

# FOUNDATIONS FOR DEVELOPING CURRICULAR STRUCTURES

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- I Curricular Advances in Secondary School
  - II Mind-Brain Research
  - III Pedagogical Styles
  - IV Assessment: Formative, Summative & Process
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Donald Stokes' book, PASTEUR'S QUADRANT made a compelling case for organizing research that links basic research to the solution of practical problems.

- "Use-Driven" basic research as contrasted to:
  - pure basic curiosity driven research
  - applied research absent of a conceptual framework

I. Technology Used Implementing Project-Based Curricula

II. Mind-Brain-Learning Research

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SECONDARY EDUCATION: We need more than having all pupils take algebra or raising everyone's scores on high-stakes tests to passing levels

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- *Students also need to master higher-order cognitive, affective, and social skills which are not central to mature industrial societies, but vital in a knowledge based economy (Drucker).*
- *They need to be able to 'thrive on chaos' (making rapid decisions based on incomplete information to resolve novel situations) (Jones).*
- *They need the ability to collaborate with a diverse team—face-to-face or across distance—creating, sharing, and mastering knowledge through filtering a sea of quasi-accurate information (Peters).*

- *Centering the curriculum on ‘authentic’ problems parallel to those adults face in real-world settings (Cognition and Technology Group at Vanderbilt).*
- *Involving students in virtual communities-of-practice, using advanced tools similar to those in today’s high-tech workplaces (Linn).*
- *Facilitating guided, reflective inquiry through extended projects that inculcate sophisticated concepts and skills and generate complex products (Schank, Fano, Bell, & Jona).*
- *Utilizing modeling and visualization as powerful means of bridging between experience and abstraction (Gordin & Pea).*

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- *Enhancing students' collaborative construction of meaning via different perspectives on shared experiences (Chan, Burtis, & Bereiter).*
  - *Including pupils as partners in developing learning experiences and generating knowledge (Scardamalia & Bereiter).*
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University of Michigan's Center for Highly-Interactive Computing in Education.

ScienceWare: software that supports students as they investigate water quality issues in their community and link those data to national scientific investigations (Jackson, Stratford, Krajcik, & Soloway).

ScienceWare has tools that support all phases of students' investigations: data gathering (RiverBank); data visualization (Viz-It); modeling (Model-It); project planning for students (Plan-It-Out); publishing findings on the Internet (Web-It); and project planning for teachers (PIViT).

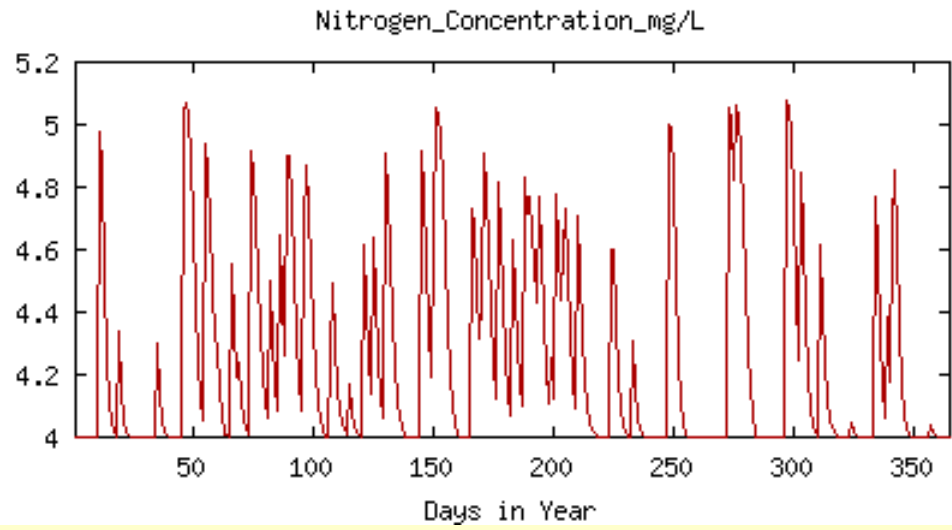
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# RiverWeb Water Quality Simulator

