Student patterns of knowledge construction

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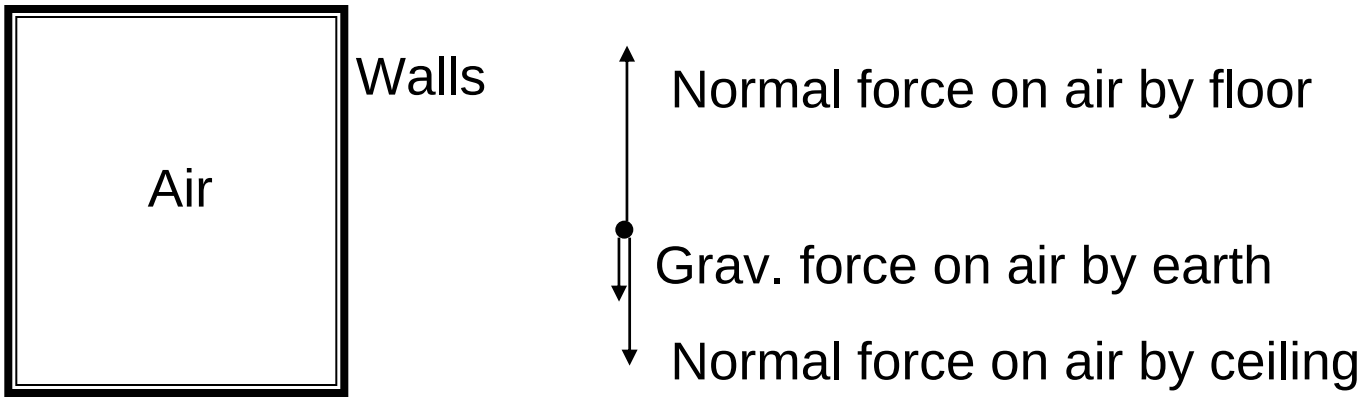
Goals

- Introduce piece of theory about student patterns of knowledge construction.
- Explain a student-TA “failure to communicate” in theoretical terms.

Intro physics homework problem

What's the difference in pressure between the ceiling and the floor of a dorm room?

(The density of air is about 1 kg/m^3, and atmospheric pressure is 10^5 Pa.)



Pressure episode *(1 min)*

Three students are working on the pressure problem together.
A TA is in the room, but isn't working with them in this episode.

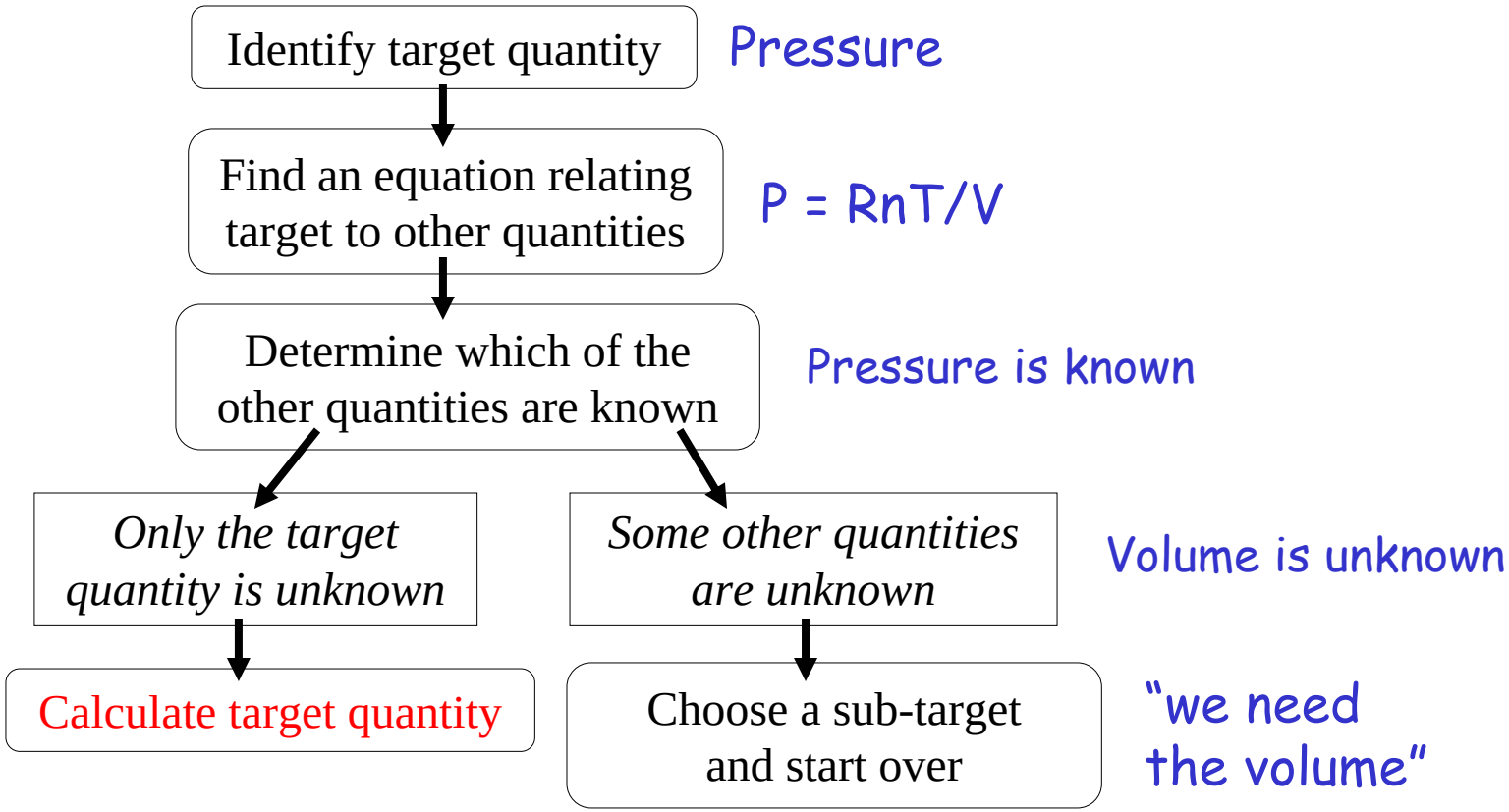
(These are students in the introductory algebra-based mechanics course, doing their homework.)

