



UiO : **Department of Physics**
University of Oslo

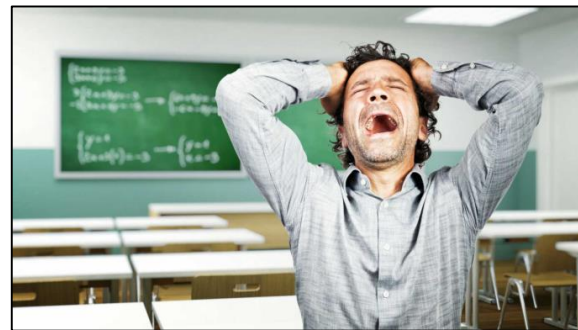
Decompiling Knowledge to Distill Learning Goals

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REAL Undervisning
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DECOMPILING KNOWLEDGE

A Common Teaching Problem



Why don't my students get this?
It seems so simple!

Bad teacher?

Not working hard
enough?

Just dumb?

What's going on here?

Cognitive Compilation

Long term memory

Working (short term)
memory

Limited: 7 ± 2 things at a time [1]

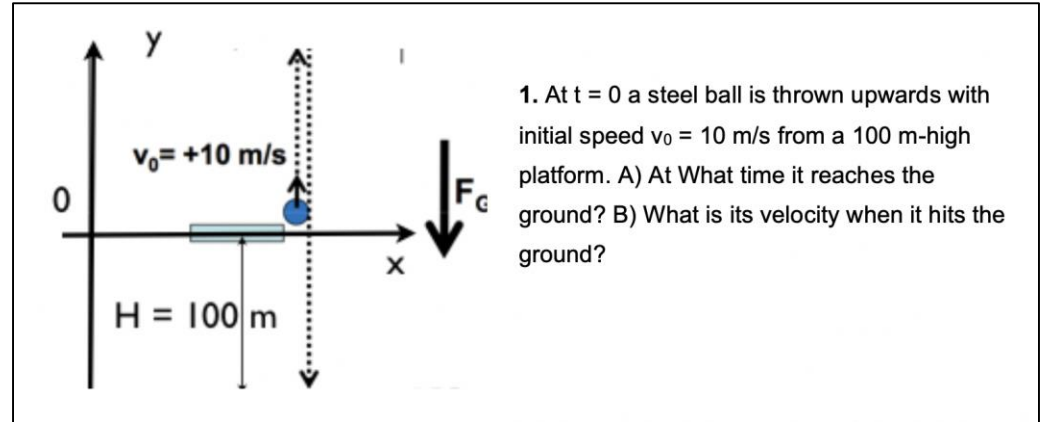
Overcome limitation by
Compiling knowledge



Examples of Cognitive Compilation



Chess [2]

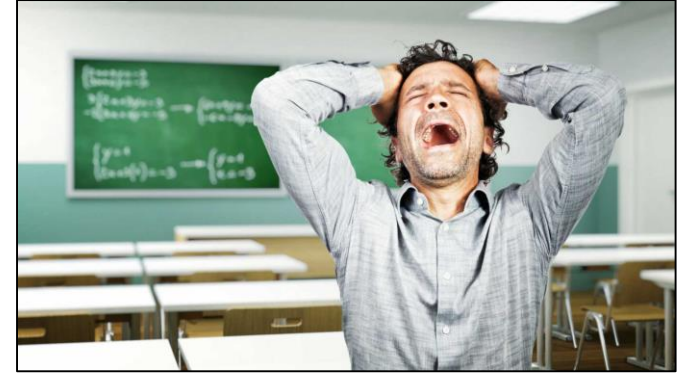


1. At $t = 0$ a steel ball is thrown upwards with initial speed $v_0 = 10 \text{ m/s}$ from a 100 m-high platform. A) At What time it reaches the ground? B) What is its velocity when it hits the ground?

