How Learning Works: 7 Research-Based Principles for Smart Teaching

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Quick Problem to Solve

There are 26 sheep and 10 goats on a ship. How old is the captain?

Adults: Unsolvable

5th graders: Over 75% attempted to provide a numerical answer.

After giving the answer “36” one student explained “Well, you need to add or subtract or multiply in problems like this, and this one seemed to work best if I add.”

(Bransford & Stein, ’93)

The Moral:

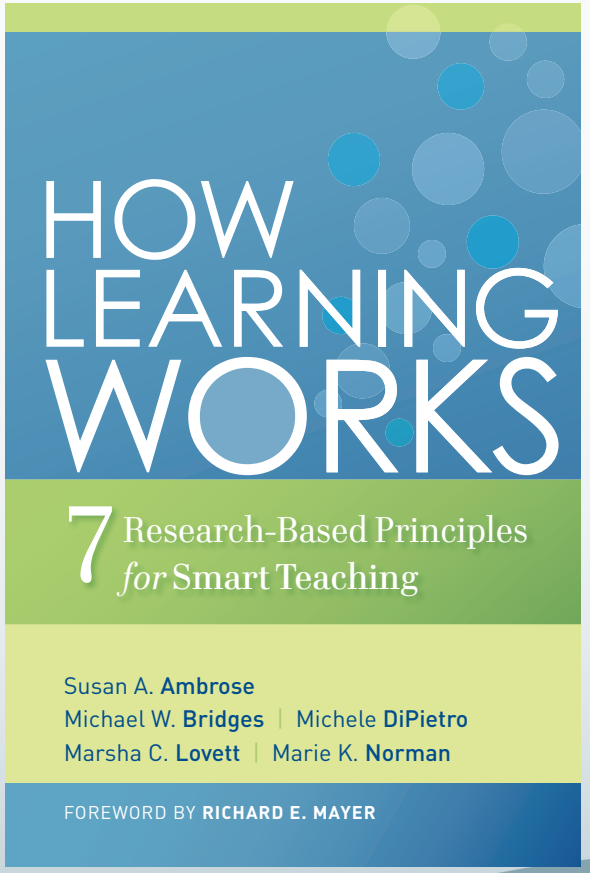
We must really understand how students process what we teach them!!

How Learning Works

Joint work with former Carnegie Mellon colleagues

Synthesis of 50 years of research

- Constant determinants of learning
- Principles apply cross-culturally
  - Translated in Chinese, Japanese, Korean, and (forthcoming) Spanish



Objectives

Following this presentation, participants should be able to:

1. List and discuss the seven principles of learning
2. Discuss pedagogical strategies to help students organize and process information effectively

What is learning?

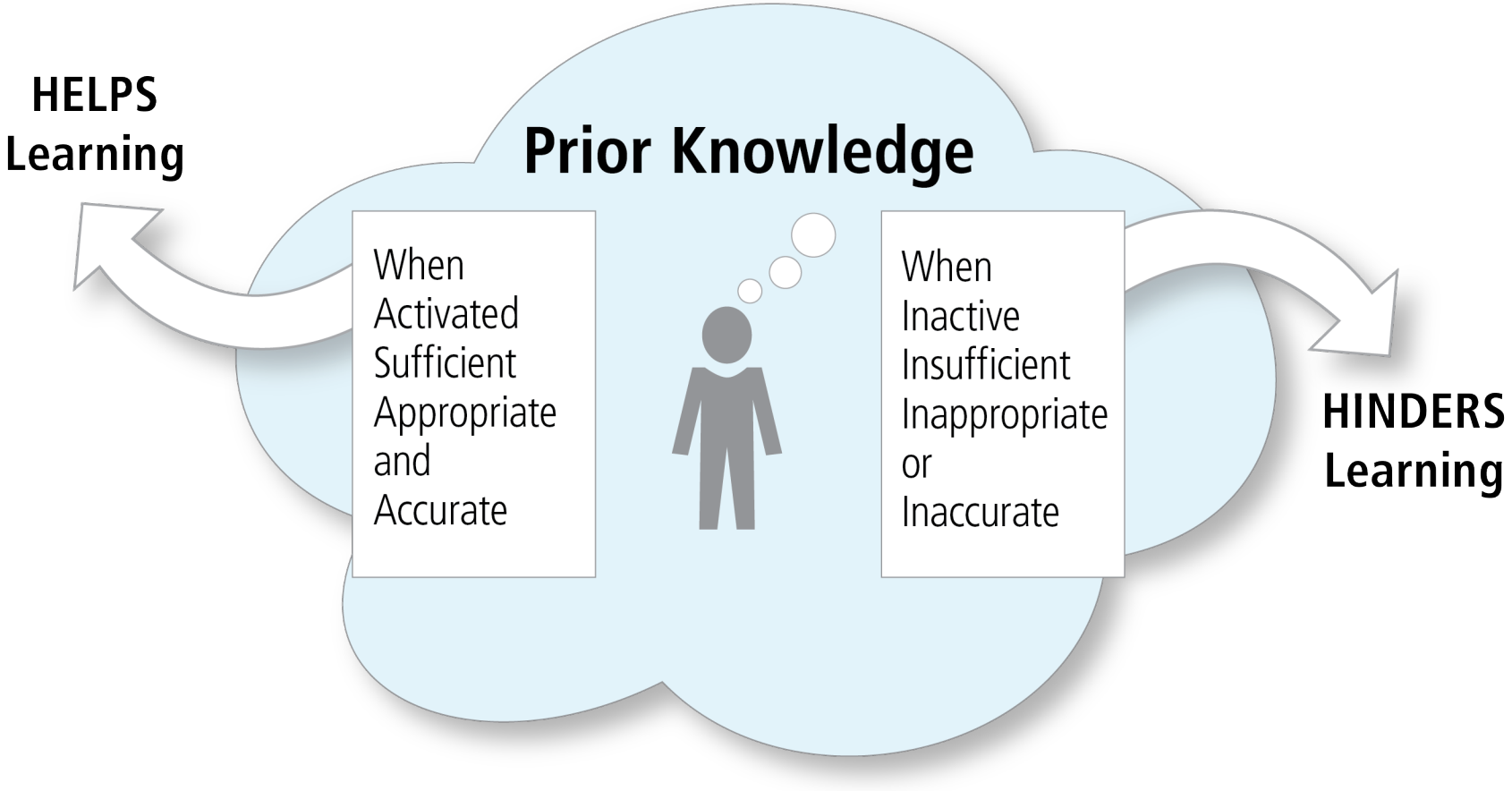
Our definition:

"Learning is a process that leads to change, which occurs as a result of experience and increases the potential for improved performance and future learning."

7 Learning Principles

1. Students' *prior knowledge* can help or hinder learning.
2. How students *organize knowledge* influences how they learn and apply what they know.
3. Students' *motivation* determines, directs, and sustains what they do to learn.
4. To develop *mastery*, students must acquire component skills, practice integrating them, and know when to apply what they have learned.
5. Goal-directed *practice* coupled with targeted *feedback* enhances the quality of students' learning.
6. Students' current level of *development* interacts with the social, emotional, and intellectual *climate* of the course to impact learning.
7. To become *self-directed* learners, students must learn to monitor and adjust their approaches to learning.

1. Prior Knowledge can help or hinder learning



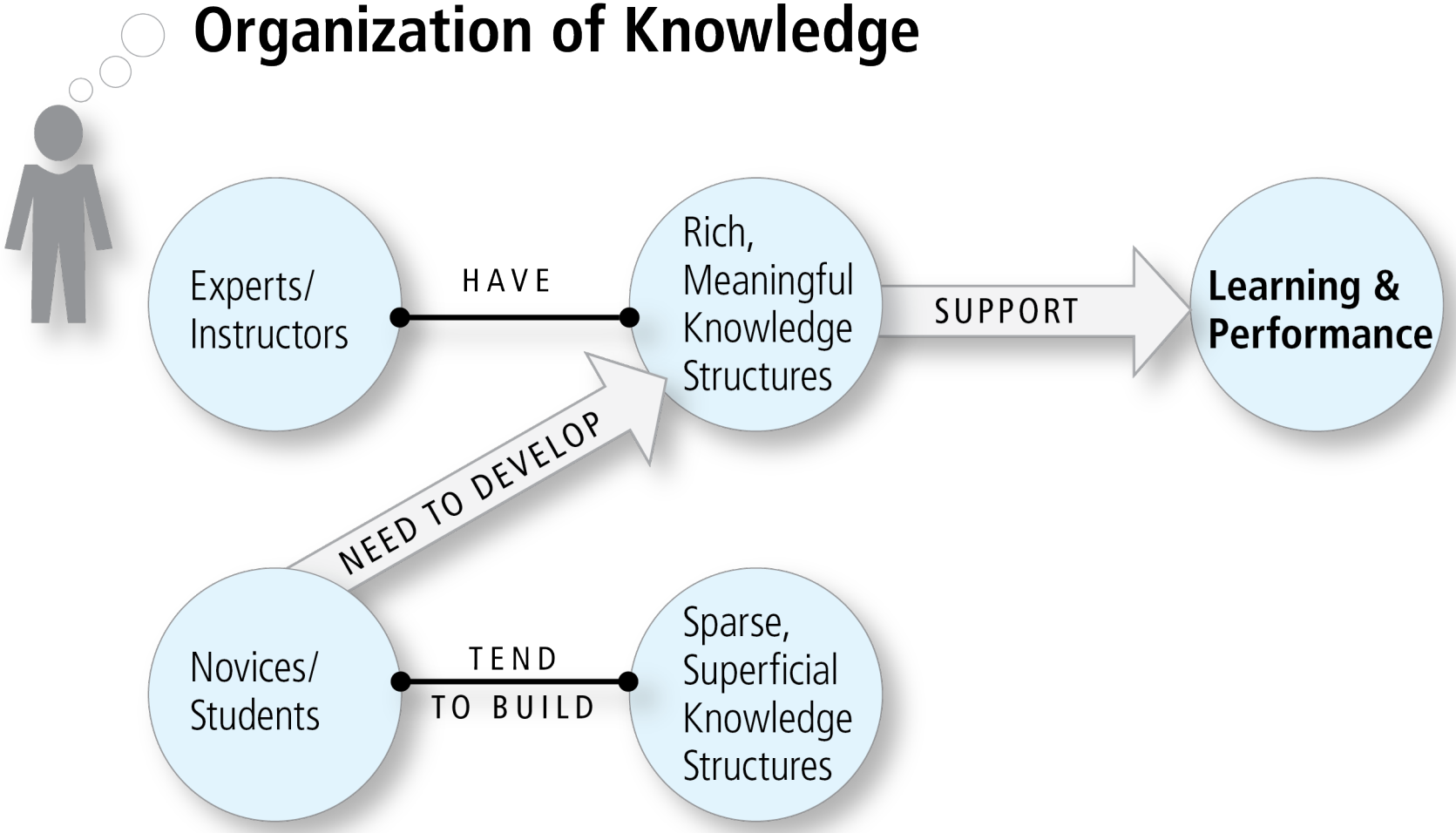
What we owe our students

Learning environments that

- Value and engage what students bring to the table
- Actively confront and challenge misconceptions

