Session Outline

Buckmaster	Hull	Mankin	Buckmaster	Brief break / Zulovich
• Introduction	• ASABE texts, text committee (P-515), process, design topics, etc.	• Present survey results • Moderate discussion of survey	• Efficiency in Learning *(book report on the topic of managing cognitive load)*	• Breakout into small groups • Reassemble and report • Wrap-up and summary
10 min	15 min	35 min	15 min	80 min

1. **<u>Identify</u>** topics in ABE and ASM curricula lacking adequate teaching materials
2. **<u>Prioritize</u>** needs
3. **<u>Develop</u>** a plan to meet the identified needs

Managing Cognitive Load

A "book report" of

Efficiency in Learning: Evidence-based guidelines to manage cognitive load. Clark, Nguyen, and Sweller. 2006. Wiley & Sons. ISBN 0-7879-7728-4

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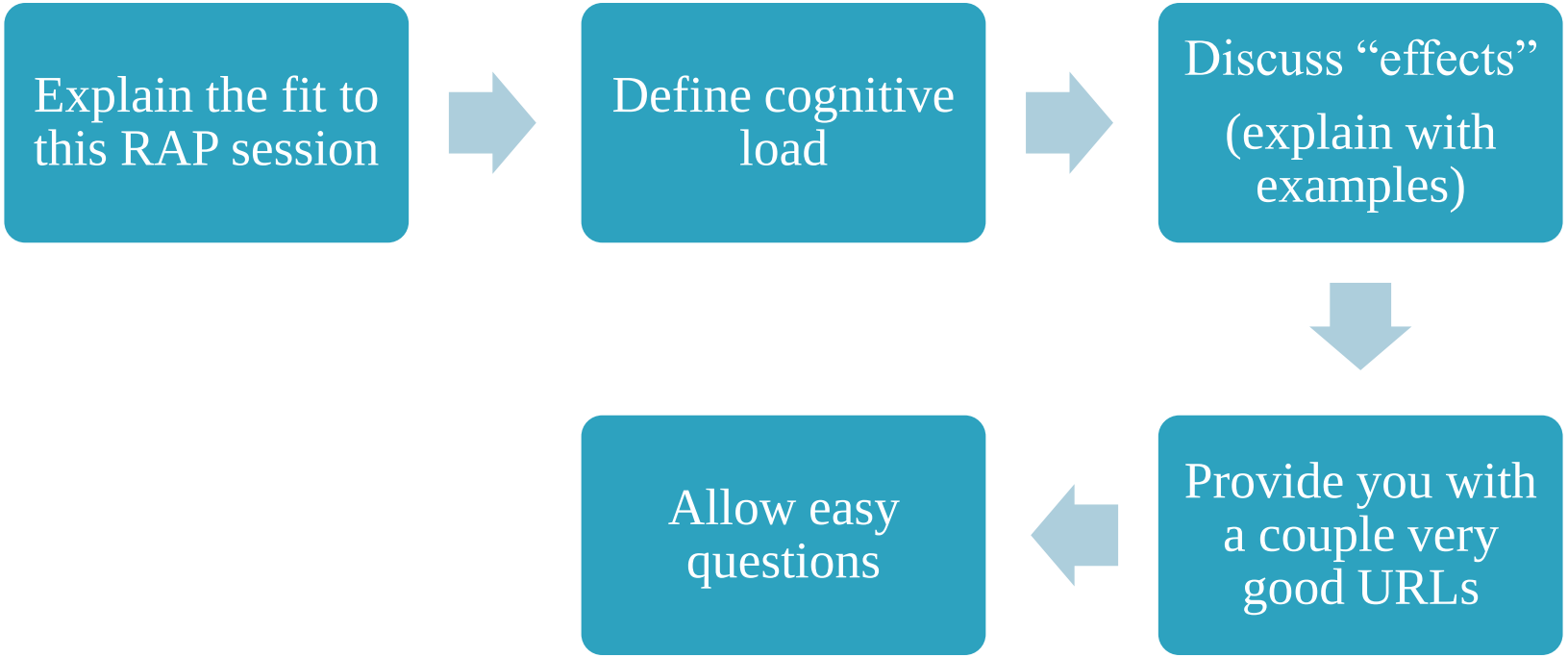
Presentation Outline



References (repeated later)

- *Efficiency in Learning: Evidence-based guidelines to manage cognitive load*. Clark, Nguyen, and Sweller. 2006. Wiley & Sons. ISBN 0-7879-7728-4

- http://www.scitopics.com/Cognitive_Load_Theory.html (Cognitive Load Theory by John Sweller)

