

# Designing self-diagnostic tools for students in large intro classes

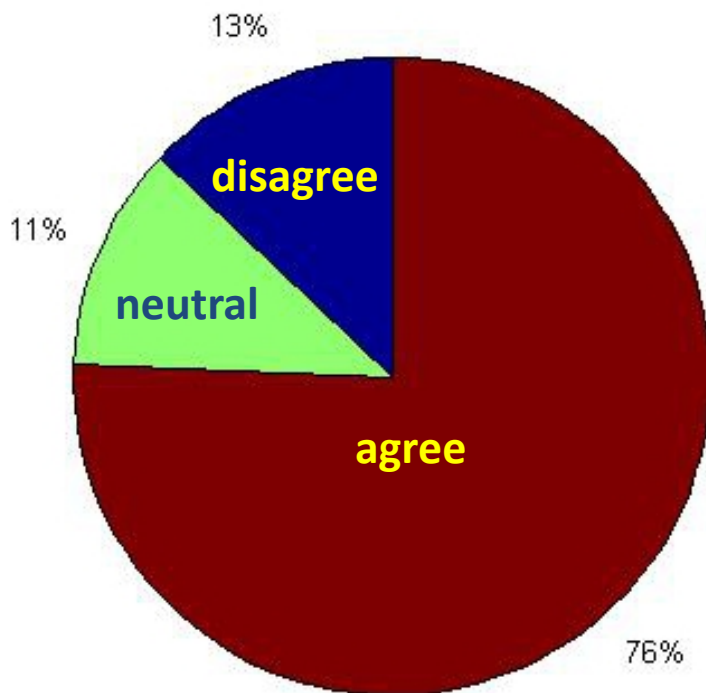
Matteo Broccio  
dB-SERC Lunch Meeting  
February 16, 2015

# Why student *self*-diagnosis?

**Students'** common attitudes in large intro science classes:

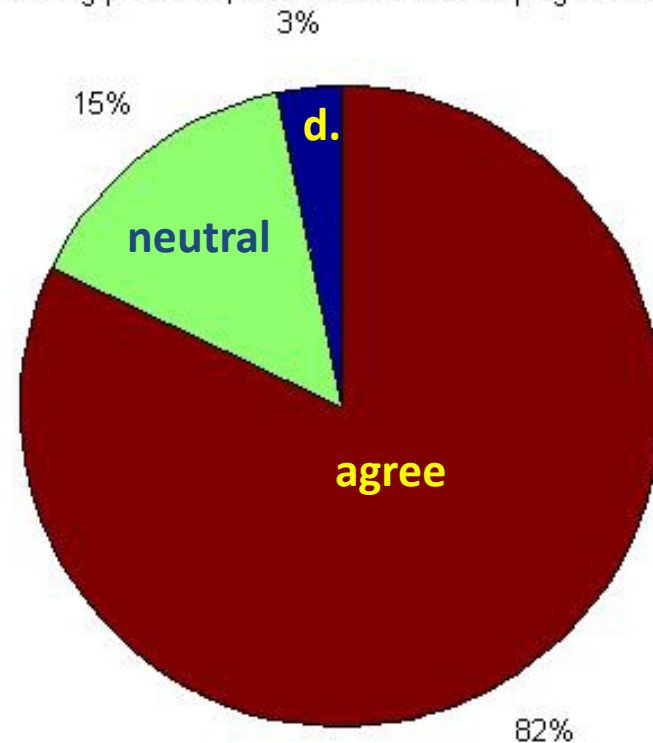
- Expectation of '*receiving*' knowledge -- not constructing it
- Search for '*recipes*' detached from conceptual understanding
- Reluctance to admit weaknesses to others (socially)

I cannot learn unless teacher explains things well in class.



Pre-instruction CLASS, Fall 2014

When solving problems, I look for formulas to plug in values into.



