

Cognitive Aspects of Project- Based Civil Engineering Education.

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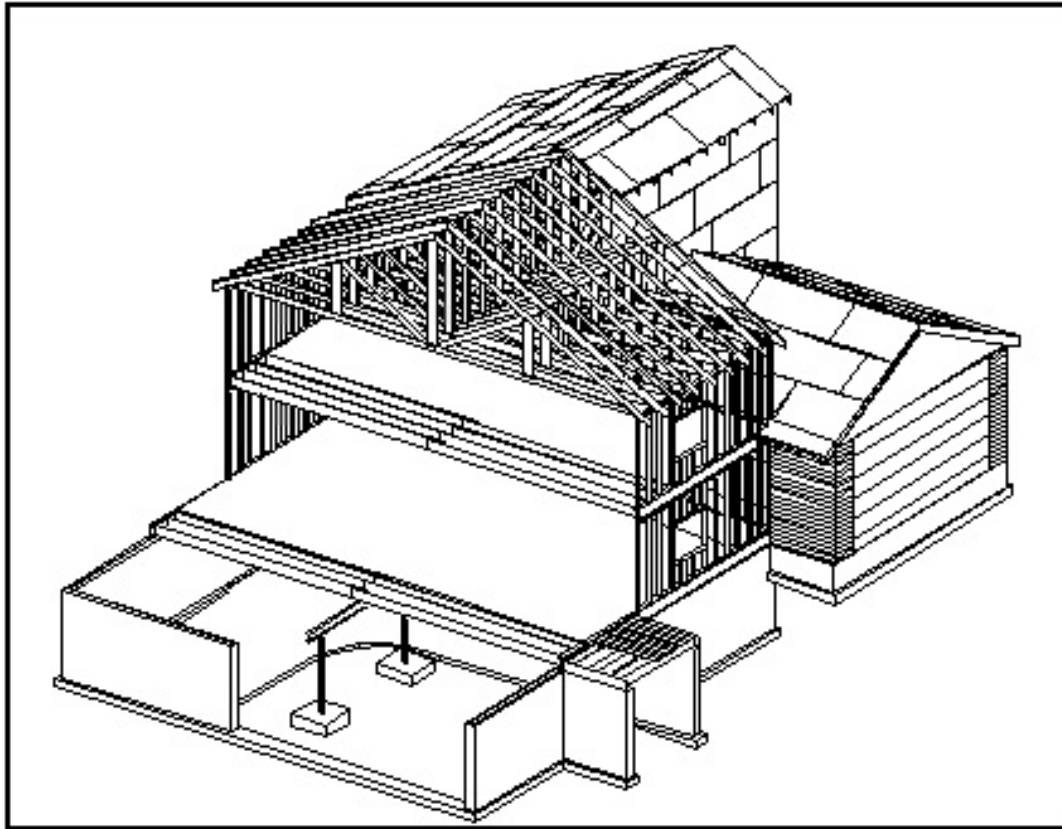
The three most important things
about learning and remembering
to take away from this talk.

- 1. Structure.
- 2. Structure.
- 3. Structure.