Physics Problem-Solving [3]

A Challenge for Teachers

Compilation is useful for experts...
...but can be a **challenge** for teachers



Teachers who ignore their own compilation risk

- Skipping crucial details
- Losing sight of challenges
- Packing too much content into a single lesson

Decompiling Knowledge: “Breaking apart”
problems or ideas into their constituent pieces

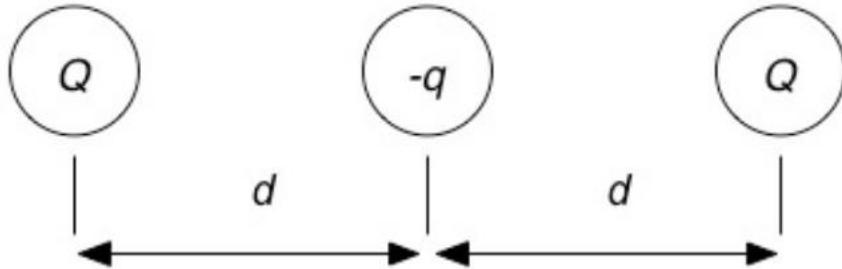
Decompilation Activity Setup

Instructions:

1. Get into groups of 4-6, based on your closest discipline (math, physics, bio, chemistry, etc.)
2. Pick up posterboard, sticky notes, science problem
3. **Briefly** discuss how you would solve this problem

Decompilation Activity

Goal: “reverse-engineer” the knowledge required to solve a “simple” science problem



A particle with a negative charge $-q$ is exactly between two identical particles with equal, positive charge Q . If you moved the particle in the middle a tiny bit to the right, what would be the direction of the total force on it by the other two charges?

- $E_e = k \frac{Q_1 Q_2}{r^2}$
 - Charge comes in + and -
 - Like charges repel, unlike attract
 - Force increases with charge
 - Equilibrium is...
- ...etc.

DISTILLING LEARNING GOALS

Learning Goals

Learning goal: the core skills or ideas in a lesson/set of lessons

Characteristics of good learning goals:

- 1-2 per lesson
- Compact (1 sentence or skill)
- Recurring

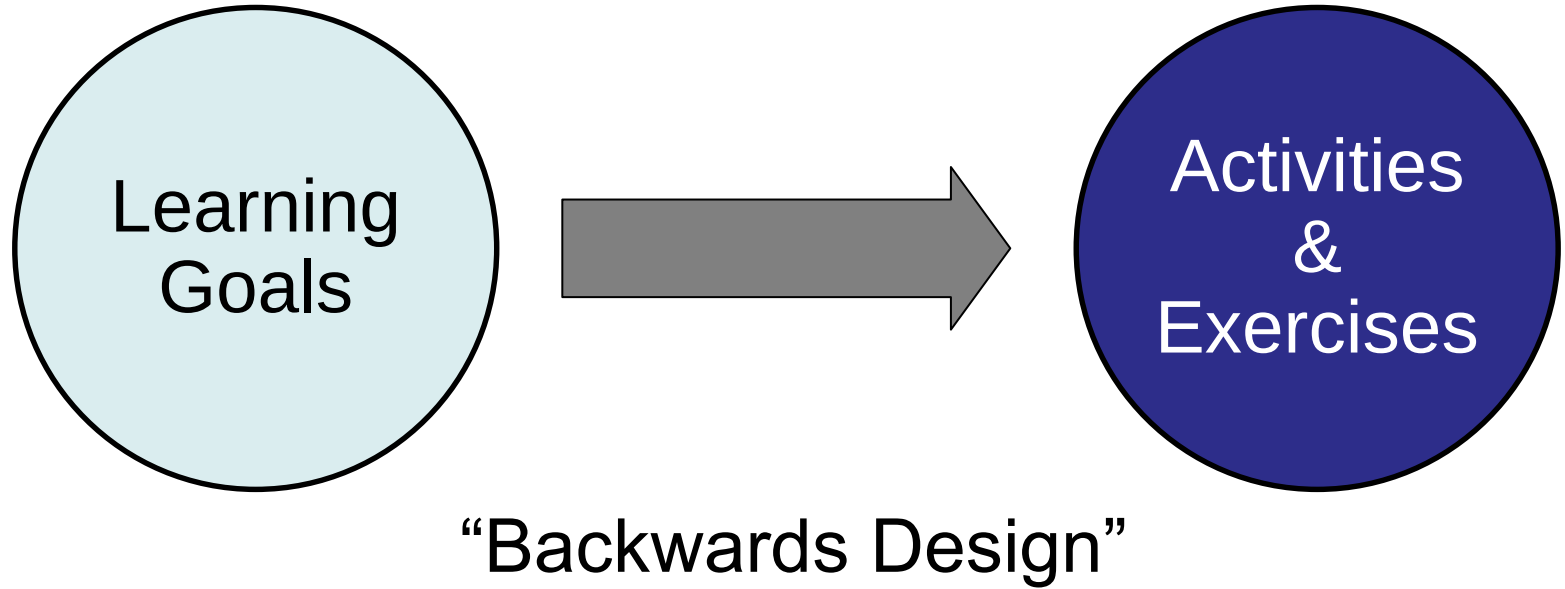
Learning Goal Examples

Integration is a process of cutting functions into little pieces and adding them all up