Pre-instruction CLASS, Fall 2014

# Why student *self*-diagnosis?

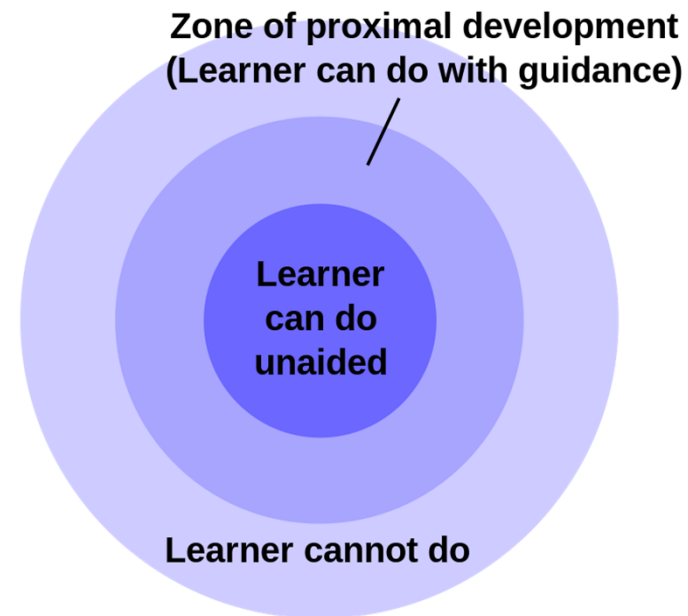
**Instructor's** common problems in large intro science classes:

- Lack of opportunities for giving personalized *feedback*
- Difficulty of 'tuning in' on a *heterogeneous\** audience
- Manifestations of expert *blindspot*

**ZPD:** Difference between what a learner can do without help and what he/she can do with help.

**Effective instruction only occurs in the ZPD** of learners (*Vygotsky*)

Oops: Learners are not all the same, and there is a natural **distribution of all cognitive variables** (*Redish*)



In large **intro** classes, there is a **broad distribution of ZPDs!**

# Learning objectives and skills

## **Learning objectives** (*content-specific*)

“You should be able to...” (apply/compare/rank/analyze...)

## **“Competencies”** (*cross-content skills*)

Mathematical proficiency\* (algebra, graphing, calculus, etc)

Translation between representations (verbal, graphical, math, etc)

Strategic planning

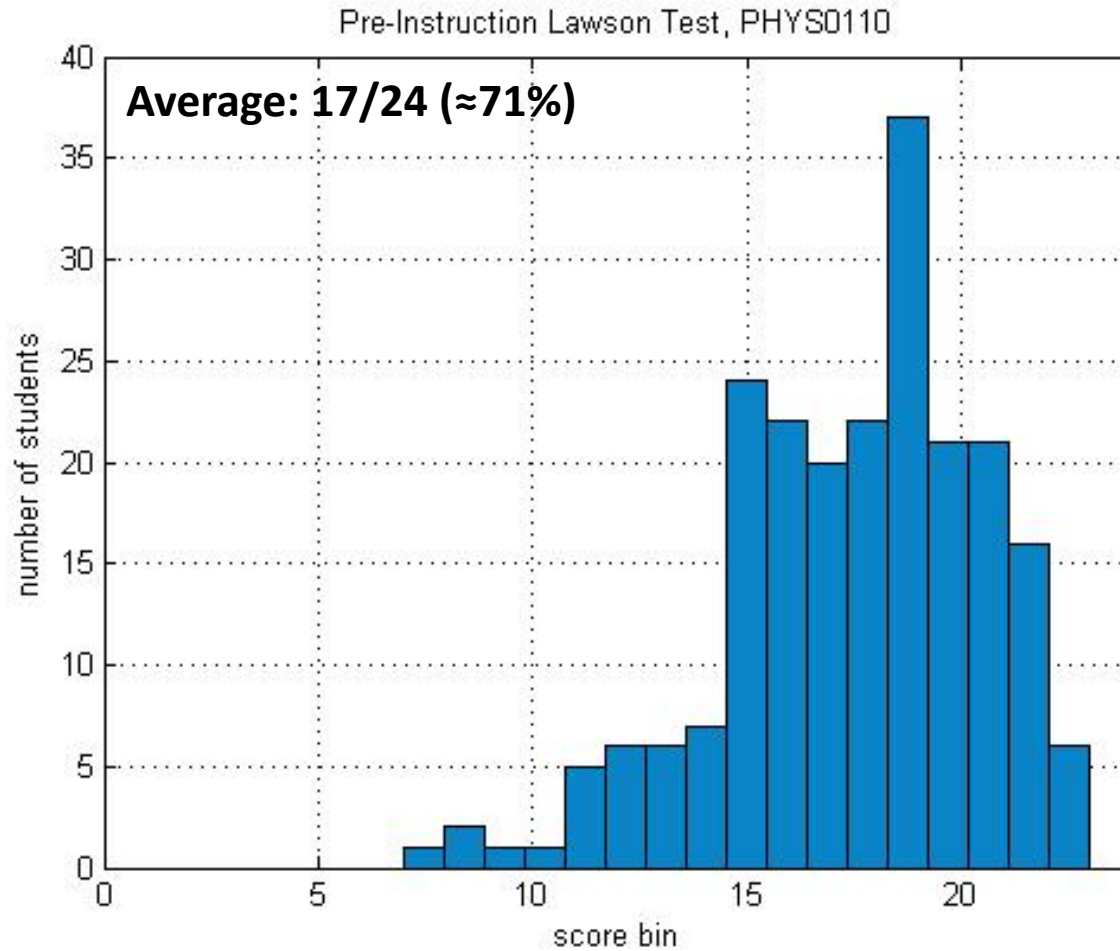
Dimensional analysis

Making estimates

Use of jargon

...