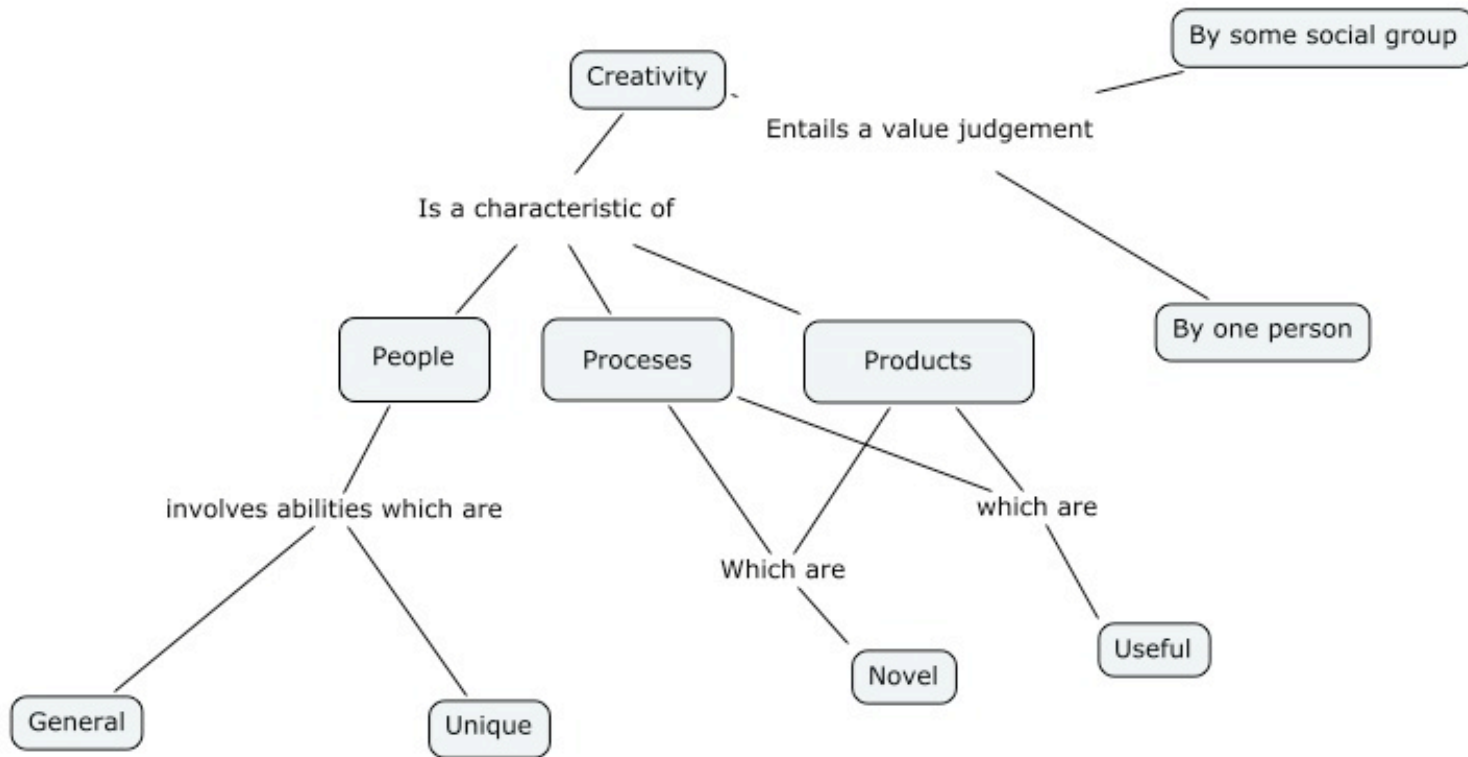
Cognitive Engineering is similar to Structural Engineering

- It involves a requirements analysis, including an understanding of what you are building the foundation on.
- It involves designing the structures you want to create.
- It involves working with the builder to help erect the structures (while recognizing that no one has a perfect memory).

We can create a picture of a building structure.



Picture of a knowledge structure (Concepts and Relationships).



Why bother with project-based learning?

- Because project-based learning is either a simulation of the context or includes some of the context in which final performance takes place.
- This is critical because the extent and nature of learning is strongly influenced by the context in which it takes place.

Why believe it works?

- Lots of support in the research literature.
- Training of skills clearly benefits from simulations and direct experience.
 - E.g., WWII Navy Fighter Pilots who survived their first dogfight were likely to survive the entire war. Hence the Top Gun school.
 - E.g., CPR Training and Resusci Anne (Rescue Anne or CPR Anne)

Goal: Improved performance.

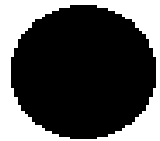
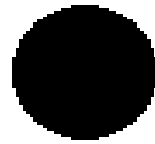
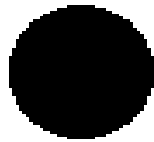
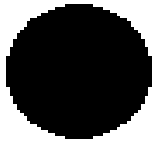
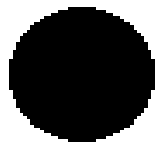
- Project-based learning is all about building structures in the context of performance:
 - Organizing knowledge structures.
 - Elaborating them.
 - Applying them.
 - Sometimes, rebuilding them to be better.

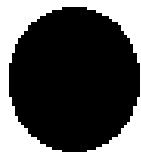
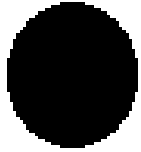
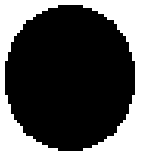
Why are structures so important?