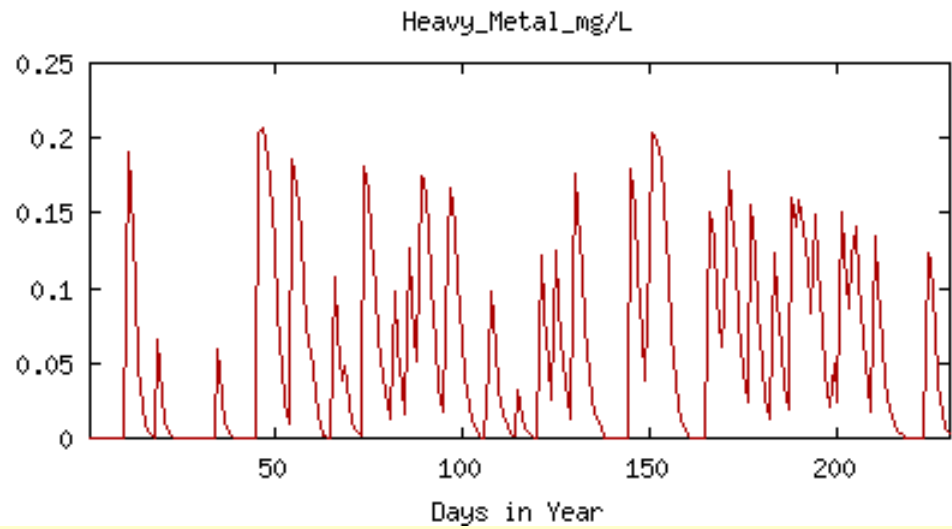
RIVERWEB<sup>SM</sup>



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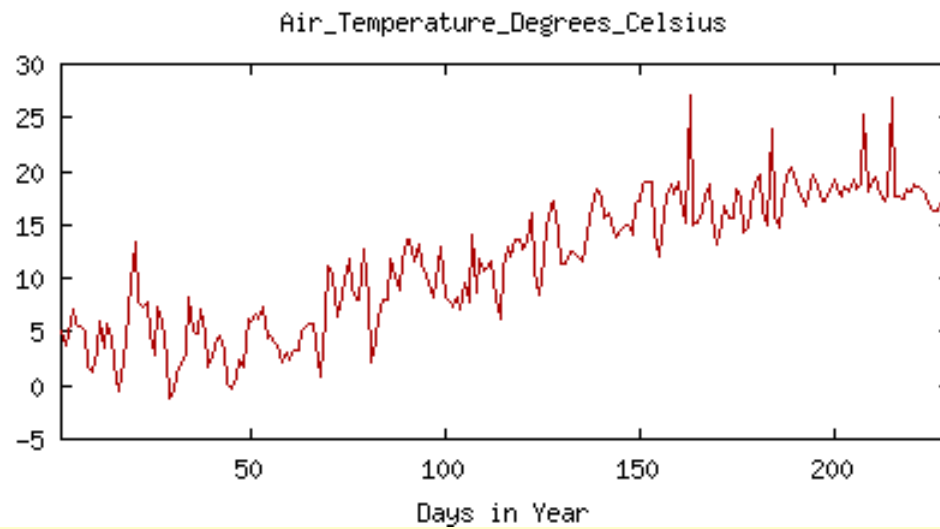


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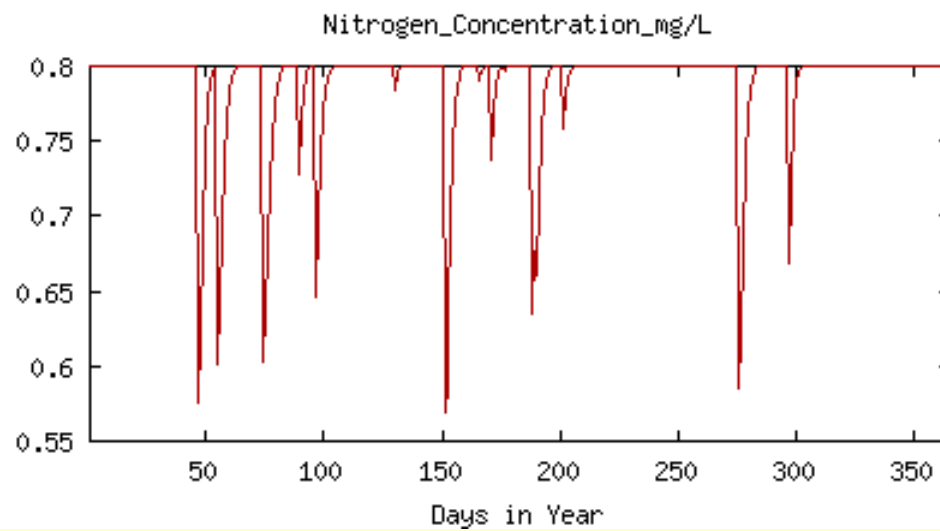




