Factors Influencing the Effectiveness of Systems Engineering Training in the Department of Defense

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Overview

- **Literature Search:** How do today's educators define effective training and education?

- **Research Question:** Do DoD's Systems Engineering courses encourage a ***deep approach to learning*** and the ***far-transfer of learning to the job***?

- **Approach:** Examine DAU and NPS Systems Engineering courses:
  - Learning Outcomes (Objectives)
  - Methods of Instruction
  - Learning Assessments

Learning – What Really Works?

- **Knowledge is constructed**, not received

- **Mental models change slowly** and only by challenging students intellectually

- **Questions are crucial** because they help students construct knowledge

- **Caring is crucial**; if students don't ask important questions and care about the answers, they will not try to reconcile or integrate new information and replace old mental models

Source: Ken Bain, <u>What the Best College Teachers Do</u>

Far-Transfer of Learning to the Job

- Requires **creative and critical thinking,**

- stimulated by **inductive training,** and

- **problem-centered instruction**

- that engages students to **build their own knowledge and skill base** in long-term memory within a real-world context
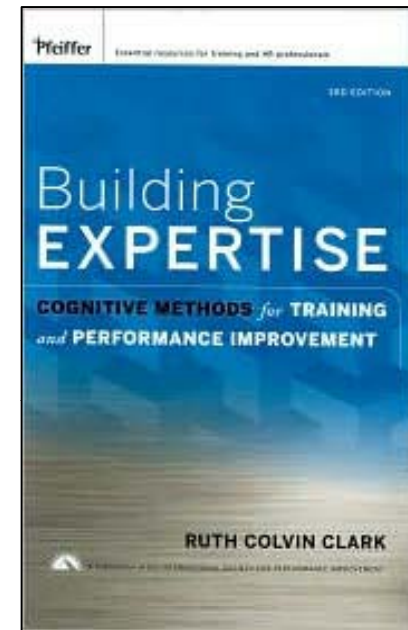
Source: Ruth Colvin Clark, Building Expertise