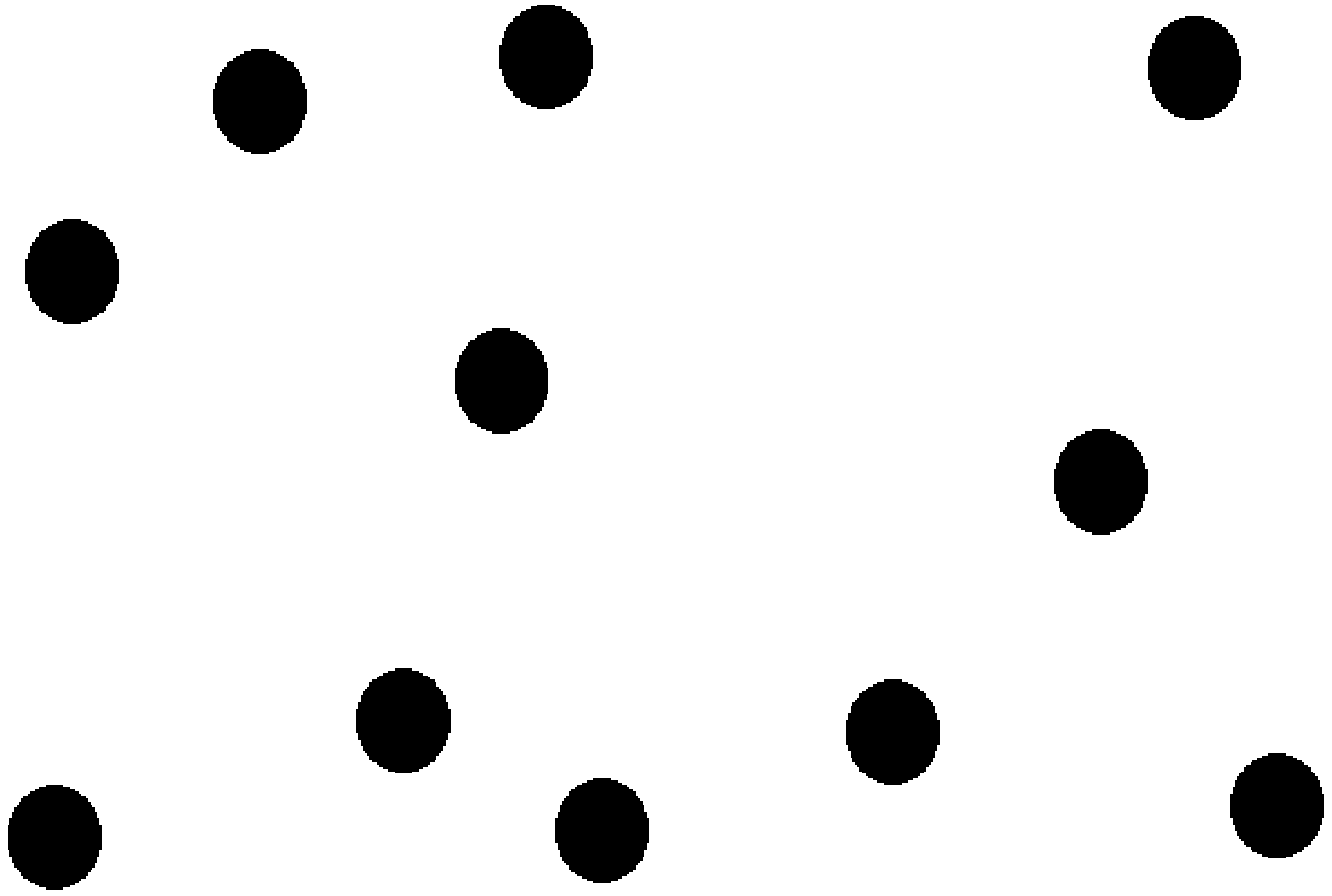
- Cognitive structures have effects on knowledge.
 - The following examples are visual and “simple.”
 - The same effects examples can also be demonstrated in numerous areas of learning, remembering and performing.

“Chunking.”