2. How students organize knowledge influences how they learn and apply what they know

Organization of Knowledge

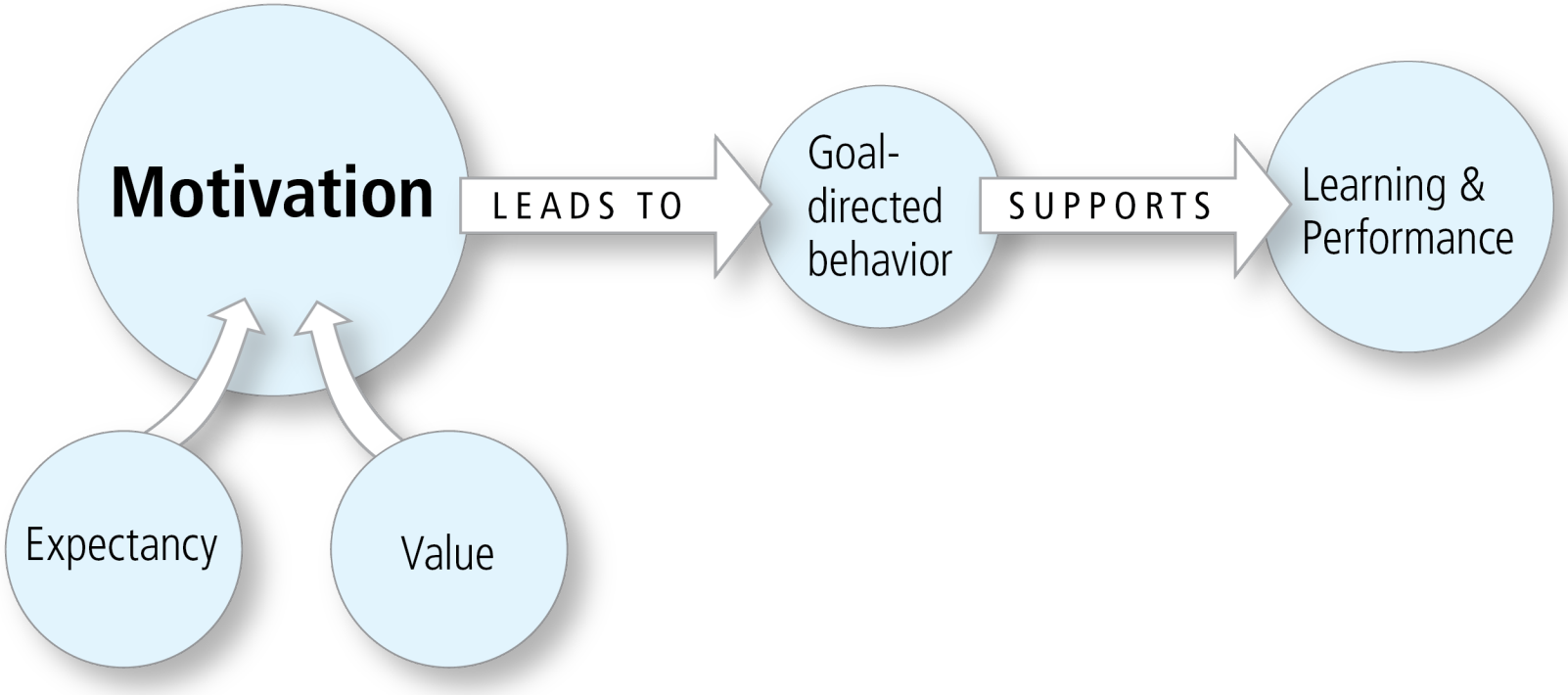


What we owe our students

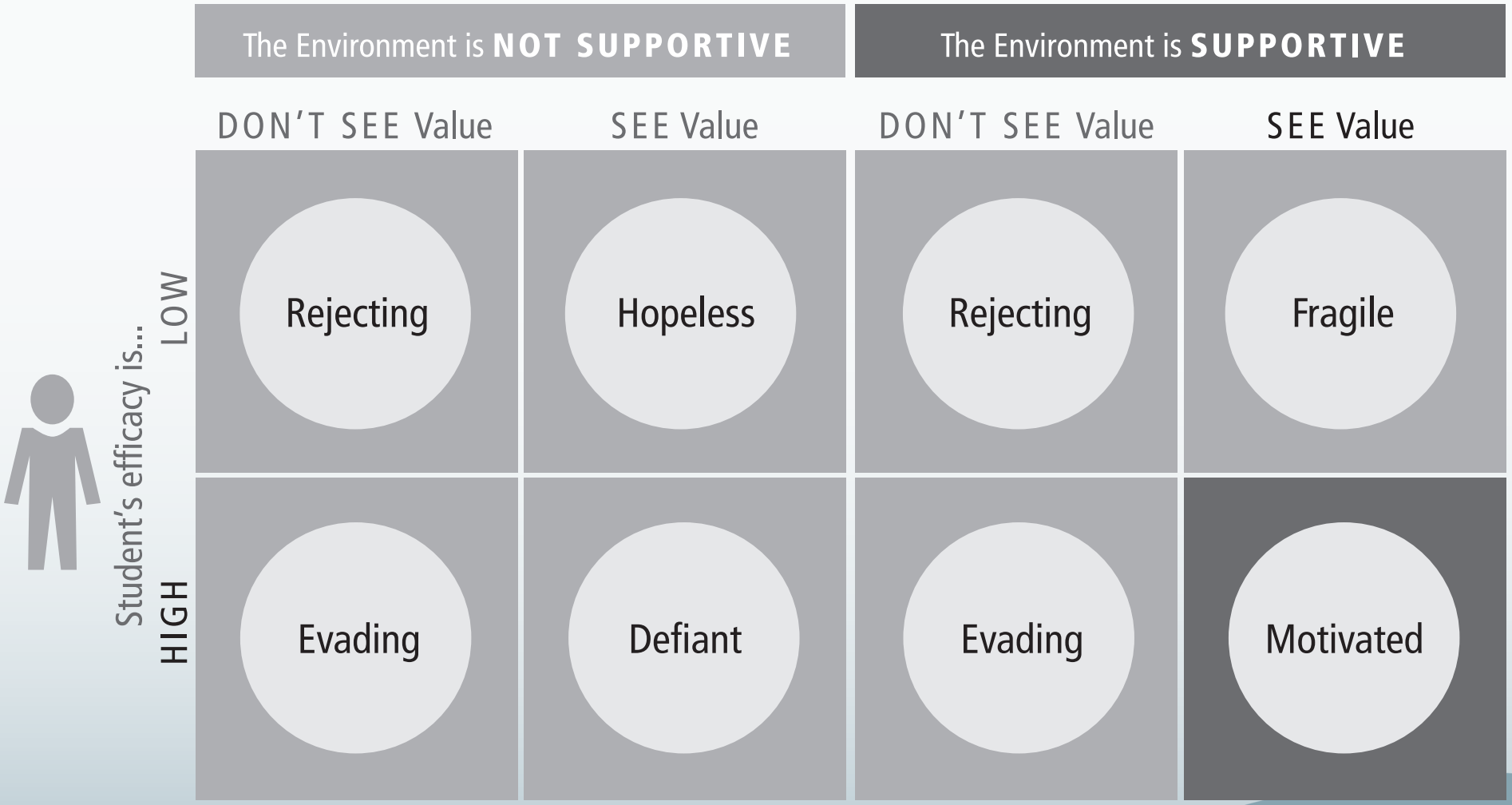
Learning environments that not only transmit knowledge, but