# Example: basic test of scientific reasoning



proportional reasoning; **control variables**; probability; **cause/effect**

# Modes of developing skills

**Group** practice of *single* skill



**Group** practice of *multiple* skills



**Individual** practice of *single* skill

**Individual** practice of *multiple* skills

Homework

# Modes of developing skills

**Group** practice of *single* skill



**Group** practice of *multiple* skills



Homework  
after **peer**  
**instruction**

**Individual** practice of *single* skill



**Individual** practice of *multiple* skills

# Modes of developing skills

**Group** practice of *single* skill



**Group** practice of *multiple* skills



**Individual** practice of *single* skill

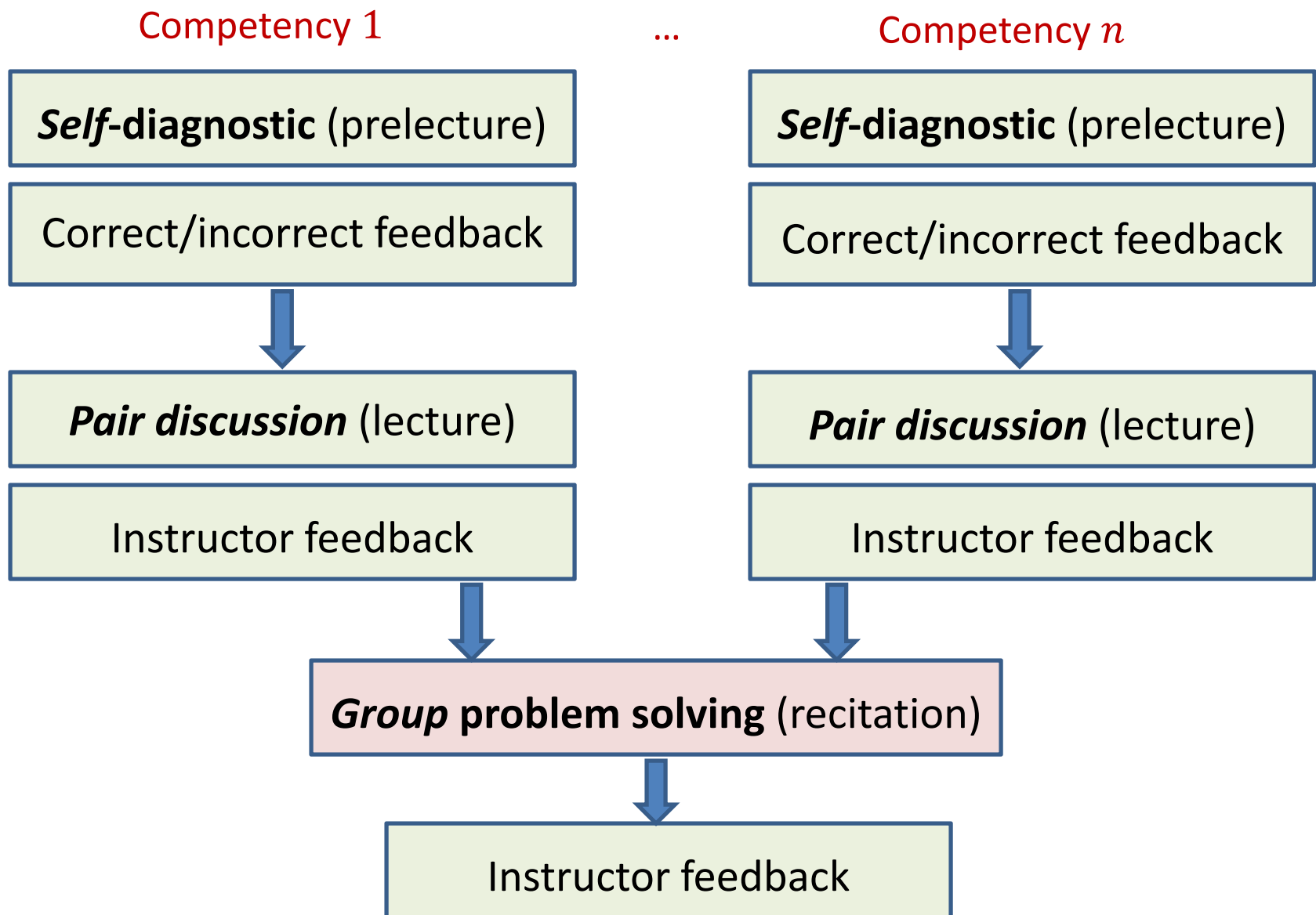
**Individual** practice of *multiple* skills



