice”)
(Mini-Whiteboards)

**Epistemology or Pedagogy, That Is
the Question**

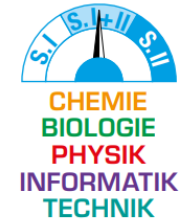
Kirschner oder Sweller?

A solid red vertical bar is positioned on the left side of the slide.

Student independence isn't the starting point; it's the destination.

Students become more autonomous as their knowledge grows.

Die 2:1-Unterrichtsmethode für Naturwissenschaft, Technik und Informatik



NIKOLAUS ALBRECHT

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GRIP - Guided Retrieval in Physics

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<https://klausalbrecht.substack.com/about>



Scientists do science,
Students learn science.

(Derek Hodson)

...and that is a big difference

(Students are not Scientists)