DAU Systems Engineering Course Hours Categorized by Method of Instruction
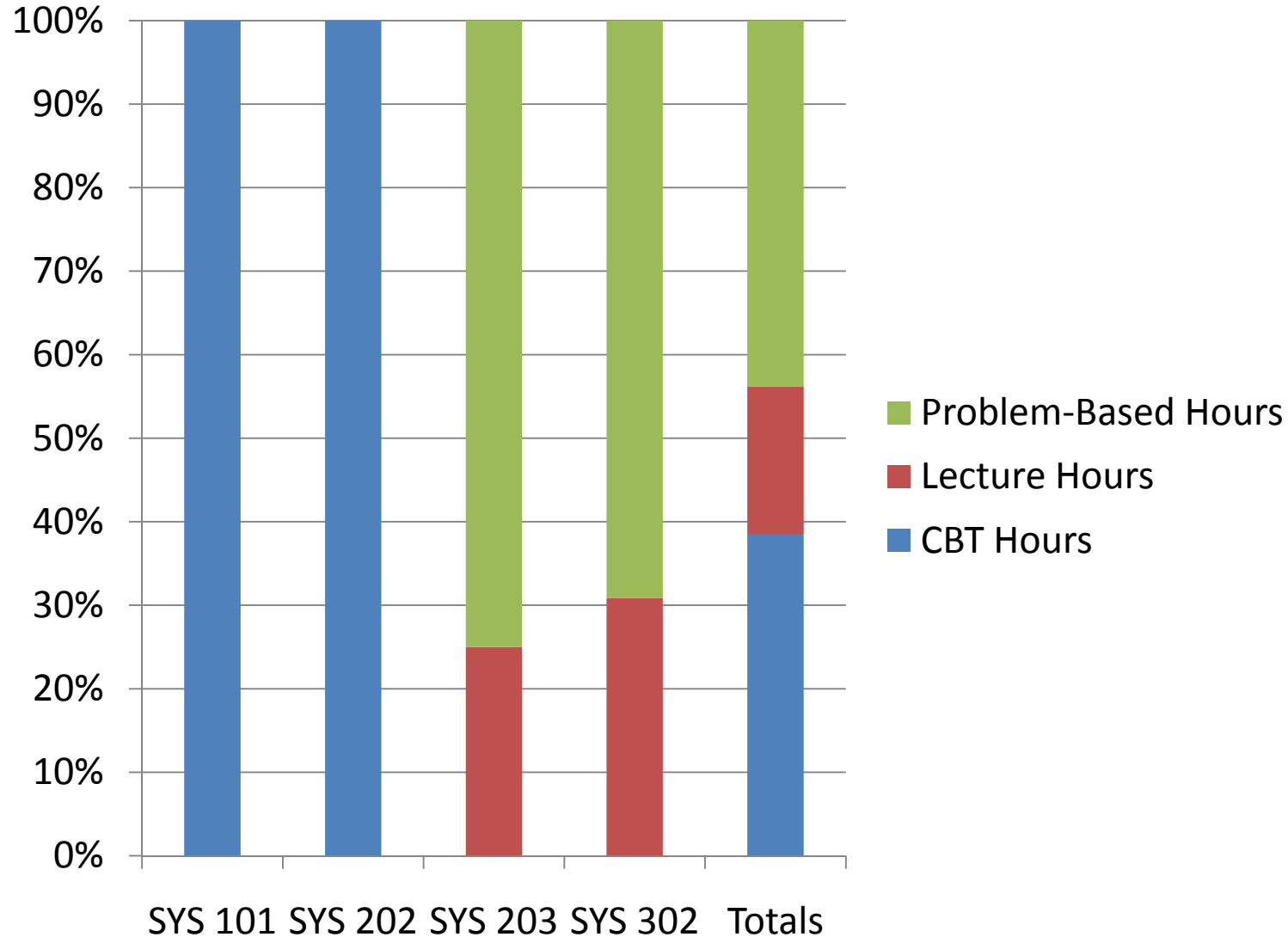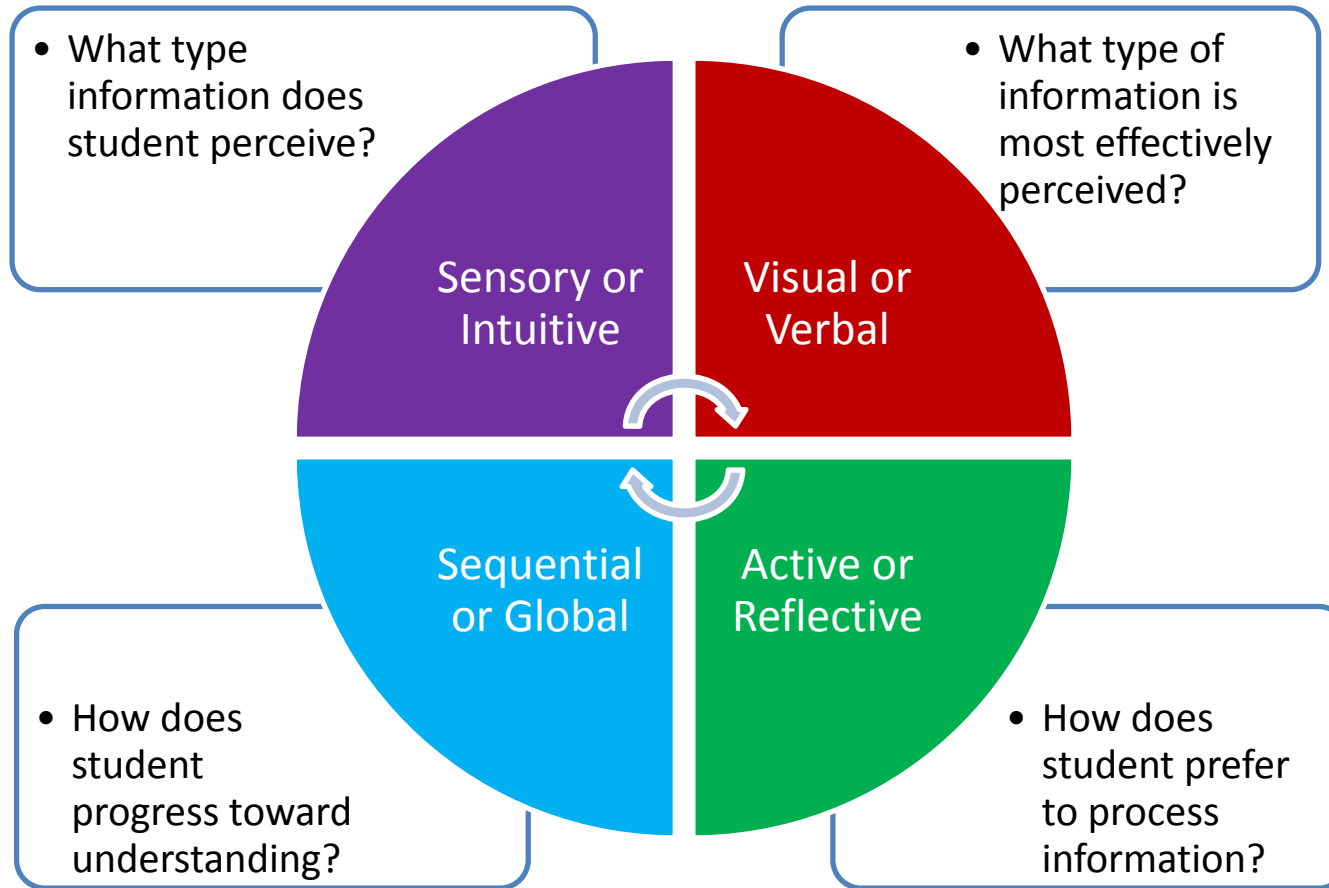
SE 203 Tower Exercise