Homework after  
**self-diagnosis**  
*and peer*  
instruction

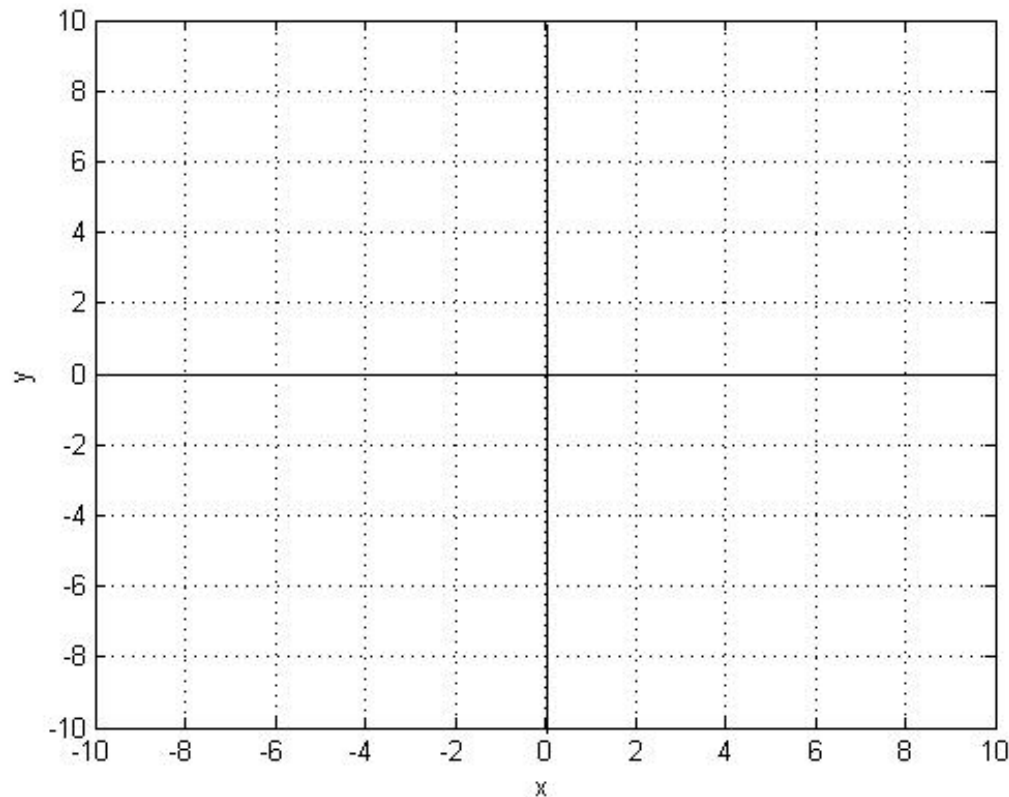


# Beta version



# Sample self-diagnostic (prelecture)

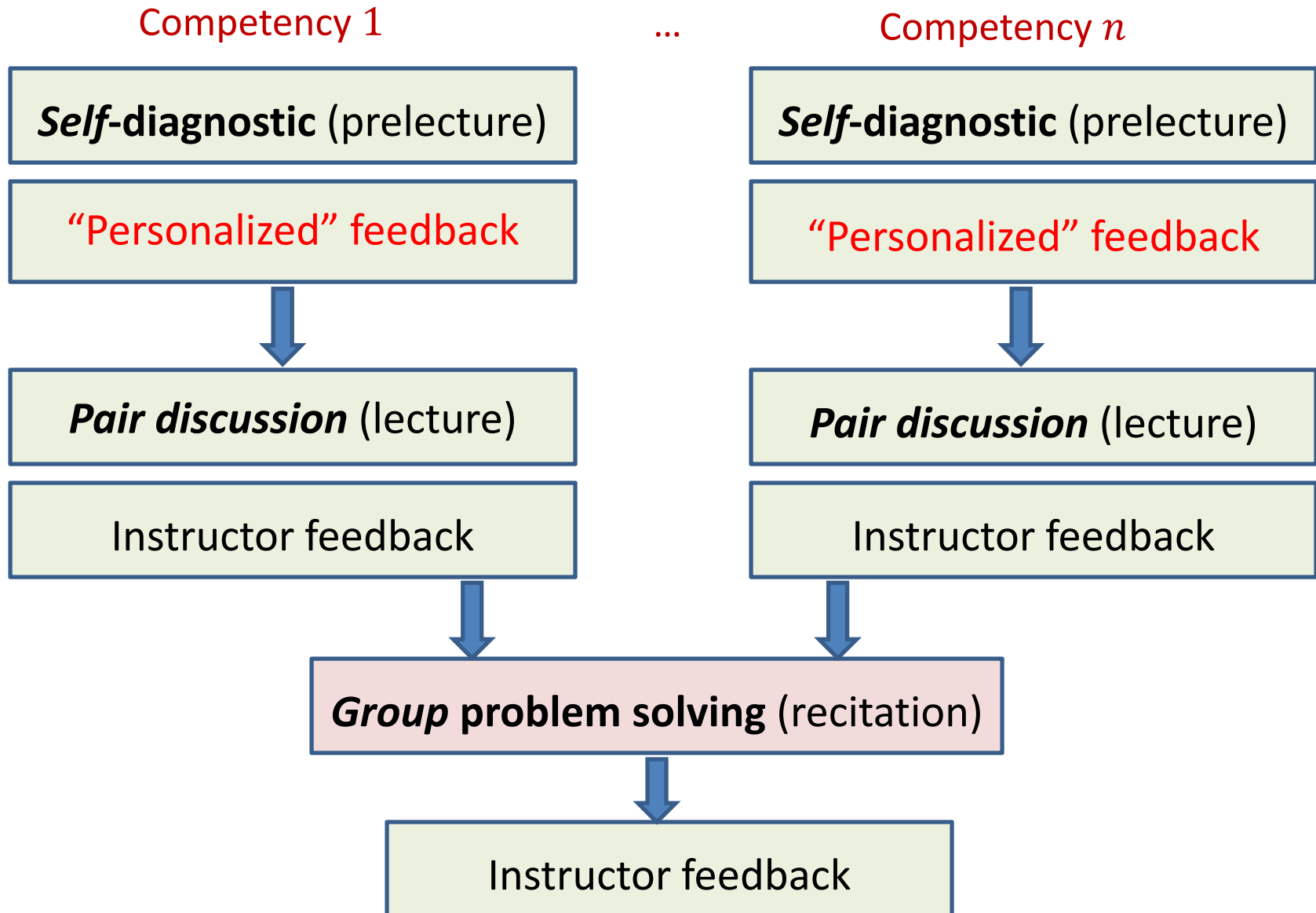
An ant is at  $2u\hat{x} + 6u\hat{y}$  and a beetle is at  $-4u\hat{x} - 4u\hat{y}$ . Locate the ant (A) and the beetle (B) in the graph and *without using a calculator*, find their mutual distance as accurately as possible.