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# Stream Ecosystem

Time: 43

Start

Stop

Reset



Factor:

Stream : oxygen

Current Value

84

wsat

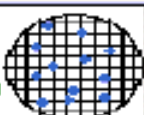
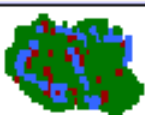
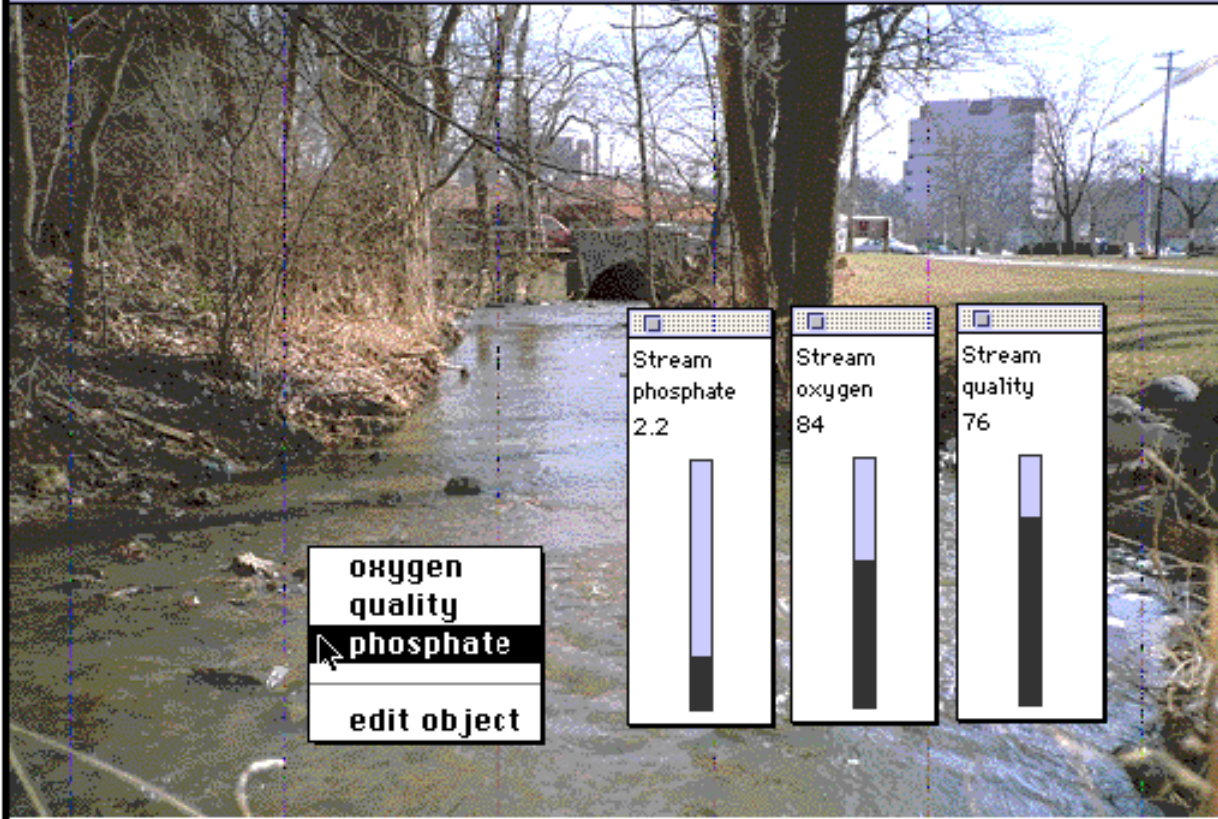
maximum = 140