Look for:
The students' (familiar) pattern of activity.

[NOT CONCEPTUAL TROUBLES]

Pressure episode *(1 min)*

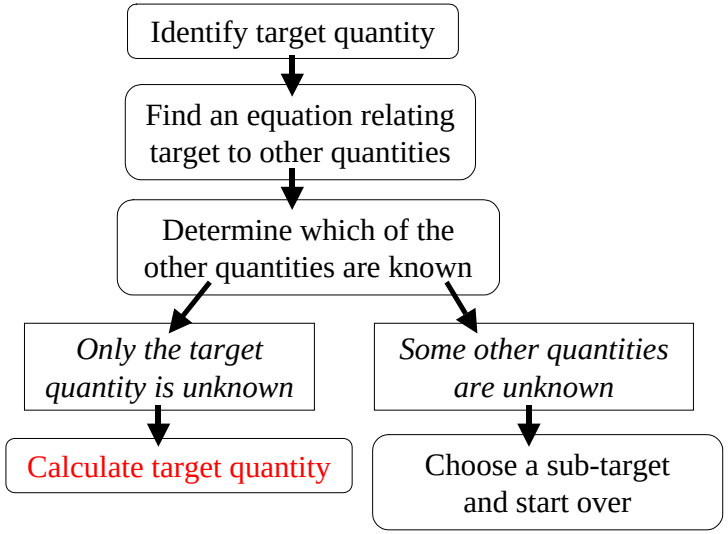
A familiar pattern of behavior



The pattern is a sort of “game.”

- It is a mildly artificial activity, separable from regular life.

- It has a routine of allowed “moves.”



- It has “pieces” which are required for play.

equations

definitions of variables

rules of algebra

etc.

The pattern is a sort of "game."

- It has a well-specified way to "win:"

  Produce a solution.

49. A 5.72-liter tank of gaseous nitrogen is maintained at 1.6 atm and 30°C. What mass of nitrogen is in the tank?

Given: V = 5.72 L R = gas constant
P = 1.6 atm N_2 is 14g/mole
T = 30°C

PV = nRT
n = PV/RT

m = (number of moles)(mass per mole)
= n (14g/mole)
= (PV/RT)(14g/mole)

$$= \frac{(1.6\text{atm})(5.72\text{L})(0.014\text{kg/mole})}{R\ (293\text{K})}$$