Problem-Centered Instruction
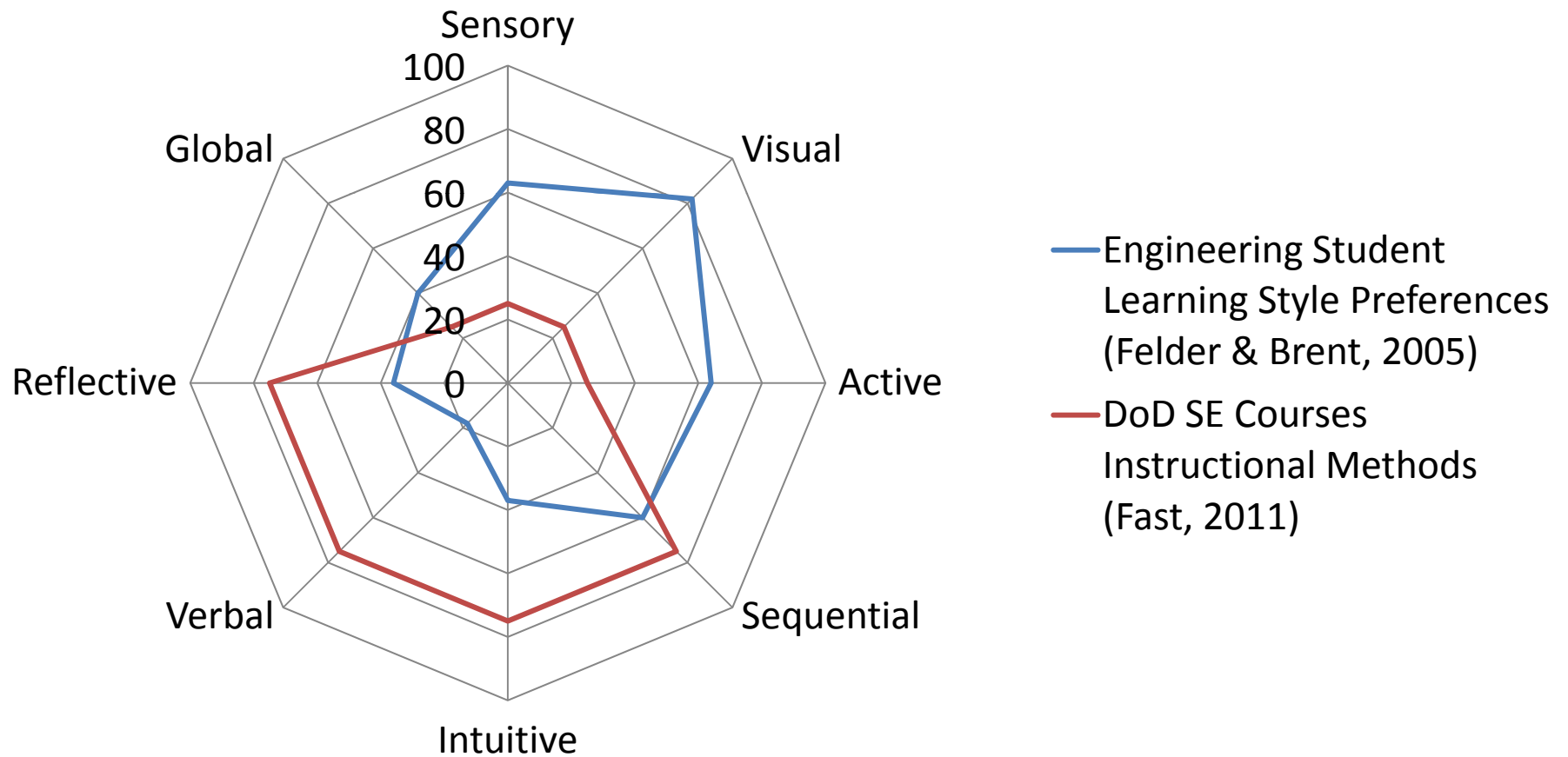

Challenging the Students' Mental Models

Teaching Around the Cycle
(Learning Style Preferences)

- What type information does student perceive?

- What type of information is most effectively perceived?