- Help students organize their knowledge in productive ways
- Actively monitor students' construction of knowledge

3. Students' motivation determines, direct, and sustains what they do to learn



Effects of value, self-efficacy, & environment on motivation

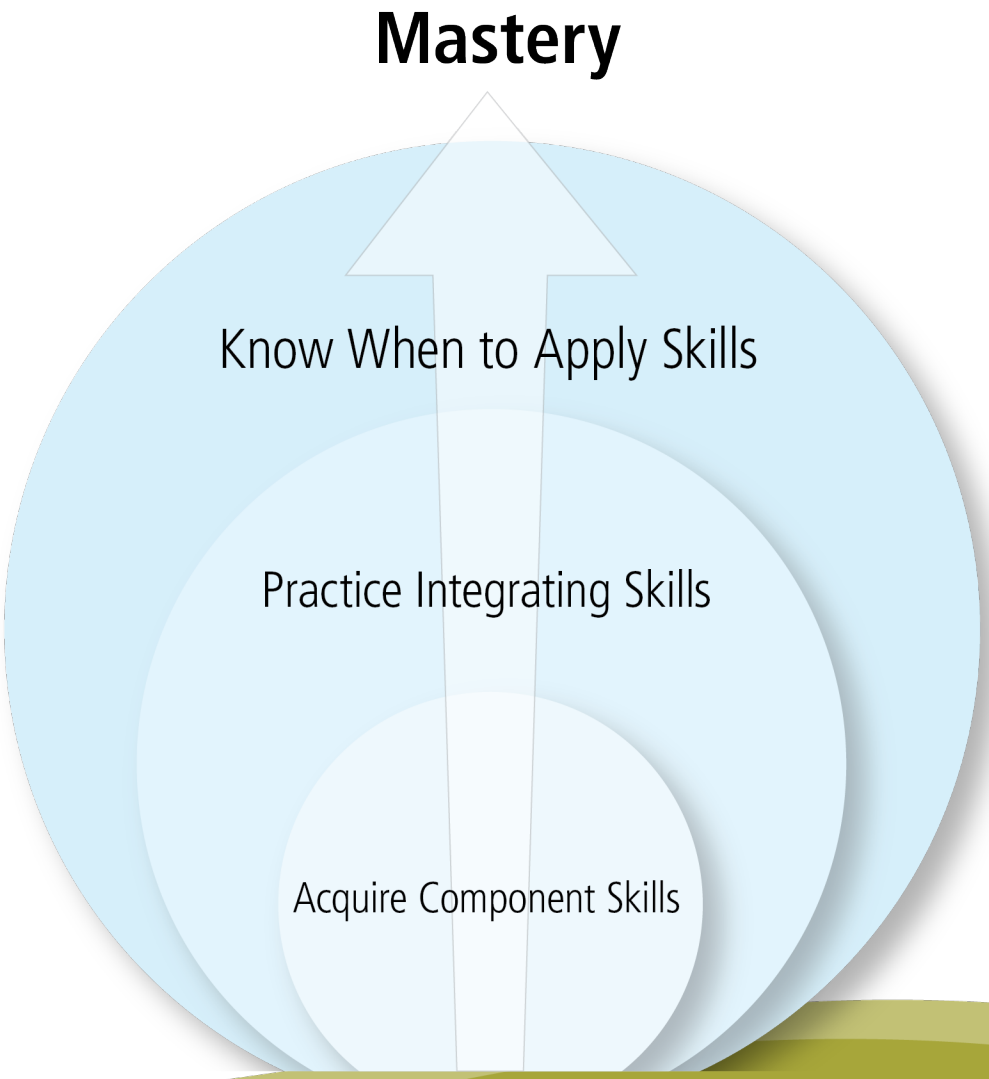


What we owe our students

Learning environments that

- Stay up-to-date with what students value
- Engage multiple goals
- Build self-efficacy
- Are responsive and helpful

4. To develop mastery, students must acquire component skills, practice integrating them, and know when to apply what they have learned