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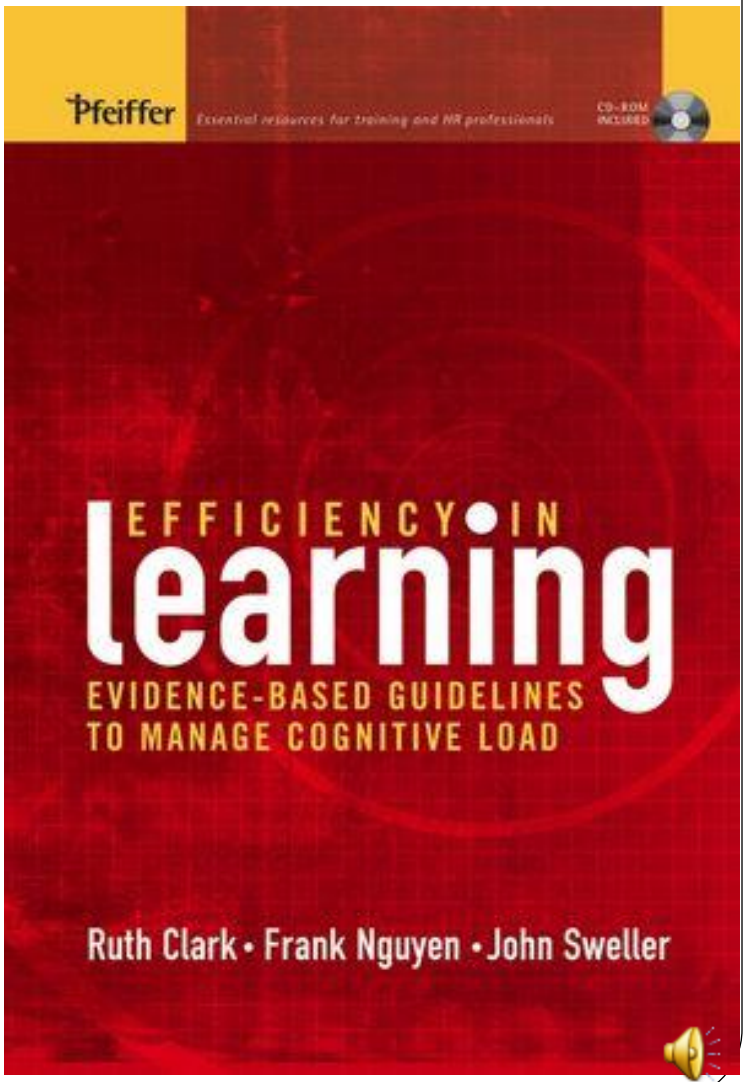


Relevance to today

TEXTBOOK NEEDS ASSESSMENT AND ACTION - Invited Speakers

(P-515, ED-203, ED-205)
Moderator: Joseph M. Zulovich, Univ of Missouri, Columbia, MO
LOCATION: Whitney

The goal of this session is to identify topics in agricultural and biological engineering and in agricultural systems curricula lacking adequate teaching materials. It will also involve prioritizing and developing a plan to meet the identified needs.

A survey will be sent out in advance of the rap session to gather information on areas lacking adequate teaching materials, determine preferred media, and interest in participating in development. At the session the highest interest needs will be determined and plans for developing content will be addressed.

- Aspects of adequate
  - Content (depth, date, audience fit)
  - Quality (style, examples, problems, etc.)
- Planning to meet the needs
  - Sweller and others have some very good things to teach any of us who teach or prepare teaching resource materials

Cognitive Load Theory

- Universal set of instructional principles and evidence-based guidelines that offer the most efficient methods to design and delivery instructional environments in ways that best utilize the limited capacity of working memory.

Cognitive Load Theory (CLT)

1. Is universal (all types of content, media, learners)
   - Technical matter
   - Soft skills
   - Text
   - Visuals
   - Audio

   "Whether you are a classroom instructor or developer of training materials for workbooks or computers, cognitive load theory applies to you"
2. CLT offers principles and related instructional guidelines
3. CLT is evidence-based

Cognitive Load Theory

4. CLT leads to efficient learning
5. CLT leverages human cognitive learning processes

Types of Cognitive Load

- Intrinsic

  Mental work imposed by the complexity of content – associated with the instructional objective

- Germane (relevant)

  Mental work imposed by instructional activities that benefit the instructional goal – diverse examples or applications are an example

- Extraneous (irrelevant)

  Wastes limited mental resources that could be directed to germane load

Remember: working memory is limited

Just a bit of vocabulary

- Working memory

  Central element of human cognition responsible for active processing of data during thinking, problem solving and learning; has limited capacity

- Long-term memory

  A relatively permanent mental repository of knowledge and skills in the form of schema that provide the basis for expertise.