*Note: units of both axes are  $u$ .*

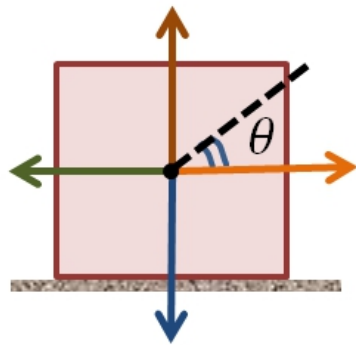
**[Answer given at end of lecture preview]**

# Version 1.0?

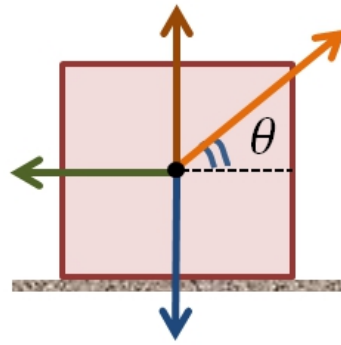


# Sample self-diagnostic

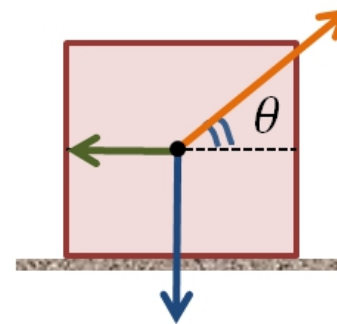
You drag a box across a wooden floor at constant speed, by pulling it at a positive angle  $\theta$  with the floor. Which is the qualitatively correct free body diagram for the box?