Sensory or Intuitive

Visual or Verbal

Sequential or Global

Active or Reflective

- How does student progress toward understanding?

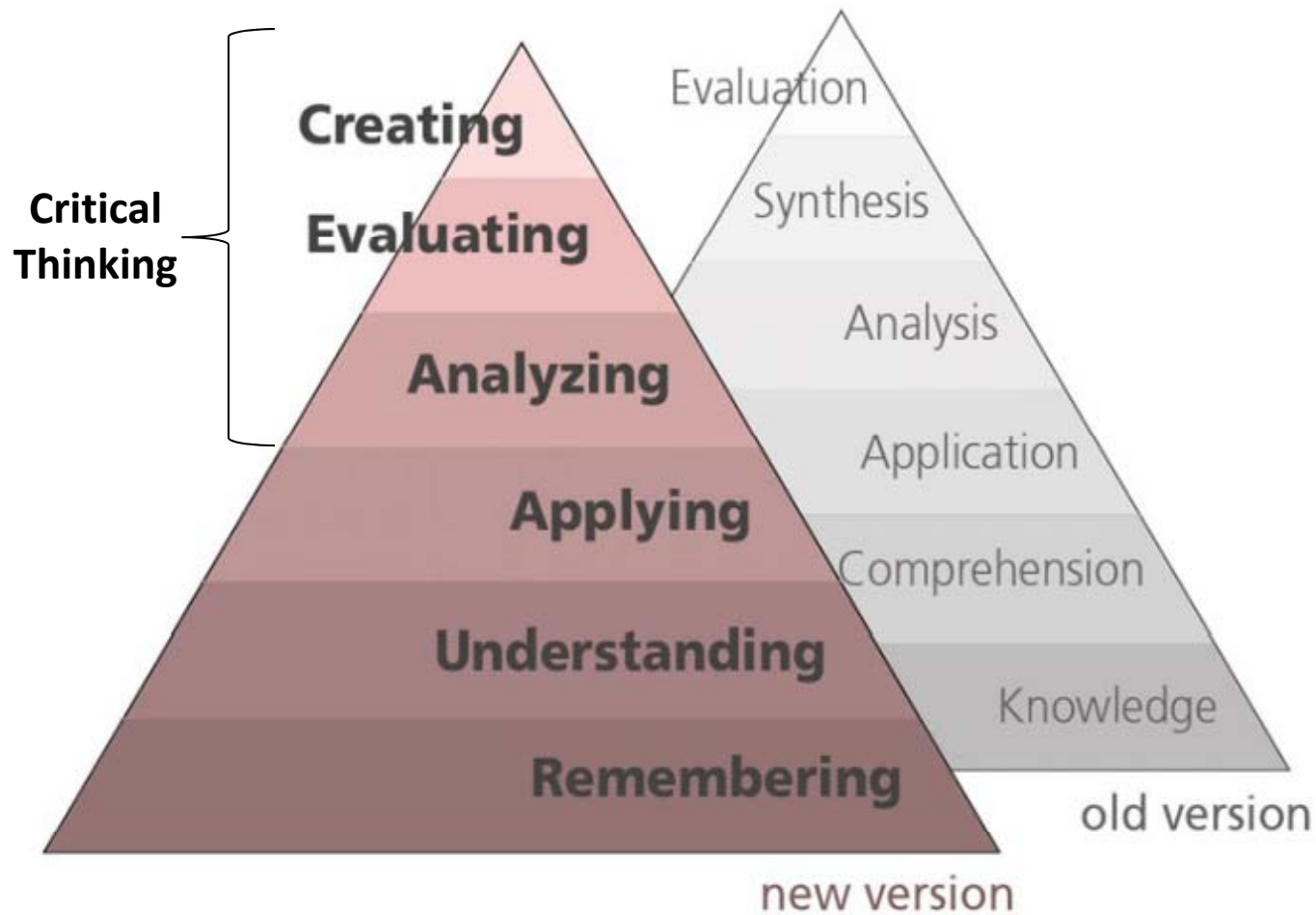- How does student prefer to process information?