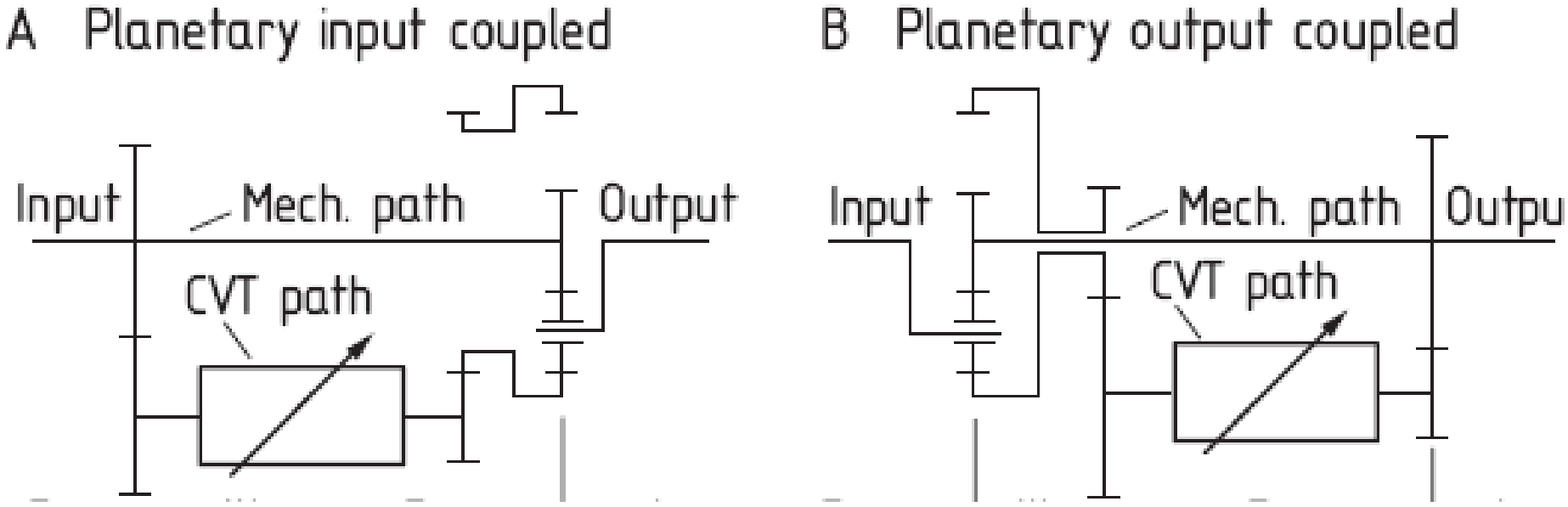
- Schema

  A memory structure located in long-term memory that is the basis for expertise. Allows chunking of many elements of information into a single element. Sometimes called mental models. Can be large or small and grow over time. (similar to scaffolding)

- Automaticity

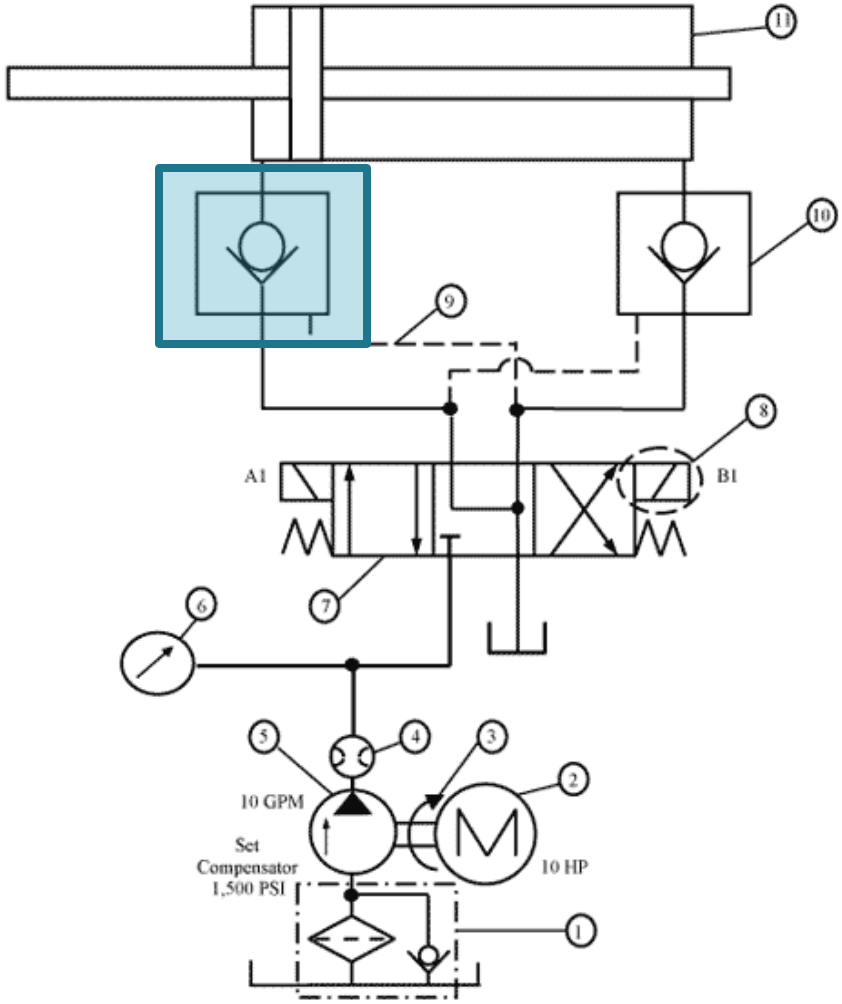
  Status of any knowledge or skill that has been used so many times that it can be activated from long-term memory and applied using minimal working memory resources.