average = 70



minimum = 0



# BioLogica

## A Systems Approach for Learning Science

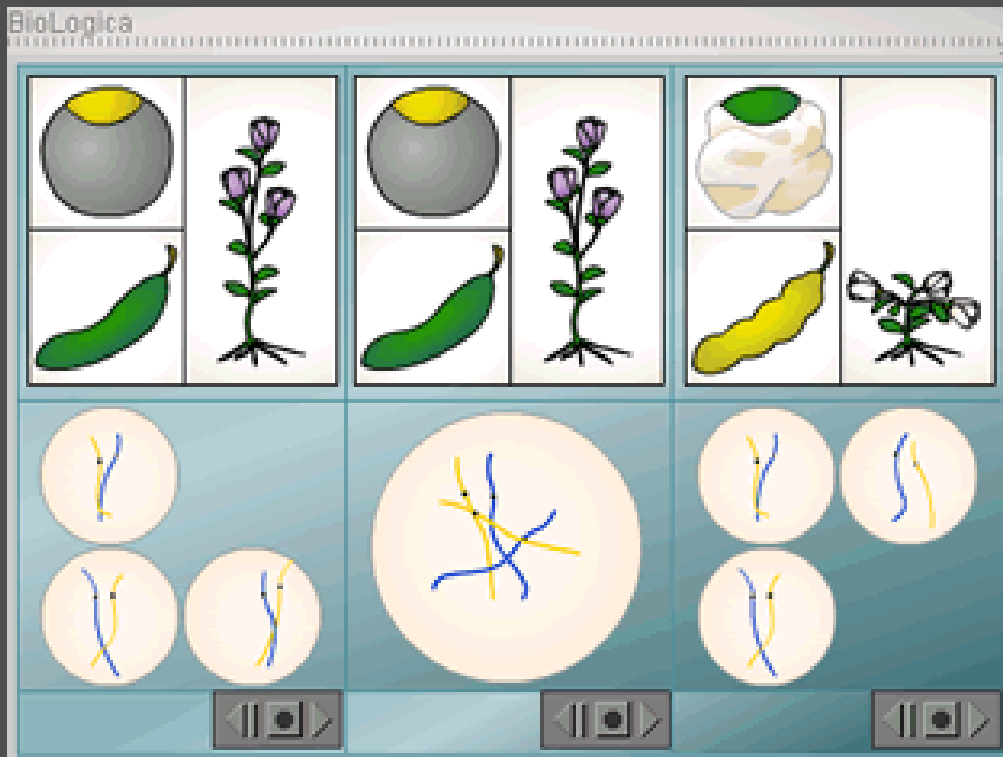
The screenshot displays the BioLogica software interface. On the left, two dragon phenotypes are shown: a blue dragon with horns and scales, and a red dragon with wings, legs, tails, and plates. On the right, a genetic map shows chromosomes 1, 2, and X with various alleles (h, s, w, L, T, p, f, A, B) and their corresponding traits (Horns, Scales, Wings, Legs, Tails, Plates, Fire, Color1, Color2).

### Dragon Genetics

This activity explores the relationship between genotype and phenotype, using both sex-linked and autosomal dominant and recessive traits. By manipulating alleles (genotype), you create corresponding changes in the dragon's physical appearance (phenotype).

# BioLogica

## A Systems Approach for Learning Science



### Mendel's Peas

Parts 1 and 2 demonstrate basic principles of meiosis, fertilization, and inheritance using the same pea traits that Mendel studied. We suggest you start at the beginning to brush up on the basics. But if you just can't wait to play the game, skip ahead to part 3, The Princess and the Wrinkled Peas.