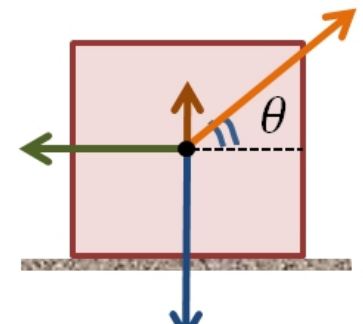
(A)



(B)



(C)



(D)

(E) None of the above diagrams is correct.

(A): HorP

(B):  $NF=W$

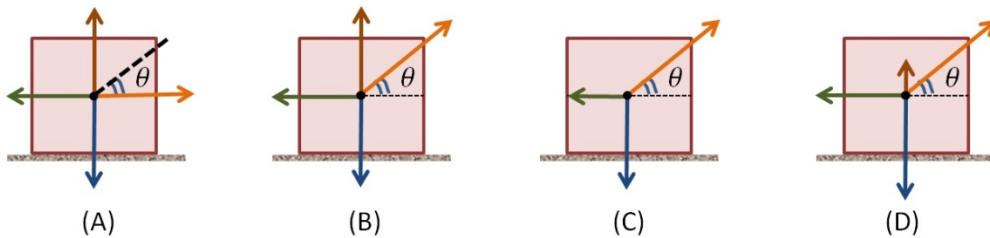
(C): noNF

(D): correct

Participation: 80%

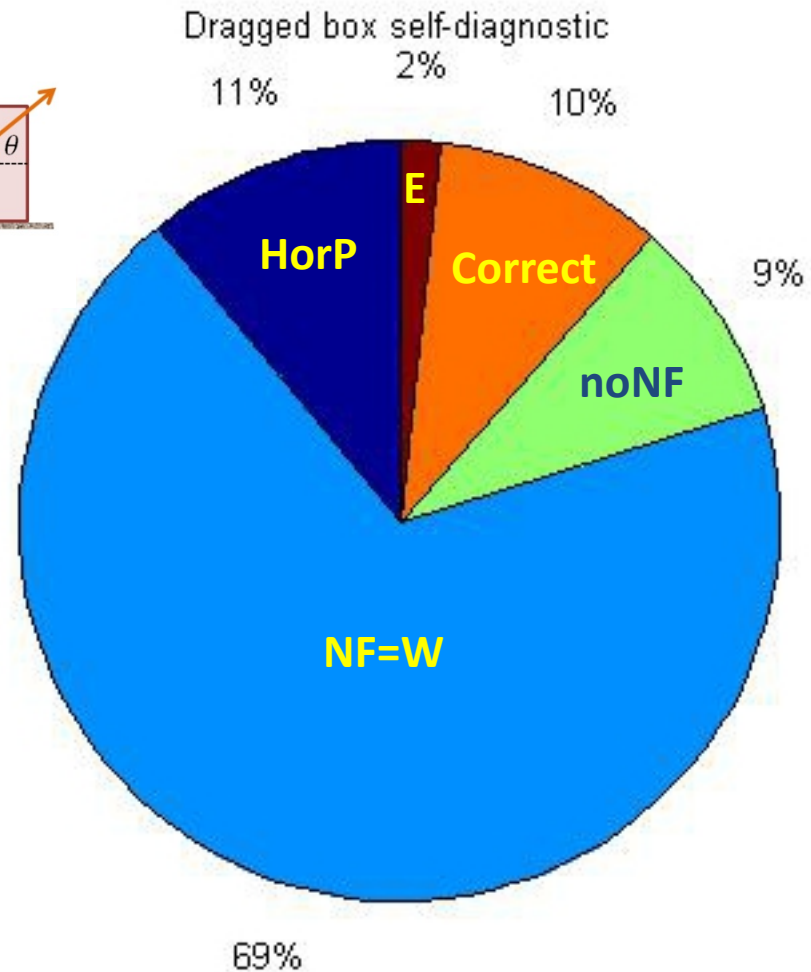
# Sample self-diagnostic

You drag a box across a wooden floor at constant speed, by pulling it at a positive angle  $\theta$  with the floor. Which is the qualitatively correct free body diagram for the box?



(E) None of the above diagrams is correct.