Schema Example #1



Source: Renius, K. and R. Resch. 2005. Continuously variable tractor transmissions. ASABE Dist. Lecture No. 29. 37 pp.

Schema Example #2



Source: Hydraulics and Pneumatics Fluid Power e-book, Edition 1 Fluid Power Basics. Chapter 21 (Practice Circuits).

http://www.hydraulicspneumatics.com/200/eBooks/Article/True/79292/

Some of this *(CLT mumbo-jumbo)* …

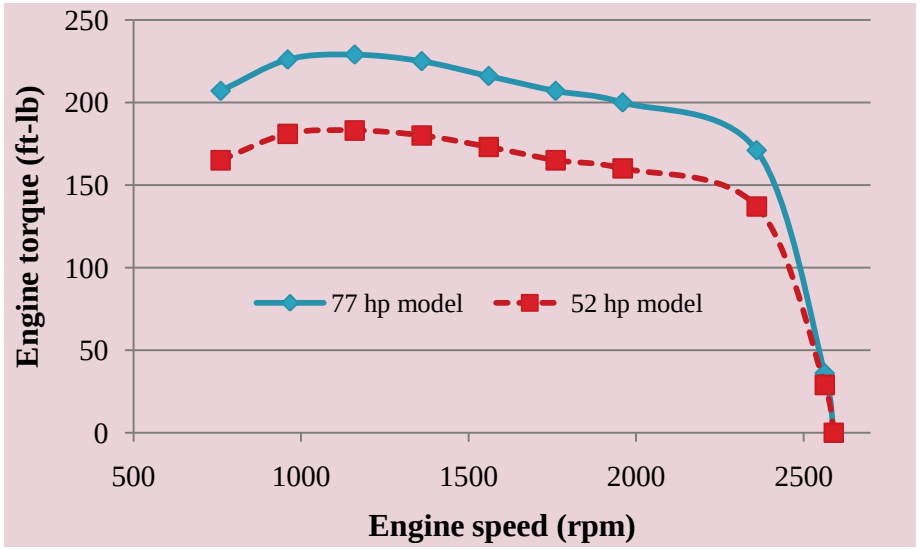
- will seem obvious … I knew that
- will seem counter-intuitive … I don't believe it
- will strike a cord … Oh, that is why …
- will reinforce the way you do things … I'll keep on …
- will lead you to experiment … I'll try it a different way next time

Split Attention Effect

- Extraneous cognitive load caused by separation of related instructional elements
- Examples:
  - Text and figures
  - Tutorial manual and computer screen
  - Note taking during lectures
- Fixes:
  - Use cues and signals when content is complex
  - Integrate text and graphics on the same page or screen
  - Provide content summaries
  - Avoid computer “manuals”

Which is a quicker read?

With Legend



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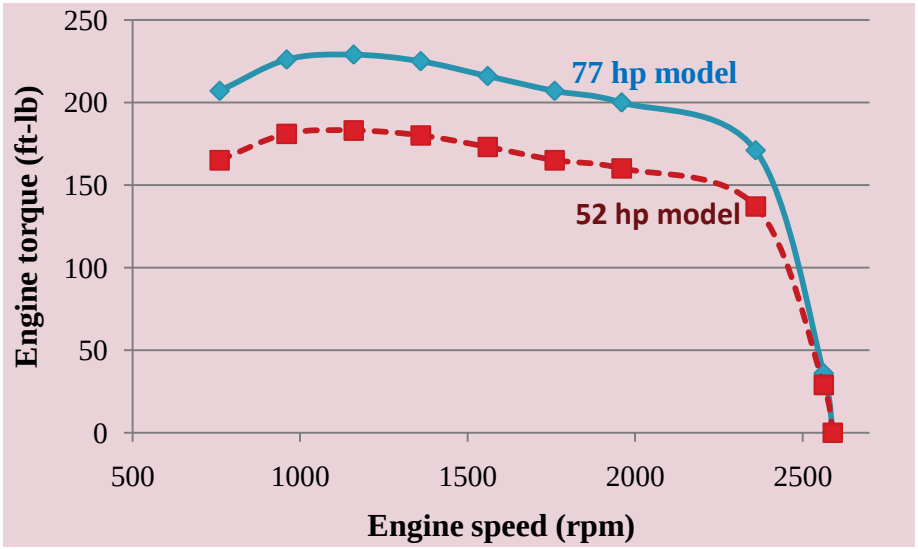
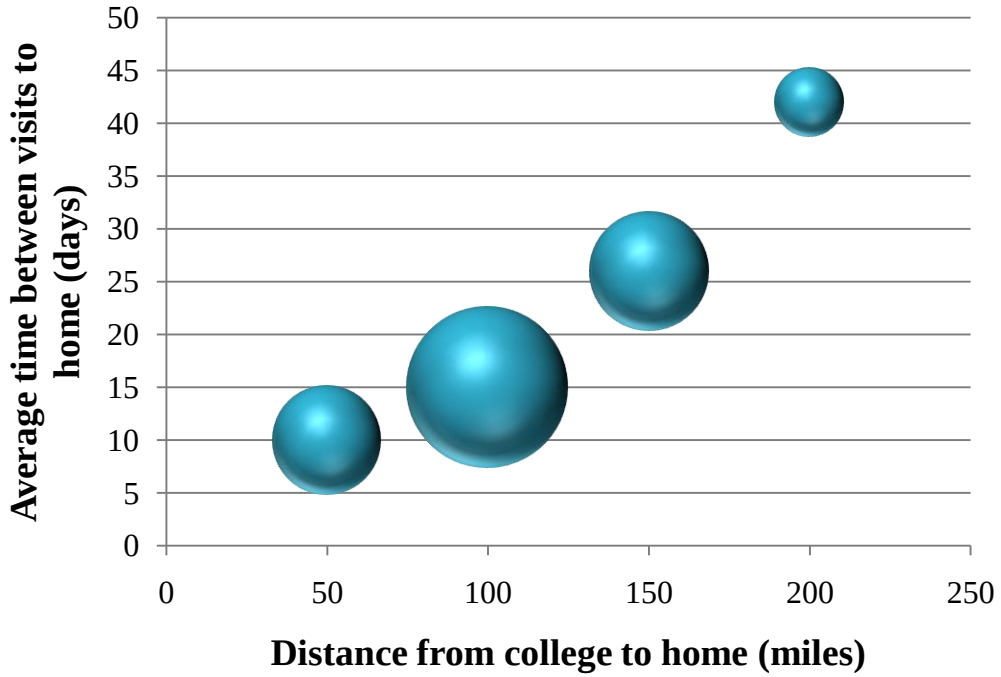