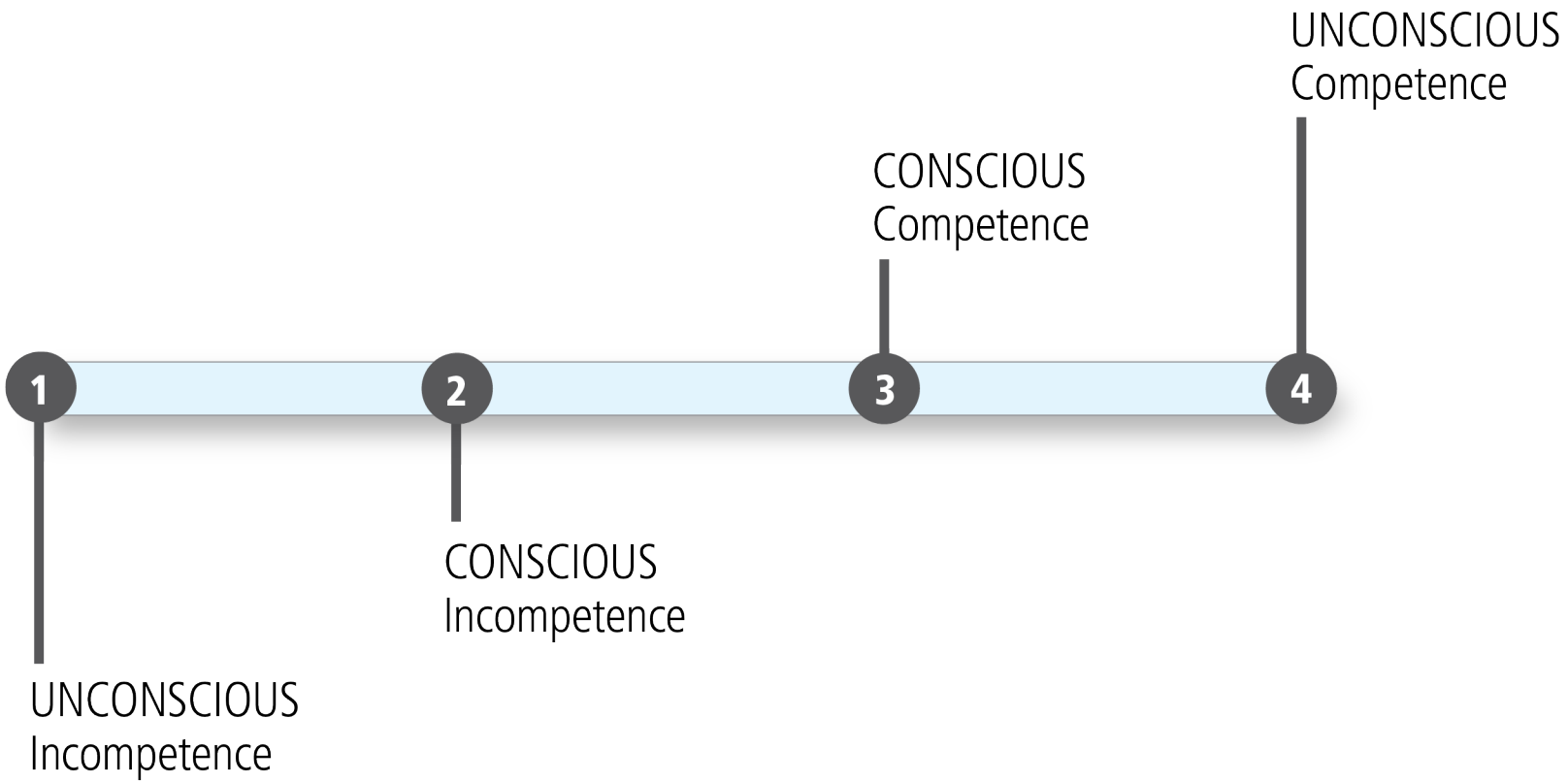
5. Goal-directed practice coupled with targeted feedback enhances the quality of students' learning

An important caveat

The Stroop Effect (1935)

XXXX	RED	YELLOW
XXXX	YELLOW	RED
XXXX	BLUE	GREEN
XXXX	GREEN	BLUE
XXXX	RED	YELLOW
XXXX	GREEN	BLUE
XXXX	BLUE	RED

The expert blindspot



Sprague and Stuart (2000)