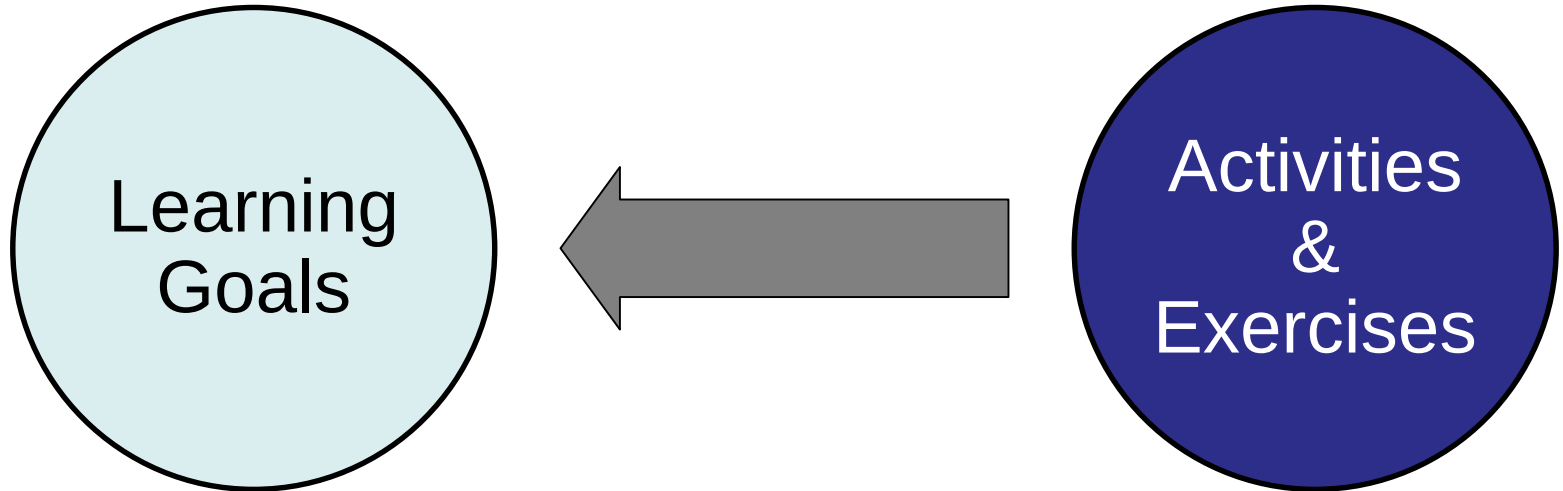
The ideal gas law lets you to calculate the kinetic pressure of a gas as long as you know the temperature, number of molecules, and volume of the gas

Newton's third law says that for every interaction, there are two forces of the same type that act in opposite directions