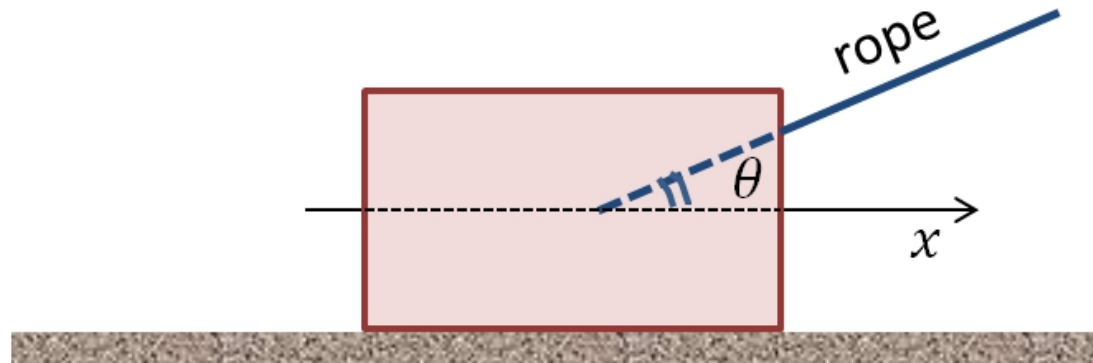
- (A): HorP
- (B): NF=W
- (C): noNF
- (D): correct



# Sample assessment (midterm exam)

During an apartment move, Tom drags a  $\{m\}$ -kg chest at constant speed across a carpeted floor. To move the chest, he pulls with  $\{P\}$  N a rope that forms an angle  $\theta = 30.0^\circ$  with the floor. What is the coefficient of kinetic friction between the chest and the carpet?

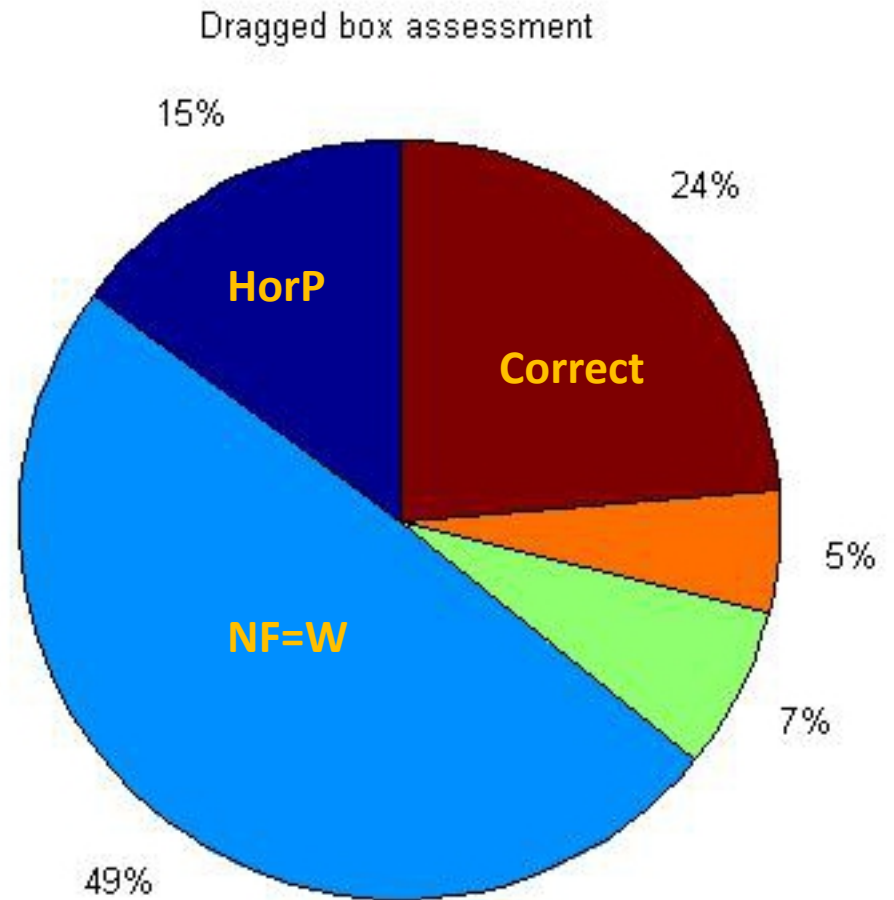
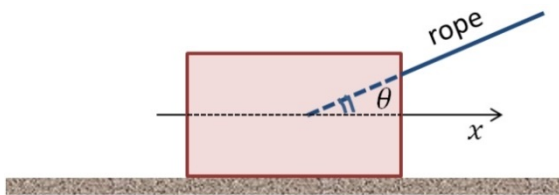
- A) {option} (HorP)
- B) {option} (NF=W)
- C) {option}
- D) {option}
- E) {option} (Correct)