$\boxed{m = 0.00003 \text{ kg}}$

Theoretical vocabulary

Collins and Ferguson, Educ. Psych. 28 (1) 1993

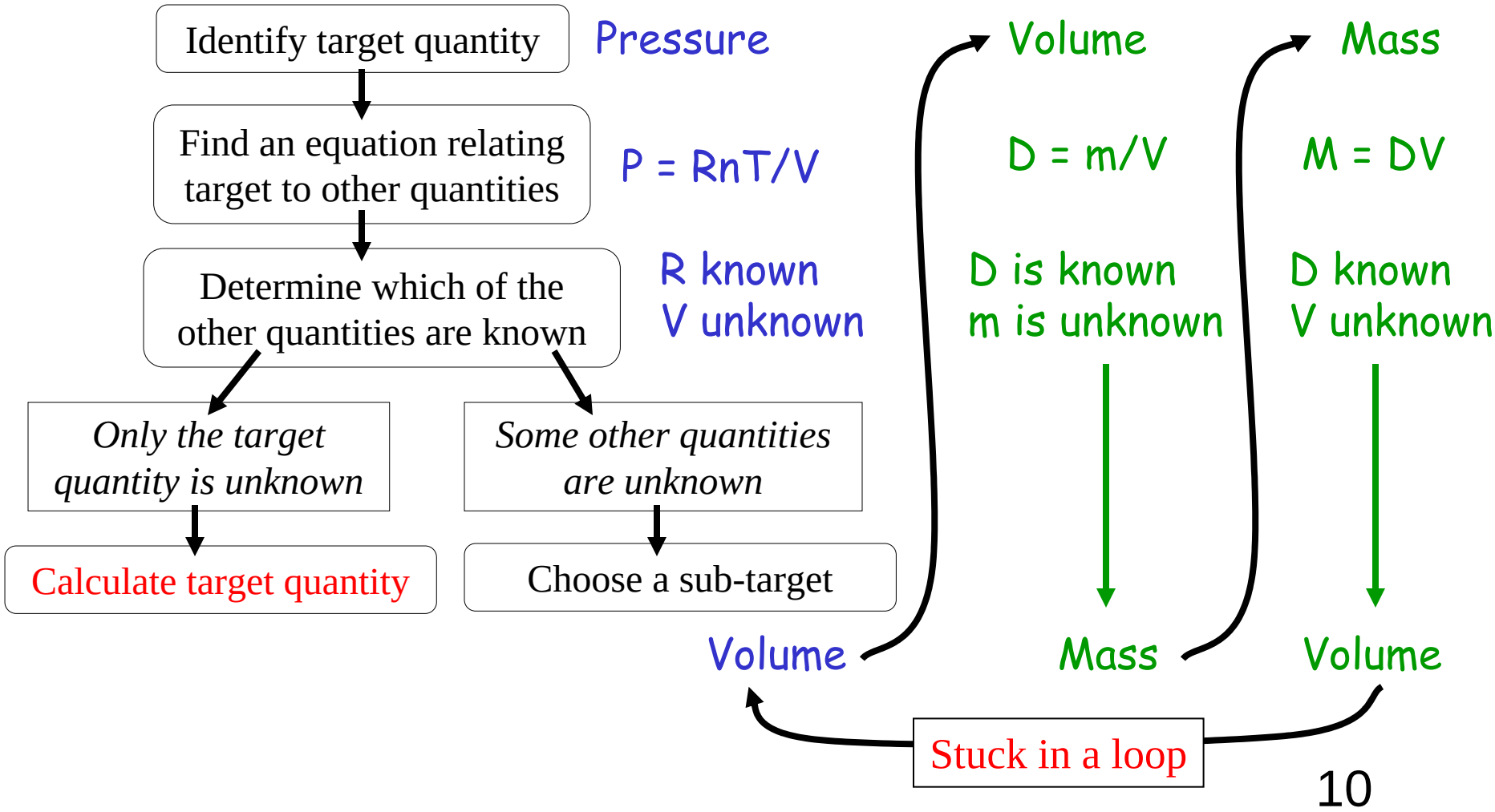
- This game is an **epistemic game** (e-game), in that its purpose is knowledge construction.
- The "pieces" are **knowledge elements.**
- The "target structure" (e.g., solution) is an **epistemic form.**

"Plug-and-Chug" e-game

Other epistemic games:

Listmaking,
Pictorial Analysis,
Mapping Meaning to Mathematics …..