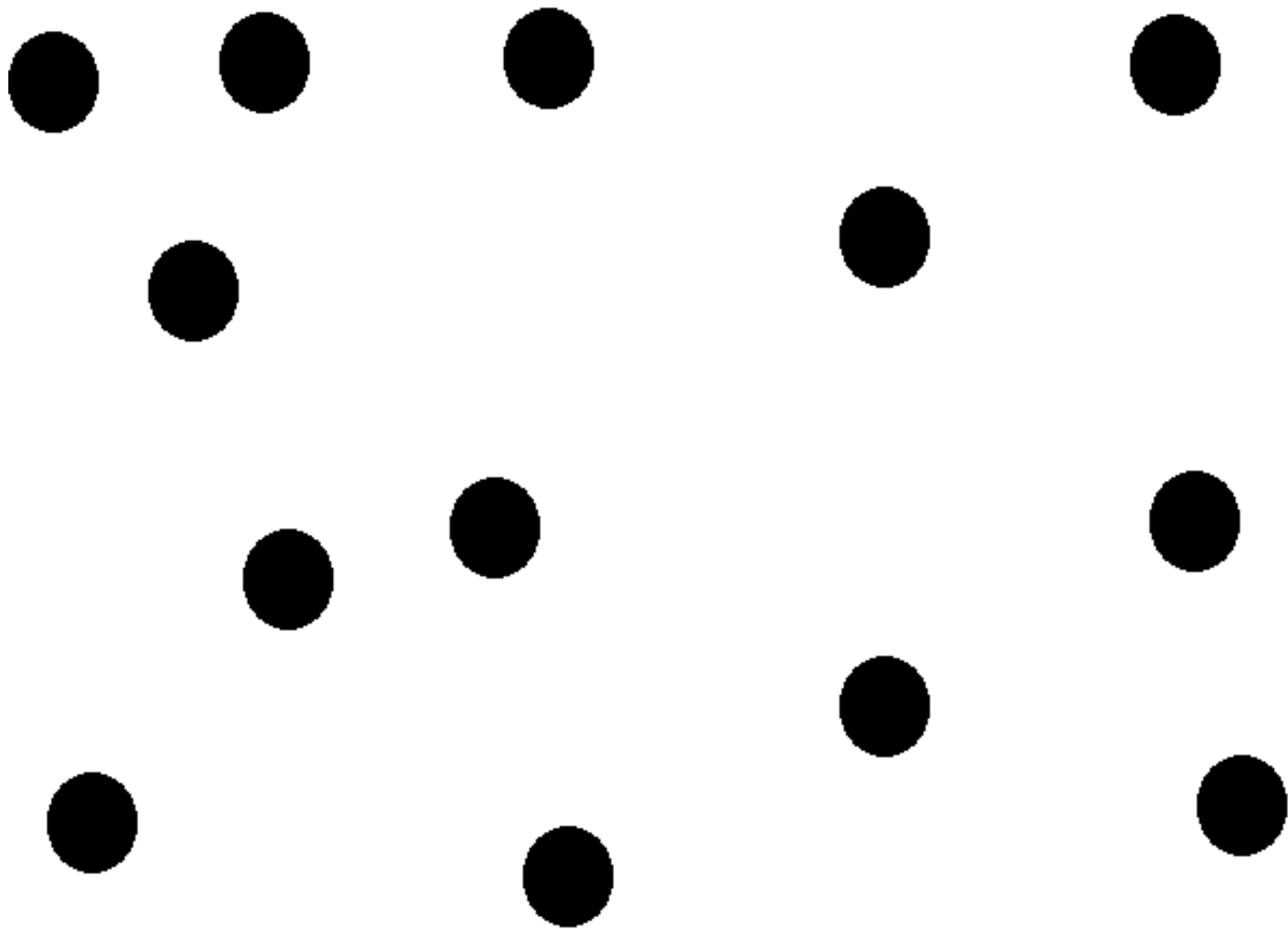
- Series of slides with large spots on them.
- Without stating a number aloud, write down or keep track of the number of spots you see on each slide.
- We’ll review them after you’ve seen them all.