What we owe our students

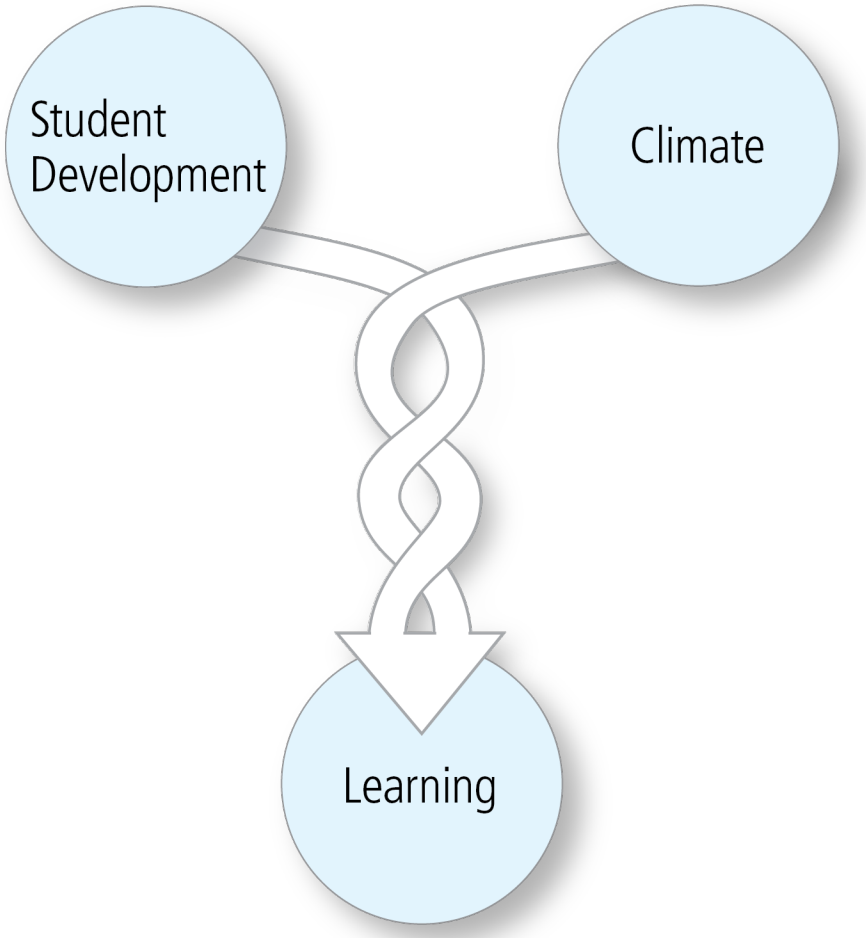
Learning environments where educators

- Actively hunt down their expert blindspots

Learning environments that

- Emphasize both individual skills and their integration
- Explicitly teach for transfer
- Provide multiple opportunities for authentic practice
    - Oriented toward clear goals
    - Coupled with targeted feedback

6. Students' current level of development interacts with the social, emotional, and intellectual climate of the course to impact learning



From Morning-Glory to Petersburg (The World Book, 1928)

"Organized knowledge in story and
picture"
confronts through dusty glass
an eye grown dubious.
I can recall when knowledge still was
pure,
not contradictory, pleasurable
as cutting out a paper doll.
You opened up a book and there it was:
everything just as promised, from
Kurdistan to Mormons, Gum
Arabic to Kumquat, neither more nor
less.
Facts could be kept separate
by a convention; that was what
made childhood possible.

Now knowledge finds me out;
in all its risible untidiness
it traces me to each address,
dragging in things I never thought
about.
I don't invite what facts can be
held at arm's length; a family
of jeering irresponsibles always
comes along gypsy-style
and there you have them all
forever on your hands. It never pays.
If I could still extrapolate
the morning-glory on the gate
from Petersburg in history—but it's too
late.

--Adrienne Rich

Theories of Intellectual Development

Describe how approaches to knowledge develop over time

- Perry developmental scheme
  - 464 interviews with 140 Harvard (male) students in 50's and 60's -- Perry (1970)
- Women's ways of knowing
  - 135 women (90 students) in late 70's and 80' in the US -- Belenky at al. (1986)
- Gendered-patters in knowing and reasoning
  - 101 students (50 males) at Miami University, followed for 5 years (86-91) -- Baxter-Magolda (1992)

Stages of Intellectual Development

<table>
<tr><td>Perry</td><td></td><td colspan="2">Dualism</td><td>Multiplicity</td><td>Relativism</td><td>Commitment</td></tr>
<tr><td rowspan="3">Belenky et al.</td><td rowspan="3">Silence</td><td colspan="2" rowspan="3">Received K.</td><td rowspan="3">Subjective K.</td><td>Procedural K.</td><td rowspan="3">Constructed K.</td></tr>
<tr><td>Separated</td></tr>
<tr><td>Connected</td></tr>
<tr><td>Baxter-Magolda</td><td></td><td>Absolute K.</td><td>Transitional K.</td><td>Independent K.</td><td colspan="2">Contextual K.</td></tr>
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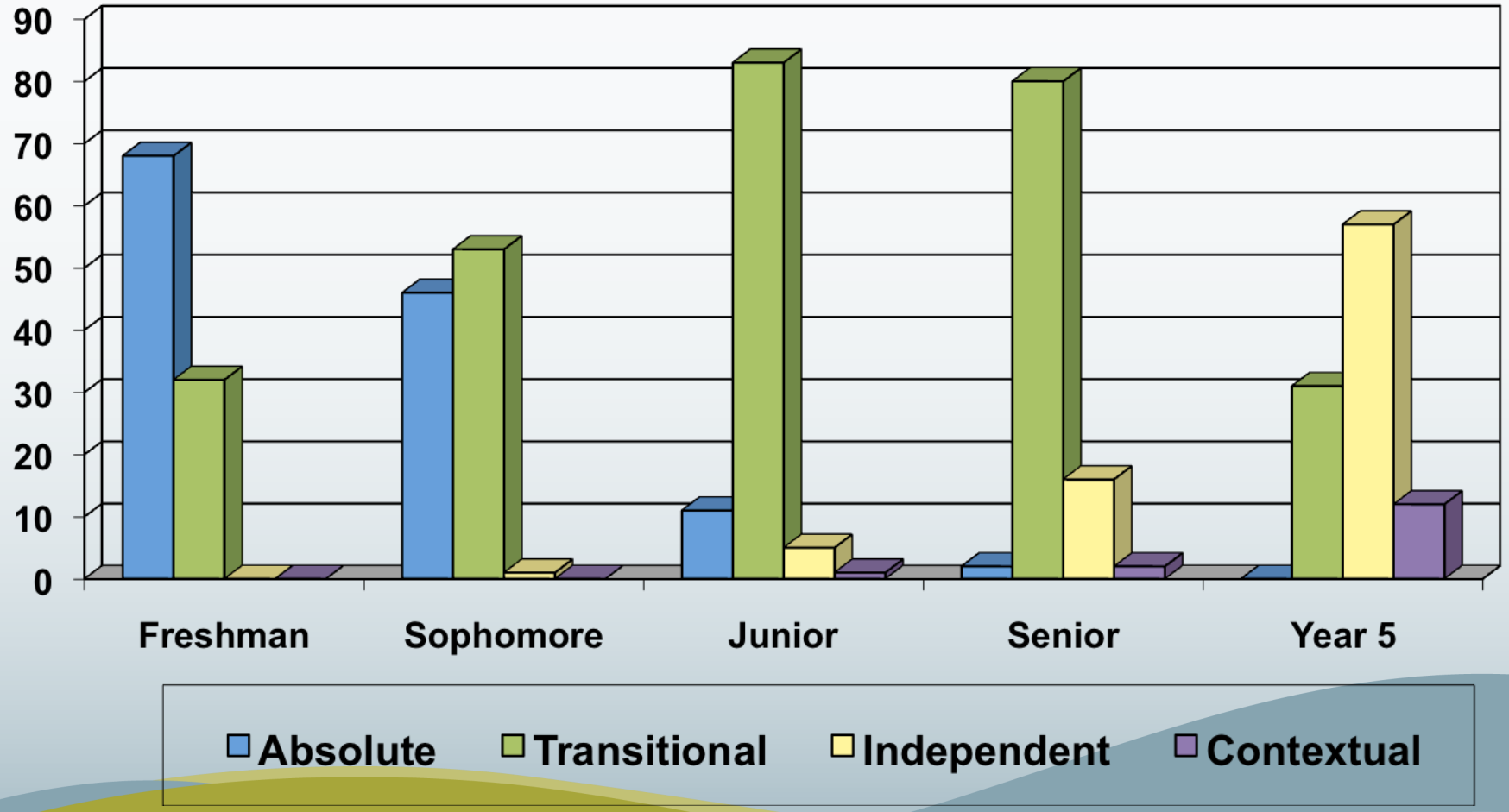
Intellectual Development by Year