Modality Effect

- Working memory includes separate processing areas for visual and auditory information
- Using auditory mode along with visual makes most efficient use of limited working memory resources
  - Complex visuals are understood more efficiently when explanatory words are presented in audio modality than when presented in written modality
- Employs dual encoding which is a combination of words and visuals

- Example follows with 3 presentation methods
  - Graphic & static (textbook style) text
  - Graphic and my explanation
  - Graphic and animated text

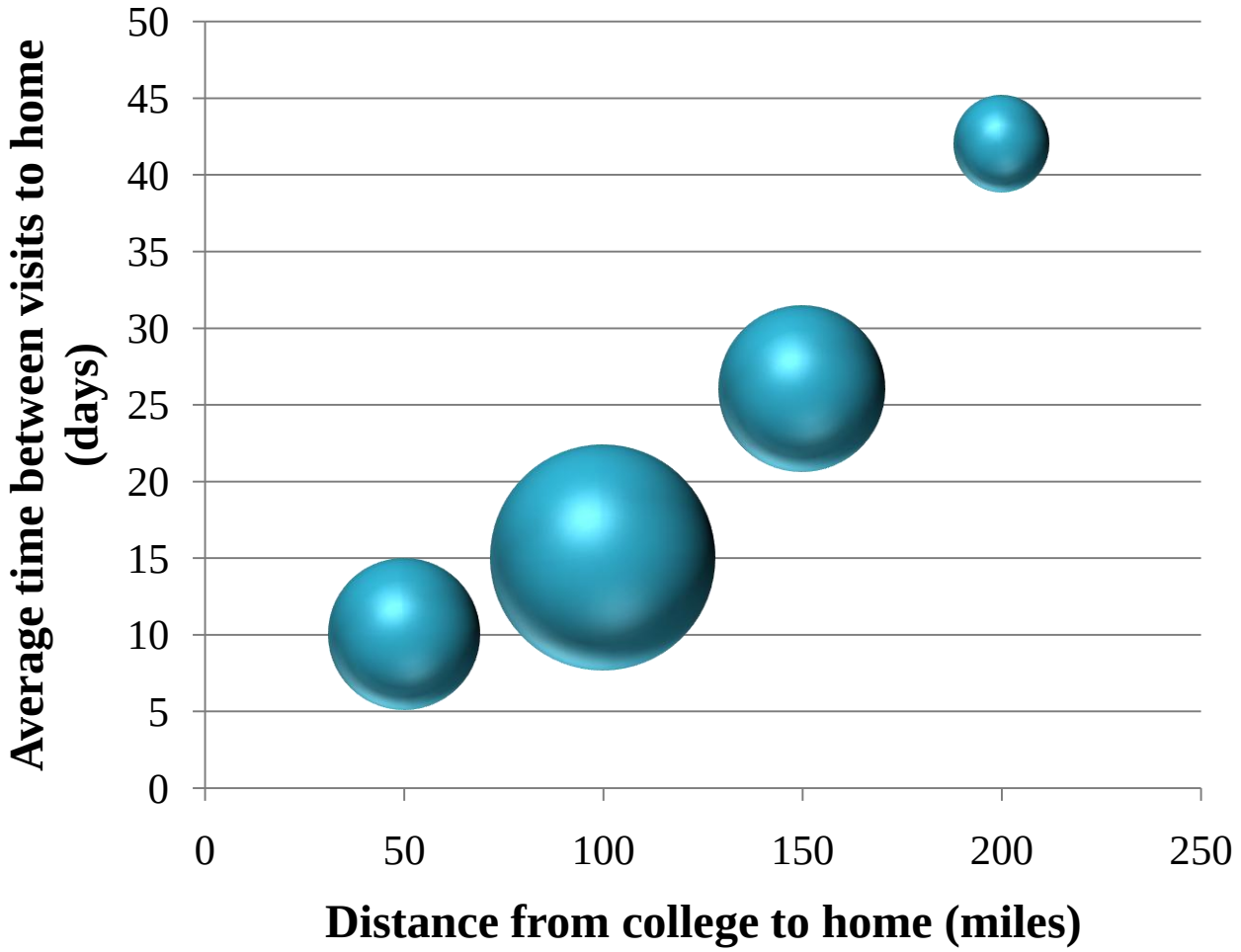
How often do students go home?