Source: R. Felder & R. Brent, <u>Understanding Student Differences</u>

Engineering Student Learning Style Preferences vs. DoD SE Courses Instructional Methods
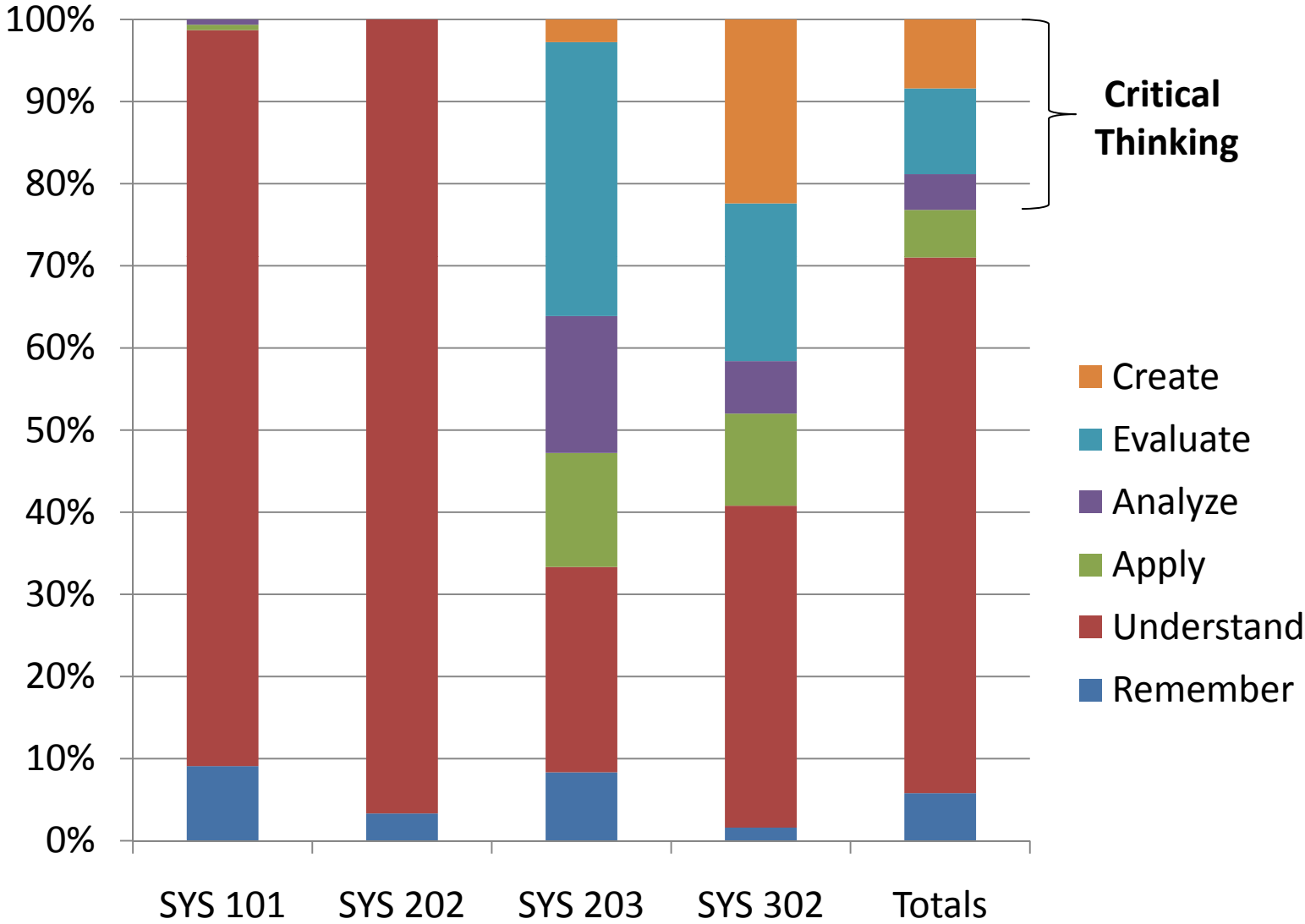
Bloom's Taxonomy