Baxter-Magolda (1992)

What we owe our students

Learning environments that

- Use the tools of the disciplines to engage and embrace complexity
- Are explicitly inclusive in methods and content

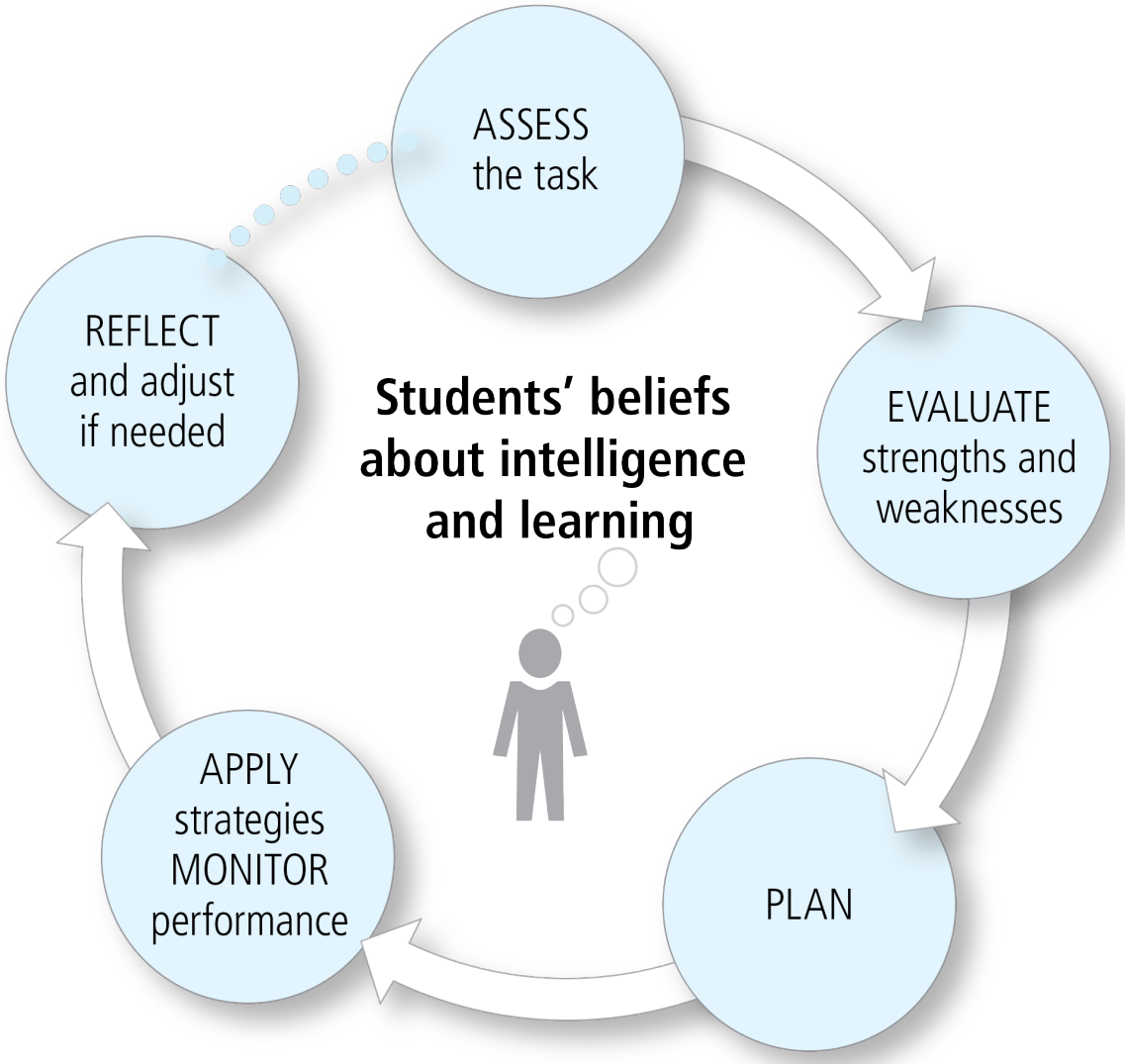
7. To become self-directed learners, students must learn to monitor and adjust their approaches to learning

Metacognition: Definitions

"Metacognition refers to one's knowledge concerning one's own cognitive processes or anything related to them, e.g., the learning-relevant properties of information or data. For example, I am engaging in metacognition if I notice that I am having more trouble learning A than B; if it strikes me that I should double check C before accepting it as fact."—J. H. Flavell (1976, p. 232).