- Larger bubbles represent more students
- Vertical axis is time between visits home
- Horizontal axis is distance from college to home

- As students live farther from home, they go home less frequently
- The curve appears to be a bit exponential
- Not many students live extremely far from home

How often do students go home?



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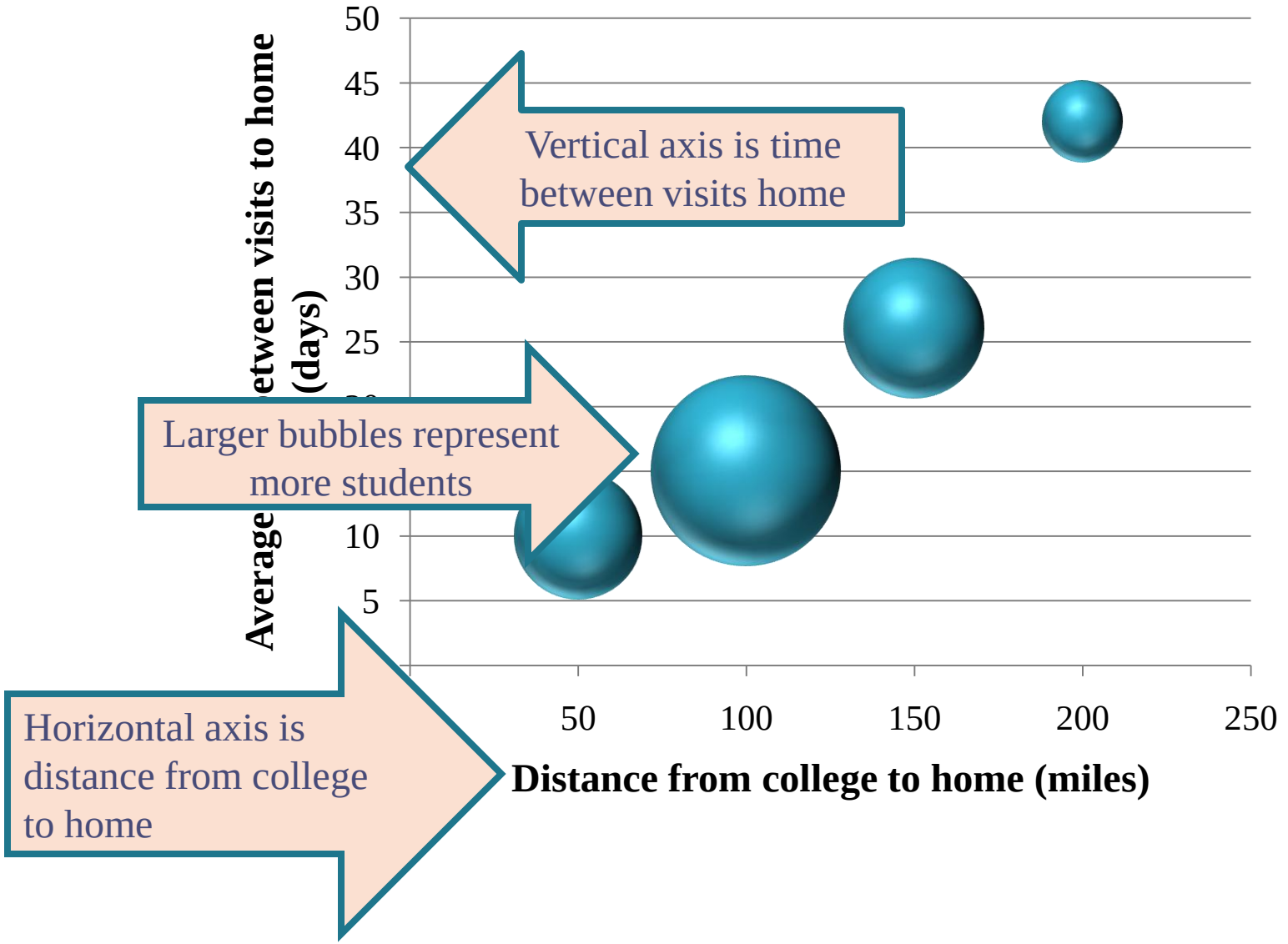