Part 1. Meiosis

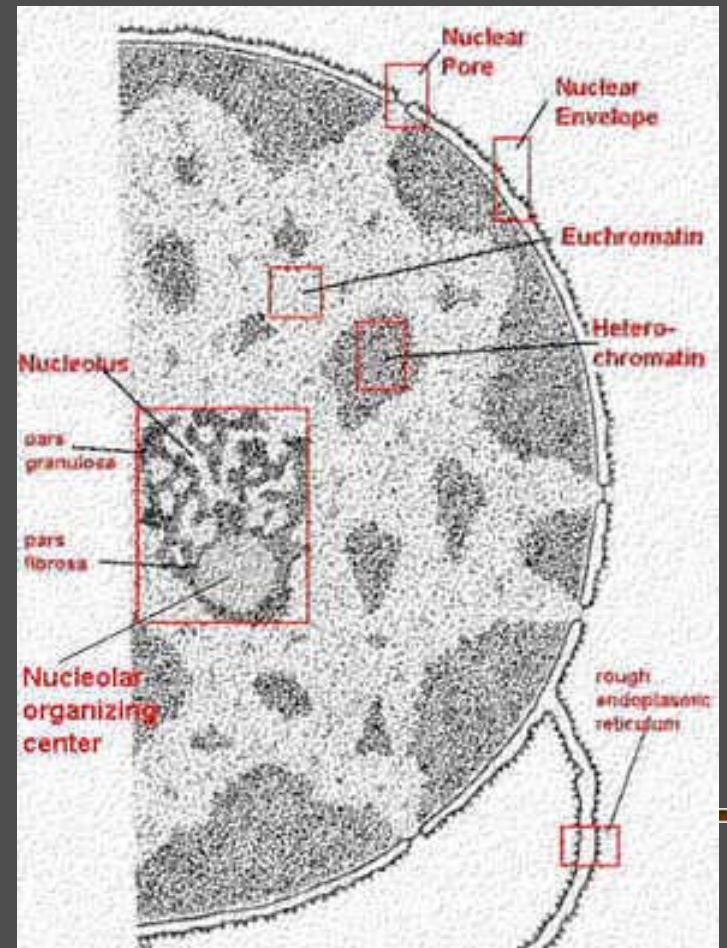
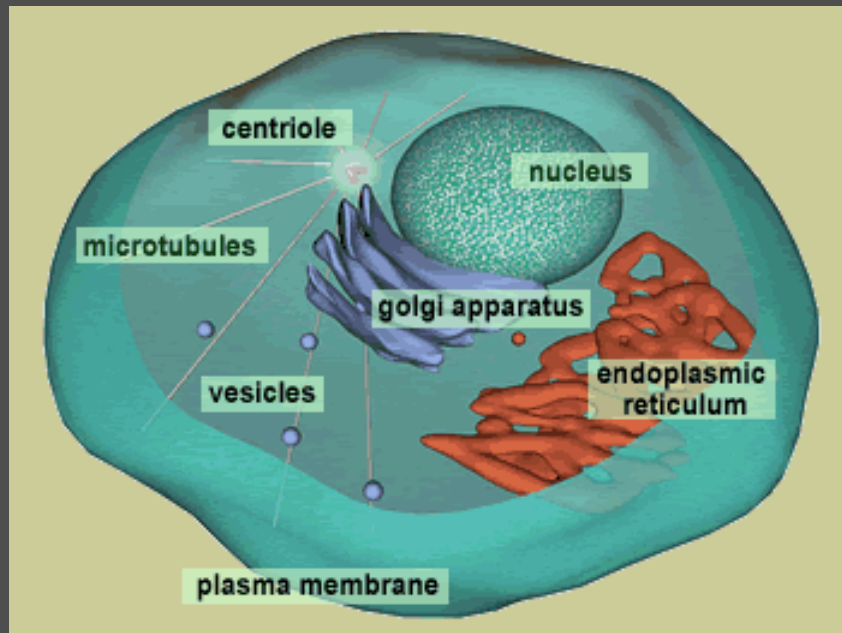
Part 2. Pedigree

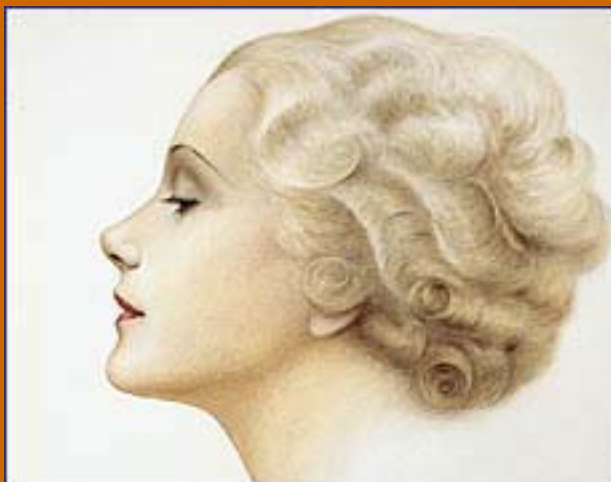
Part 3. Activity: The Princess and the Wrinkled Peas