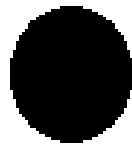
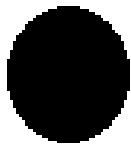
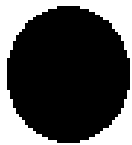
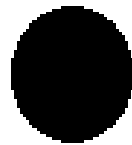
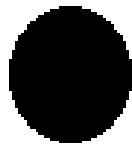
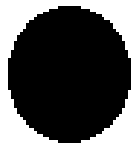
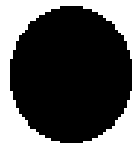
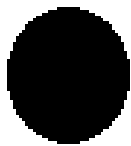
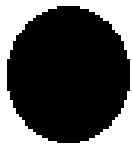


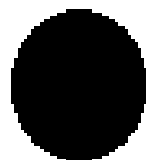
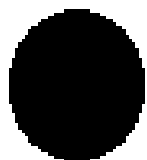
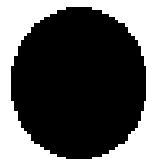
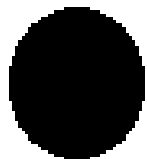
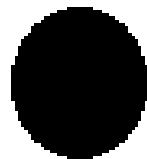
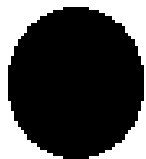
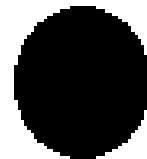
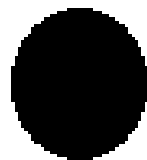
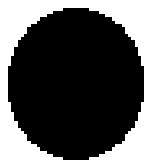












OK, lets review.

- How many on slide 1?
- How many on slide 2?
- How many on slide 3?
- How many on slide 4?
- How many on slide 5?
- How many on slide 6?
- How many on slide 7?

The value of chunking.

- We can store and remember more information if it is structured and organized in ways that make sense to us.
- We can suffer from information overload when that information is not structured and organized in ways we can easily grasp.
- Caveat: Chunking is not just visual it happens in other areas of cognition as well.

Structure can have other powerful effects.

- An organized knowledge structure can help make sense of things.
- In fact, once you have a knowledge structure it is hard to prevent there being an effect from that network of concepts and relationships.

An example.

- Identify how many things there are on the next slide.
 - Are there?
 - One
 - Two
 - “A lot”
- Please do it silently to yourself!



What did you see?

- Who saw one thing?
- Who saw two things?
- Who saw “a lot” of things?

- Did you see anything in particular?
- How many people saw a Dalmation dog?
- Let’s look again.



A powerful effect.

- How many saw the dog this time?
- Now that you know it is a Dalmation, try to not see the dog.



Learning involves assimilation.

- Thus we can argue as did Ausubel (1963, 1968, Ausubel et al., 1978), that learning takes place by assimilation of new concepts and propositions into existing structured networks of concepts and propositional relationships among concepts.

Conditions needed for assimilation to take place.

- The to-be-learned material is organized and presented using language and examples the learner can relate to knowledge in the head.
- The learner must, in fact, possess the relevant prior knowledge.
- The learner must be motivated to chose to learn meaningfully rather than by just attempting rote memorization.

Summary

- Project-based learning can be used to create the appropriate context for learning.
- These project-based problems can also promote the development of higher level cognitive structures involving concepts and relationships going well beyond just facts.
 - These structures enable more knowledge to be organized, retained and applied.

Questions?

References

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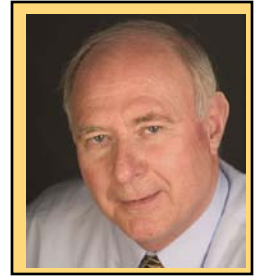
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Why believe it works?

- One illustration from many:
- In Becker's (1996) review of empirical studies on **teaching statistics** there are clear results showing that instruction in statistics and computer assisted data analysis are **more effective** when students are interacting with **real data**.

But do we understand learning?

- We understand it better than most people realize.
- There is useful and appropriate guidance in a 1999 National Academy of Sciences Report.
- Donovan et al. (1999) How People Learn: Bridging Research and Practice.
- Based on lots of empirical research.

Ex: learning/teaching.

- Students come to the classroom with preconceptions about how the world works.
 - Teachers must draw out and work with the pre-existing understandings that their students bring with them.

Ex: learning/teaching.

- To develop competence....students must: (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.
 - Teachers must teach some subject matter in depth, providing many examples in which the same concept is at work and providing a firm foundation of factual knowledge.

Goals for the teacher.

- Develop a clear sense of existing knowledge the learner brings to the situation.
- Figure out ways to translate new knowledge into terms, representations and examples that connect to the student's knowledge.
- Develop pedagogical strategies that help motivate the student to engage in meaningful learning rather than rote.