Critical Thinking

Creating
Evaluating
Analyzing
Applying
Understanding
Remembering

new version

Evaluation
Synthesis
Analysis
Application
Comprehension
Knowledge

old version
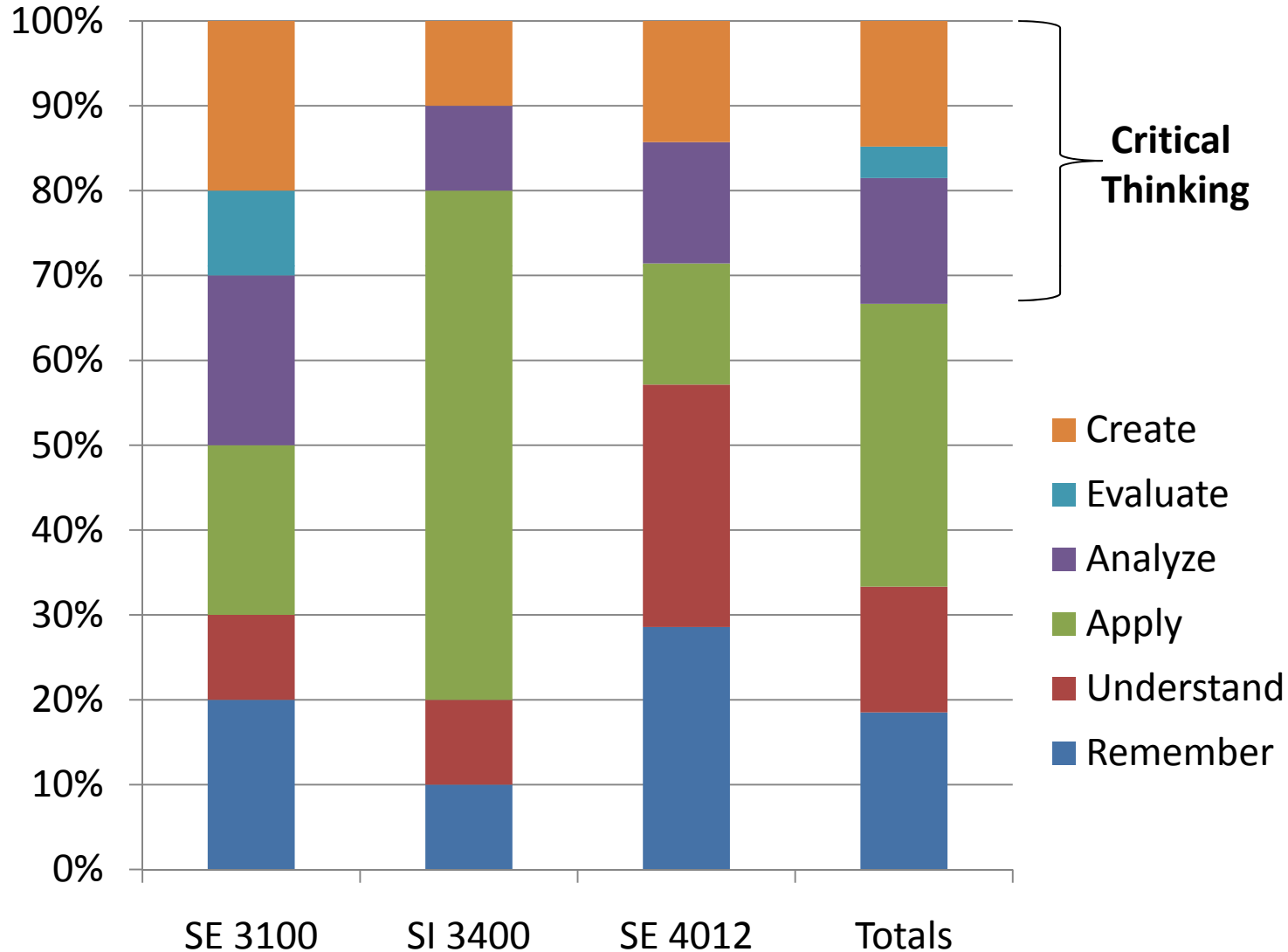
DAU Systems Engineering Lesson Objectives Categorized by Bloom's Level