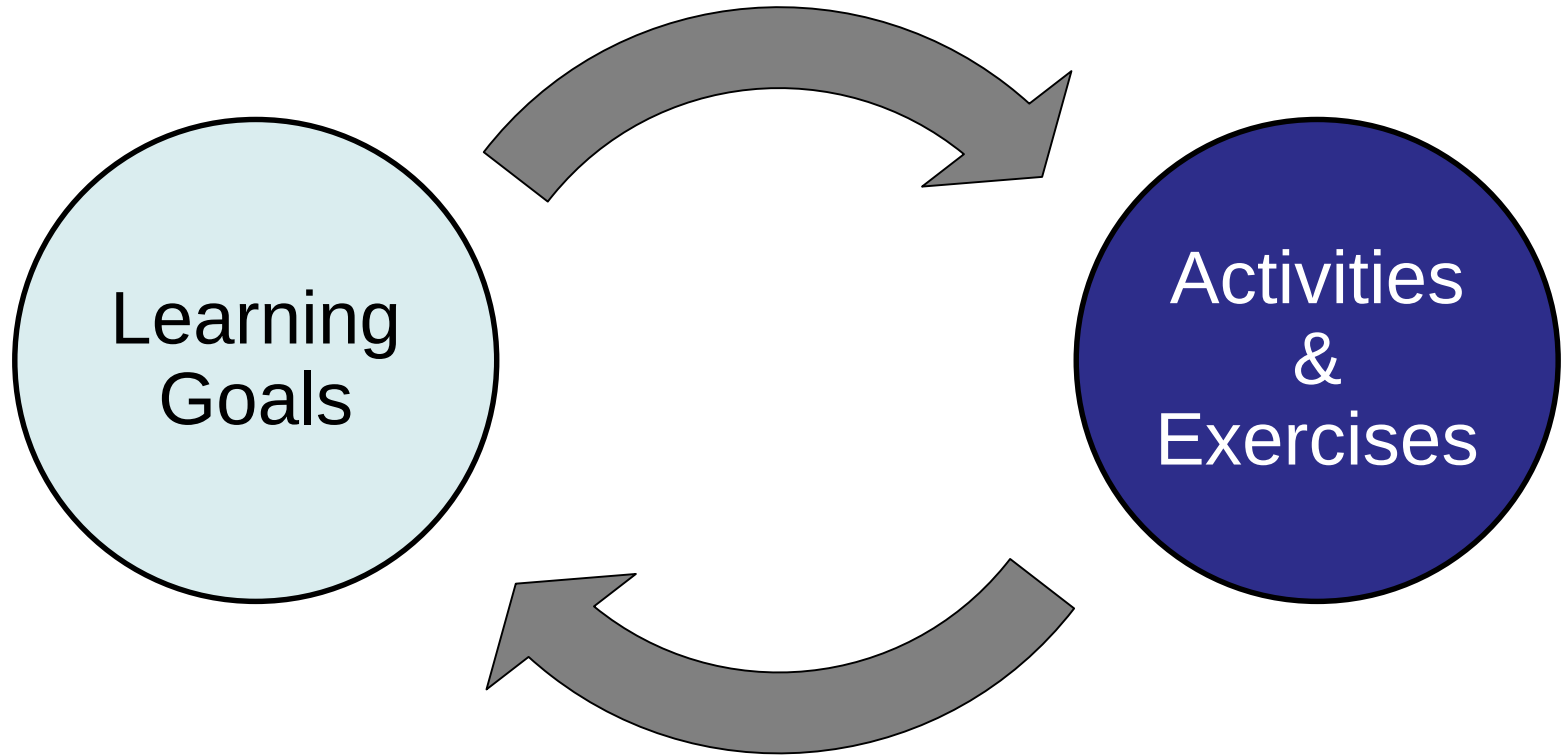
Designing Based on Learning Goals



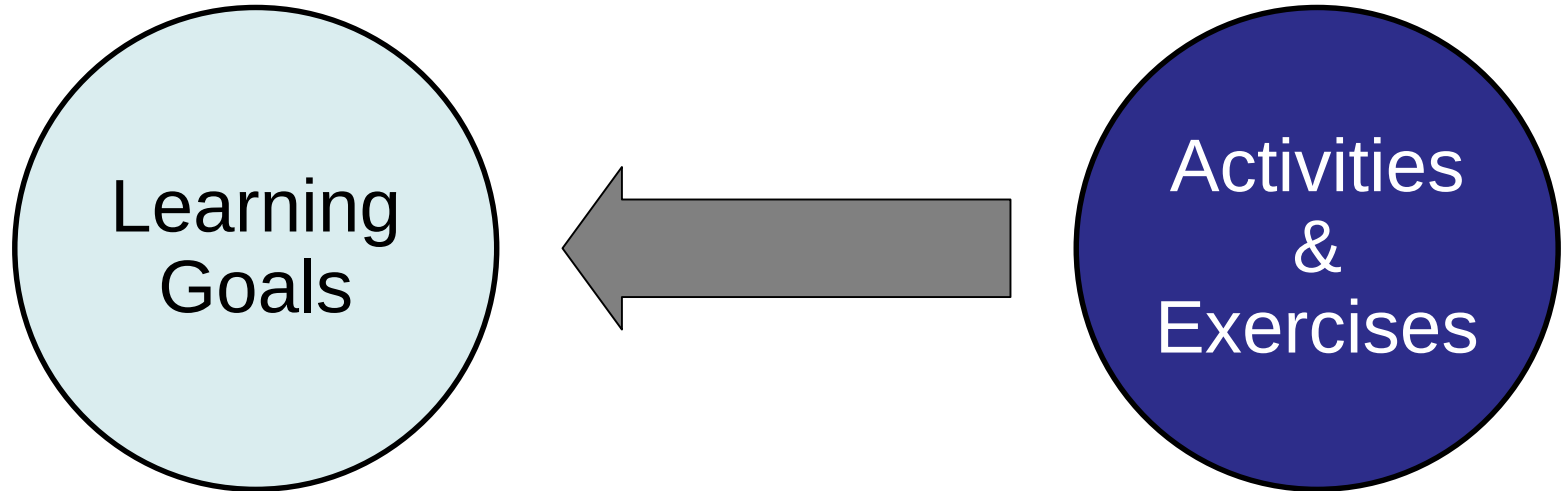
Distilling Learning Goals



Distilling Learning Goals



Distilling Learning Goals

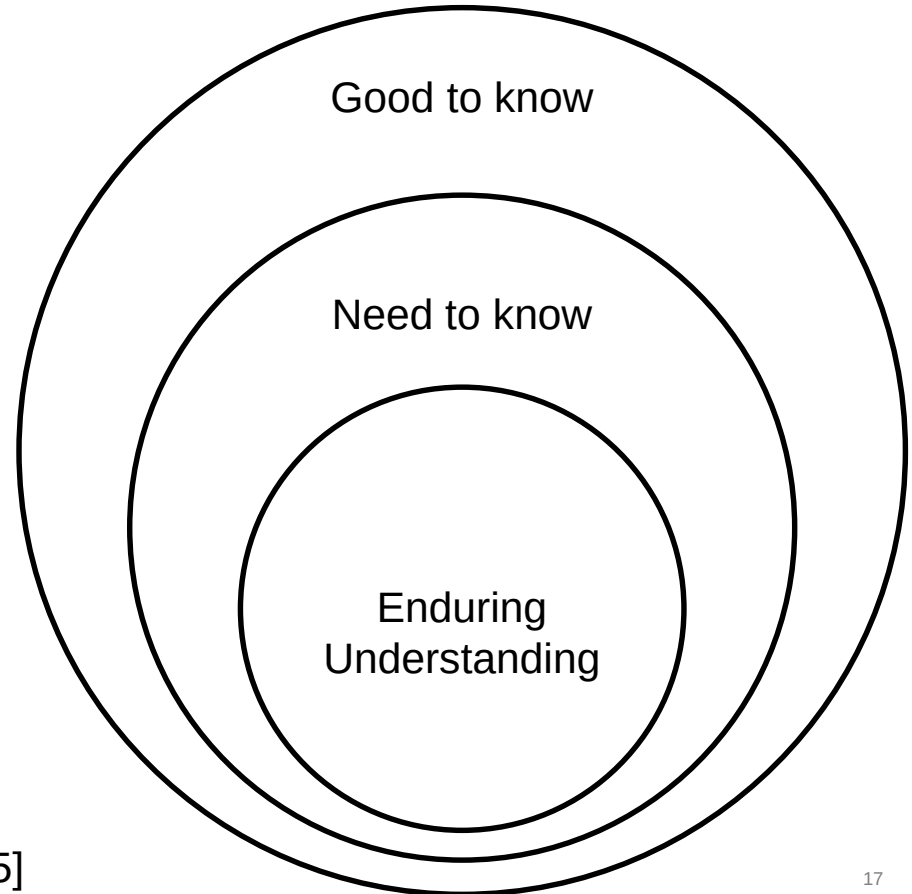


Learning Goals Activity

Enduring understanding: core idea (learning goal)

Need to know: Necessary to solve the problem

Good to know: Useful, but not essential



Concluding Remarks

1. **Respect** for the learner!

- Learning math and science is often harder than it looks! [4]

2. Look for the "enduring understanding" (learning goal)

- Ideally, this will be **aligned** for all problems

3. **Foreground** your learning goal!

References

1.  A. Miller, “The magical number seven, plus or minus two: Some limits on our capacity for processing information,” *Psychol. Rev.* 63, 81–97 (1956).
2.  Chase, W. G., & Simon, H. A. (1973). Perception in Chess. *Cognitive Psychology*, 4, 55–81.
3. Chi, M., Feltovich, P., & Glaser, R. (1981). Categorization and Representation of Physics Problems by Experts and Novices. *Cognitive Science*, 5, 121–152.
4. Redish, E. F., Scherr, R. E., & Tuminaro, J. (2006). Reverse-Engineering the Solution of a “Simple” Physics Problem: Why Learning Physics Is Harder Than It Looks. *The Physics Teacher*, 44, 293.
5. Wiggins, G. P., & Mctighe, J. (2005). What is Backward Design? In *Understanding by Design* (pp. 7–19).