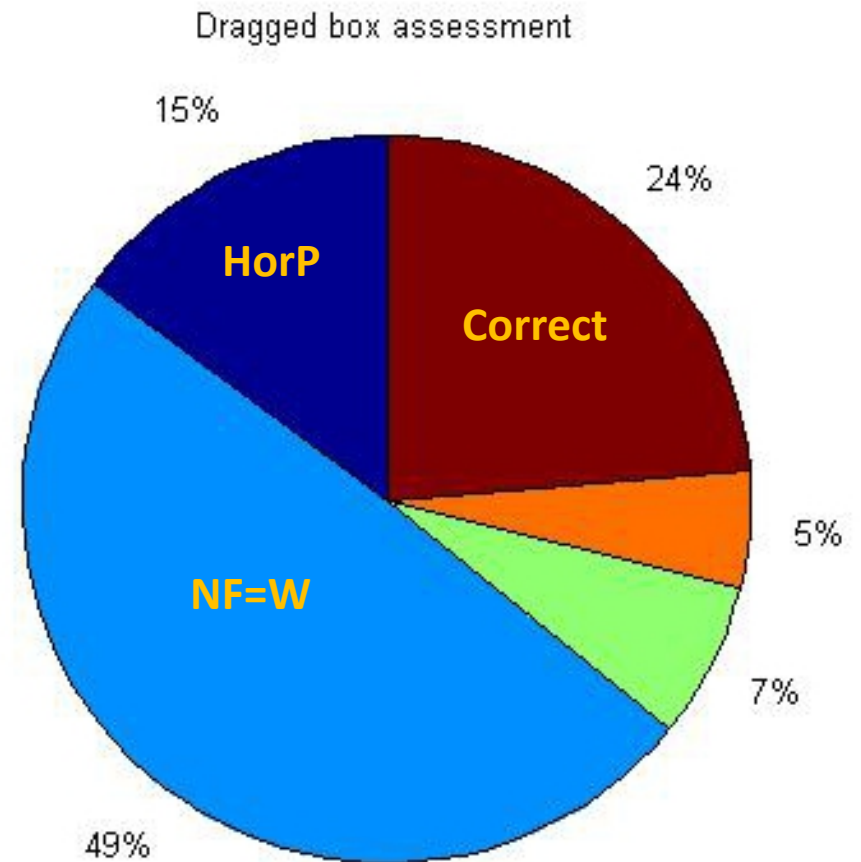
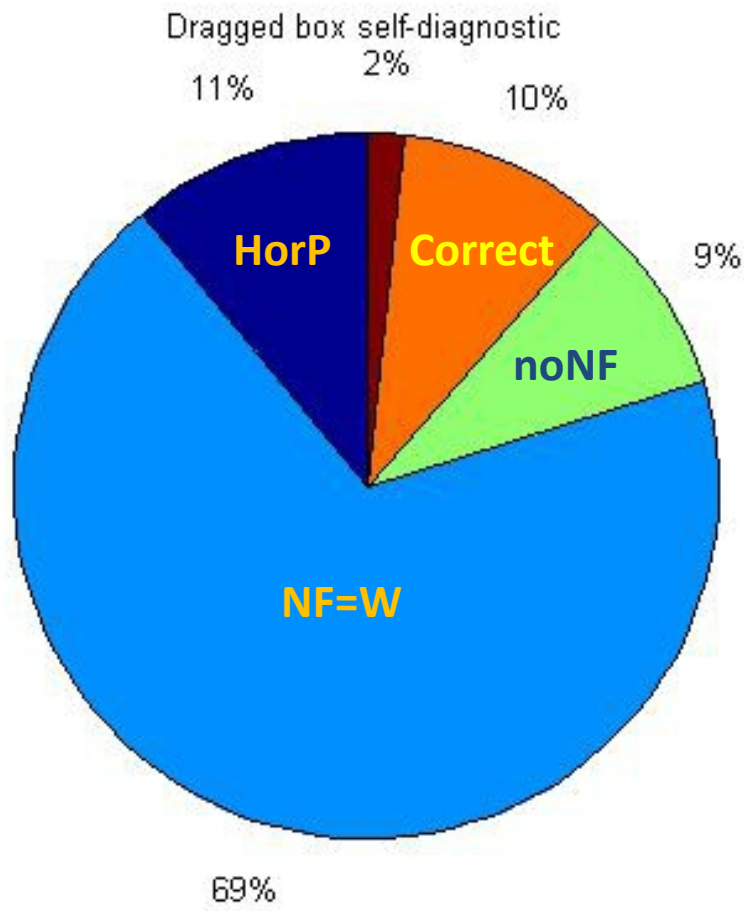
Time lag: 1 week  
Participation: 100%

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## Summary



$$P(NW\_a | NW\_d) = 0.564$$

$$P(NW\_a | noN\_d) = 0.400$$

$$P(Cor\_a | Cor\_d) = 0.137$$

$$P(HP\_a | HP\_d) = 0.053$$