# Bio

# Logica

A Systems Approach  
for Learning Science

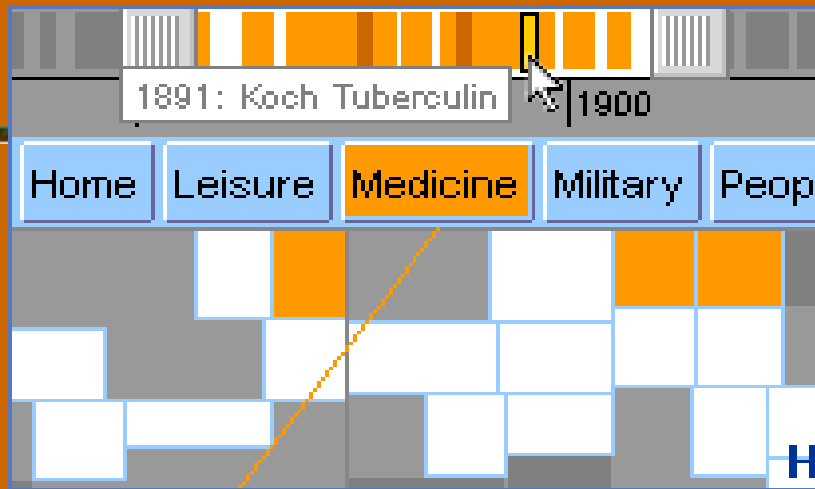




## **The First Breck Girl 1936**

### **Pastel portrait of Olga Armstrong**

Charles Sheldon drew this portrait of Olga Armstrong--first of the memorable and long running "Breck Girls" ad campaign--in 1936. Through their advertisements for shampoo, Breck Girls came to represent the ideal American woman--desirable yet chaste--for more than half a century.



## Koch Tuberculin

1891

### A cure for TB?

In 1882, German bacteriologist Robert Koch discovered the bacillus *Mycobacterium tuberculosis*, the primary cause of tuberculosis. Eight years later, Koch announced that tuberculin--a sterile liquid he produced from cultures of the bacillus--could be used to combat the disease in its early stages. People from all over the world streamed to Berlin for the new cure. They were to be disappointed. Though tuberculin proved not to be a tuberculosis cure, it has been a good diagnostic tool for the disease. This bottle of Koch's tuberculin dates from 1891.

### Notes

Accounts of TB can be found in the writings of the ancient Egyptians, in those of the Greek physician Hippocrates, and in the medical writings of most urbanized societies since then.

Robert Koch, born December 11, 1843, Clausthal, German free city; died May 27, 1910, Baden-Baden, Germany (1843-1910)

Web display only



# MIND-BRAIN-LEARNING

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- Piaget's formulation of the stages of cognitive development are like steps of a ladder.
  - Current findings support “recurring growth cycles”—mind-brain scientists have now identified some 13 developmental levels which emerge between birth and 30.
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# Electroencephalogram (EEG)

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- The electrical activity in the cortex shows a systemic spurt that closely parallels the optimal levels of cognitive development. This EEG coherence (the correlations of wave patterns between regions) shows demonstrative qualitative shifts in optimal abilities.
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# EEG

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- When these reorganizations of neural network cycles occur they tend to follow the same general principles, but there is substantial variation from individual to individual.
  - One property which seems universal is that most complex skills or understandings i.e. optimal level, come only with strong support.
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A Good Teacher will bring out optimal thinking in the classroom, but that level will not typically be evident while working alone

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# Enhancement Programs

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- Emerging Scholars Program – UT Austin
  - STARS – Yale
  - Meyerhoff Program – UMD-Baltimore
  - Chemistry Program –Williams
  - Spend a Summer with a Scientist – Rice
  - Gateways Program – Northwestern
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# Curricular Implications for Developing Optimal Levels of Thinking

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- The Challenge---When doing educational assessments and thinking about fundamental and optimal levels of thinking (they would say webs and nodes), we will be able to teach better, write more effective curriculum materials, and improve the quality of student learning.
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# Alternative Teaching Styles

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Snippets of teaching

Eric Mazur—physics

Phil Sessler--astronomy

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# MIT Teaching and Learning Lab

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## Research Methods Used in Assessment and Evaluation

- Tests and surveys
  - Naturalistic descriptive observations
  - Structured interviewing
  - Focus groups
  - Case studies
  - Pretest-posttest investigations of change
  - Historical or matched comparison groups
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# In Summary

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- I. A major shift taking place in science instruction in secondary school—it is moving rapidly toward modeling phenomena and examining interactions among components, and away from memorizing formulas and physical principles.
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# Summary Continued

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- II. Mind-brain research findings indicate that “support” is essential for optimal learning.
  - III. The best of pedagogical styles are student-centered with teacher as a resource rather than teacher in command central.
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# The last hurrah

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IV. Assessment and evaluation should be an integral part of the curricular enterprise

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