Students playing "Plug-and-Chug" e-game

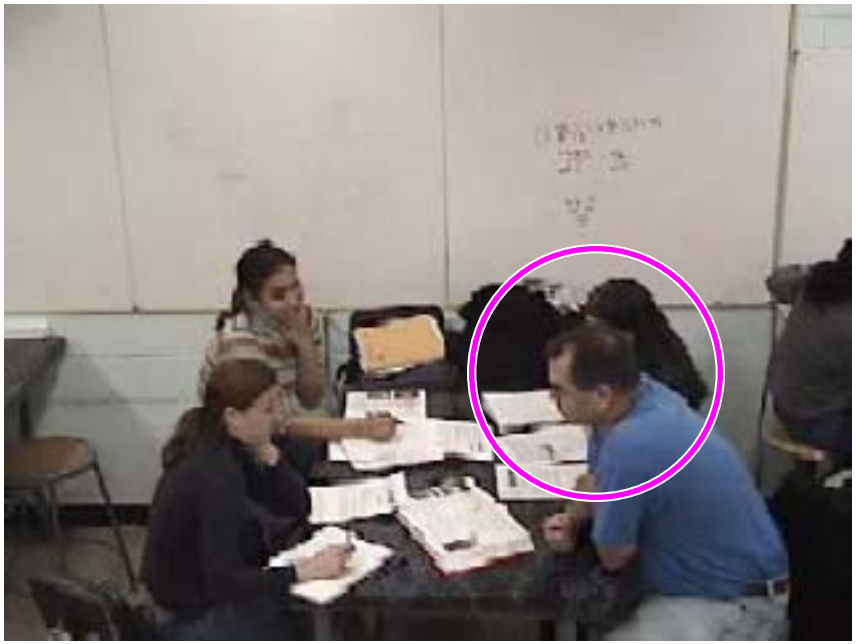


The problem is partly the game

It's not just that students have conceptual difficulties.

Students can have difficulties due to getting stuck in an unhelpful game.

Students have a TA check their moves



Off camera:

- TA affirms formulas.
- The students decide:

D is known (1 kg/m^3)

m = 1 kg and V = 1 m^3

In this clip:

The TA tries to help students spot their interpretation error.

Look for:

The TA makes two different moves, neither of which work.

Helping episode *(1 min)*

TA's first move: **"Physicalizing"**

TA: Right, so if you lived in a room that was **this big** [gestures], one meter cubed there would be one kilogram of air there.

S2: Yeah.

TA: I don't think you live in a room that big.

TA tries relate quantities to physical experience

S2: Yeah, I feel silly. OK. So, it's one kilogram...

TA: So, what um...

S1: So, the mass is one kilogram, is what you're saying.

Students think he's helping them identify a known quantity.

TA's 2nd move: **Suggest *estimation***

TA: Would you agree with me this is an estimation problem.

S2: Um. S1: Yes. TA: OK.

S2: To a certain extent, yeah.

TA: What this problem is about a dorm room. How big is a dorm room?

S2: Oh!

TA pushes for them to try estimation

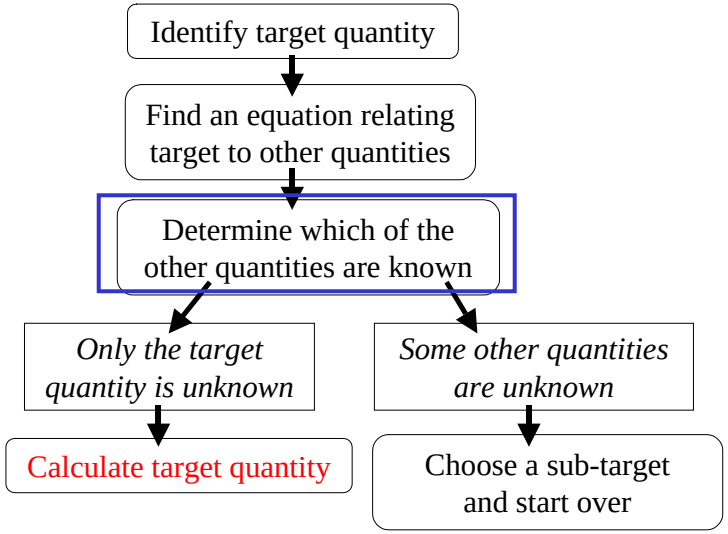
S1: Not big at all.

S2: He gave it in another problem. Like another homework.

Students think he's indicating a known quantity again.

Interrelated claims

- The TA's moves go unrecognized (or misinterpreted) by the students.
- The TA's moves are not part of the plug-and-chug game.
- The students hear the TA as though he were making a plug-and-chug move ("identify known quantities").



Their "failure to communicate" is a problem of mismatched epistemic games.

What does theory gain us?

Q. Why not just say that the students and TA miscommunicated, and leave it at that?

A. Fitting the problem into a theory *provides pedagogical assistance.*

Saying “they miscommunicated” is like saying “they’re wrong;” it doesn’t help you with what to do next.

“You guys are doing this plug-and-chug thing. How about you try something else?”

Summary

- Students engage in recognizable patterns of knowledge construction – epistemic games.
- In addition to conceptual difficulties, students may have difficulties due to being stuck in an unhelpful e-game.
- “Failures to communicate” may be usefully modeled as arising from mismatched e-games.