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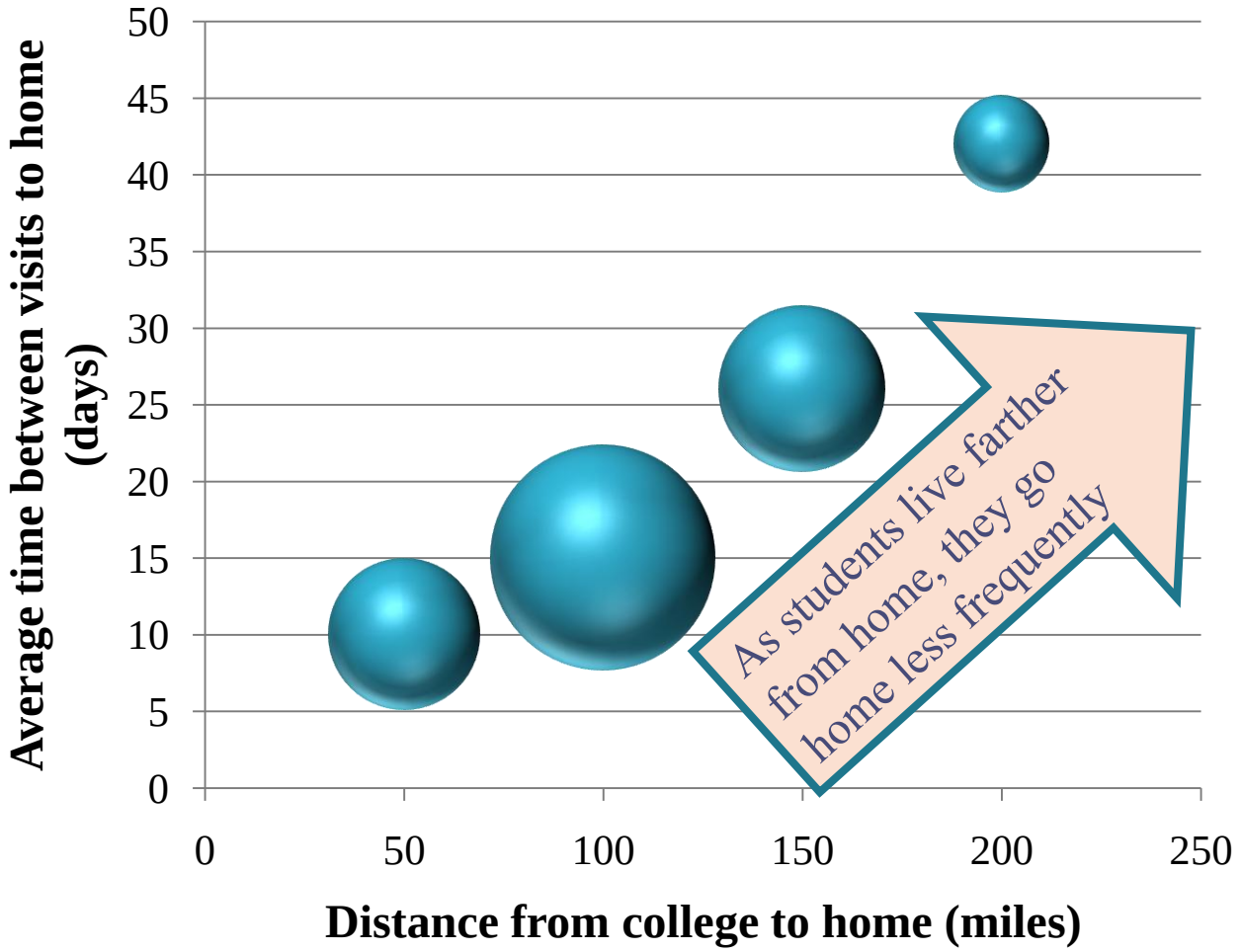