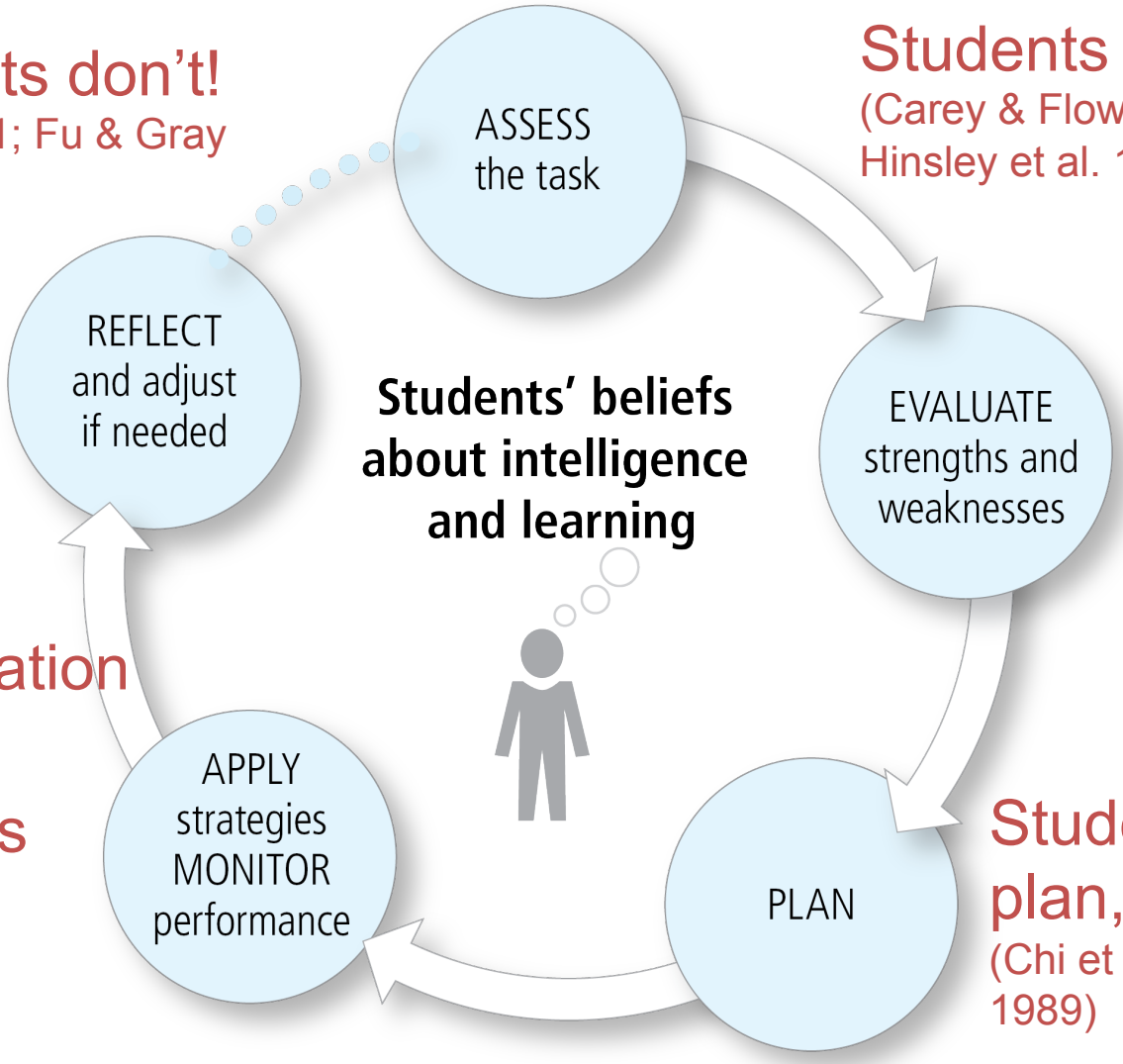
"The process of reflecting and directing one's own thinking."—National Research Council (2001, p. 78).

7. To become self-directed learners, students must learn to monitor and adjust their approaches to learning



Evidence from research on metacognition

Students don't!
(NRC 2001; Fu & Gray 2004)



Students don't!
(Carey & Flower 1989; Hinsley et al. 1977)

Students overestimate their strengths
(Dunning 2007)

Students don't plan, or do it poorly
(Chi et al. 1989; Carey et al. 1989)

Self-explanation effect

But students don't do it!
(Chi et al 1989)

Research on beliefs about learning

- Quick<----------> Gradual
- Intelligence <----------> Intelligence
as Entity Incremental

Beliefs about learning influence effort, persistence, learning and performance (Schommer 1994, Henderson & Dweck, 1990)

Metacognition can be taught

- ✓ Early research found it was EXTREMELY hard
- ✓ More recent research is a little more optimistic

In particular:

- Students can be taught to monitor their strategies, with greater learning gains as a result (Bielaczyc et al. 1995; Chi et al. 1994; Palinscar & Brown 1984)
- Students can be taught more productive beliefs about learning and the brain (Aronson et al. 2002)

What we owe our students

Learning environments that foster

- metacognitive awareness
- a lifelong learning disposition

Teaching strategies

2 in particular:

- Guided self-assessment (Appendix A):

http://www.cmu.edu/teaching/designteach/teach/examwrappers/

- Exam Wrappers (Appendix F):

http://www.cmu.edu/teaching/designteach/teach/examwrappers/

Thank you.

See you at the panel!