NPS Systems Engineering Course Objectives Categorized by Bloom's Level

Critical Thinking

Create
Evaluate
Analyze
Apply
Understand
Remember

SE 3100   SI 3400   SE 4012   Totals

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Types of Learning Assessments Used In DAU and NPS Systems Engineering Courses

| Assessment	SYS 101	SYS 202	SYS 203	SYS 302		SE 3100	SI 3400	SE 4012
Objective Exam/Quiz	X	X	X	X		X	X	X
Subjective Exam/Quiz						X	X	X
Homework						X	X	X
Discussion Participation			X			X	X	X
Reflective Writing							X	
Individual Briefing			X	X		X	X	X
Individual Project						X	X	X
Team Project			X	X		X	X	X

Recommendations

• SYS 101 and SYS 201 could be improved by adding **problem solving scenarios** to stimulate the mind and help students build more sophisticated mental models of the systems engineering discipline earlier in their training

• To promote critical thinking, more of the lesson objectives within all of the DAU and NPS systems engineering courses could be written with verbs that target the ***analyze, evaluate, and*** *create* **levels** of Bloom's Taxonomy

• Additional research into **learning for rapid cognition** and **learning patterns of response** might reveal other ways to improve the effectiveness of systems engineering training and education

Learning for Rapid Cognition

…the ability of our subconscious mind to **recognize *patterns*** in everyday life situations based upon narrow slices or samples of experience…

Source: Malcolm Gladwell, <u>Blink: The Power of Thinking Without Thinking</u>
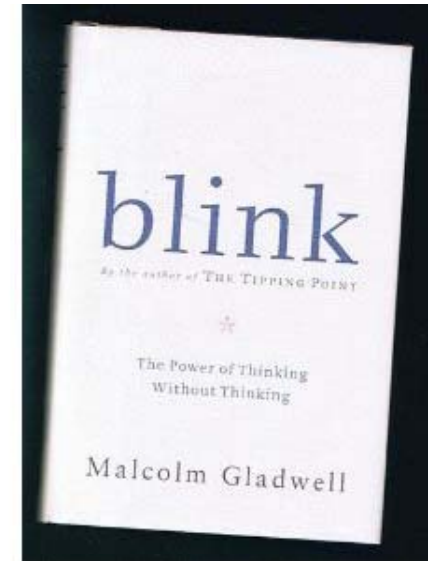
"Experts see patterns that elicit from memory the things they know about such situations [and]…what distinguishes experts is that they have very good encyclopedias that are indexed and **pattern recognition** that is that index"

 Source: Nobel laureate Herbert Simon

Learning Patterns of Response

- The human brain has the ability to adapt to chaos, uncertainty, and change

- Human experience consists of about:
    50 percent stored responses, and
    50 percent newly created responses

- Can we teach more "patterns of response" to help systems engineers better solve complex acquisition problems?
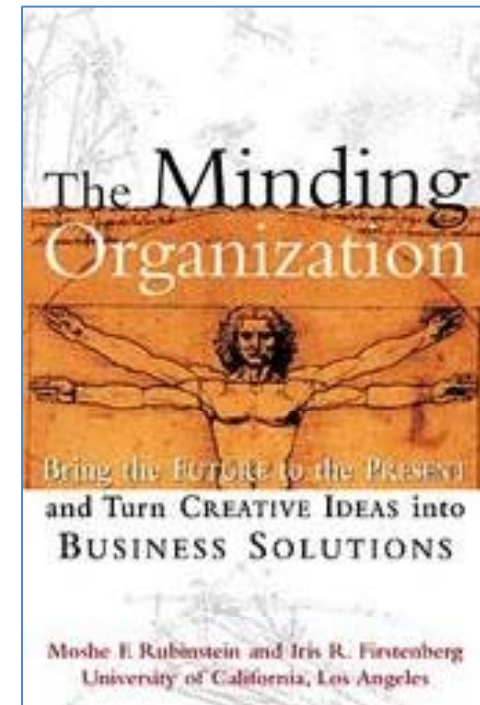
Source: Moshe Rubinstein & Iris Firstenberg, The Minding Organization