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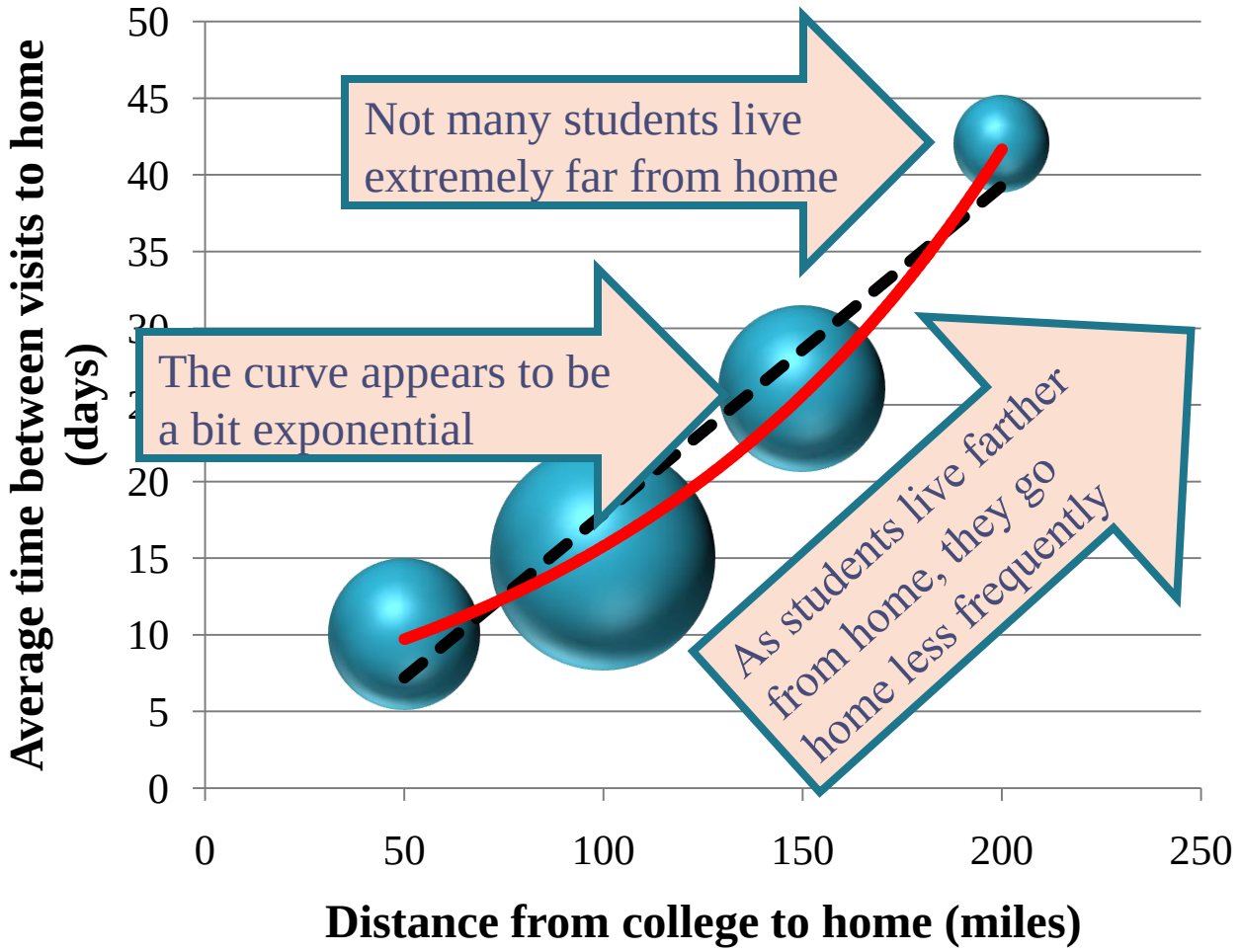

Expertise Reversal Effect

- Because experts have a relatively large schema relevant to the instructional goal, they are able to manage their own cognitive learning processes without external instructional support.
- In some cases, instructional methods such as worked examples interfere with the learning of experts because of conflict between the instruction and the existing schema of experts.

Expertise Reversal Effect

- EXAMPLE: How would you explain the operation of a track dozer to …
  - A teenager with little driving experience (perhaps a car only)
  - A farmer with lots of different vehicle experience (skid steer loaders, SP harvesters, tractors of various brands, trucks, cars, … if it has a key they could run it)

Redundancy Effect

- Content or content expressions that are duplications of each other impede learning.
- Frequently applied to information presented that is irrelevant to schema acquisition.
- Should not be confused with rehearsal or repetition (which aids in automation

- Examples:
  - Reading of text on a slide
  - Text (or audio explanation) for a visual that truly doesn't need any explanation
  - For you, an audience experienced with charts, the earlier explanation of axes was redundant with the axis label itself

Self Explanation/Mental Rehearsal

- Process new knowledge and skills in working memory
- Mental processing of examples in which learners attempt to clarify or elaborate on an example presented in instruction … leads to better learning
- May be rote processing … maintenance rehearsal
- May be deeper processing … elaborative rehearsal
- Helps automate schemas

- Examples:
  - Athletics
  - Presentations
  - Early problem solving instruction

Self Explanation/Mental Rehearsal

- Think of a time you perhaps overwhelmed your students' working memory with extraneous cognitive load

- Think of a skill or knowledge that you have which is automated

- Think of an example where you could apply your newfound knowledge of the expertise reversal effect

Worked Examples

- Step b
  comp
- Repla
  has be
- Often implemented with backwards fading (partially incomplete)
- Varied context increases germane load, but is beneficial for far-transfer learning of concepts and principles
  - Worked example/problem pairs is more efficient than all-practice lessons

Likely the most obvious of these effects to us as engineers.

Learner Control

- Giving the learner control of
  - Pacing
  - Content
- No (or very little) learner control in lecture
- Partially applicable in textbooks
- Takes thought with web/CD content

- How to:
  - Teach in segments and modules
    - Allows for repetition as necessary
    - Allows user to skip as desired
  - Teach support knowledge separately
  - Teach components before full systems

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