An Application of Concept Mapping for Instruction and Assessment

(see *http://funnel.sfsu.edu/courses/gm310/assessment/*)

Dave Dempsey, Pro f. of Meteorology
Dept. of Geosciences
(ddempsey@sundog.sfsu.edu)

Kathleen O'Sullivan, Prof. of Secondary Ed.
Dept. of Secondary Education
(kaosul@sfsu.edu)

San Francisco State University

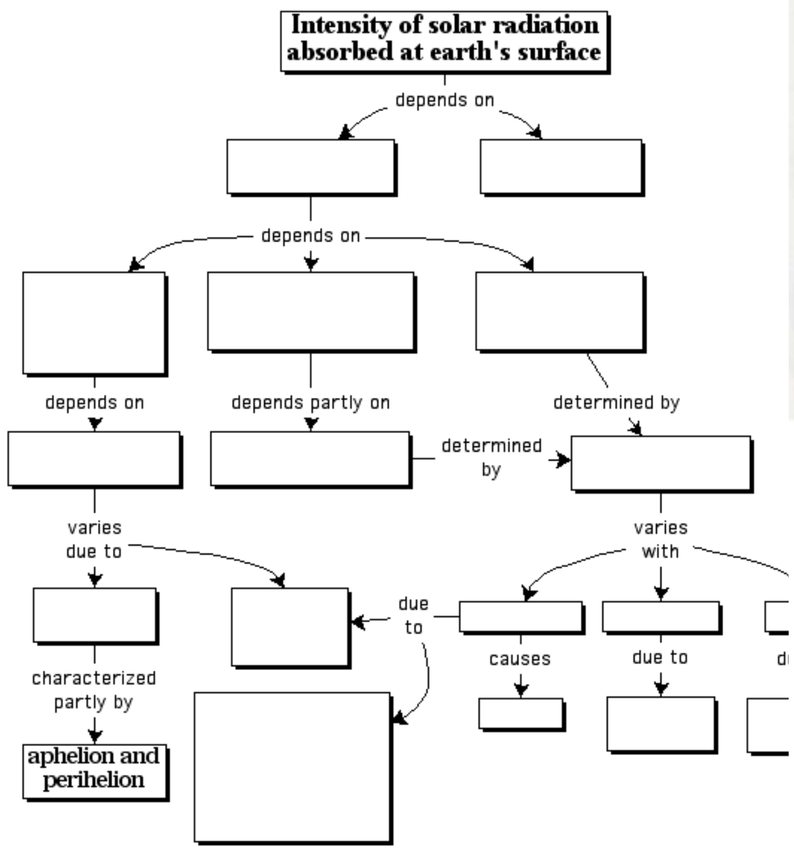
I. The Course: *Planetary Climate Change*

- Upper division; four semester units (3 lecture + 1 lab)
- Prerequisite: 12 units of physical science (any)
- Designed for future high school science teachers (geosciences breadth); Geology and Meteorology majors (elective); & others.
- Attempts to meet NSES and California state standards for pedagogy and geosciences subject matter
- Enrollment 5-12; co-taught (meteorologist, geologist)
- Text: *The Earth System* (Kump, Kasting, and Crane)
  (uses "systems diagrams", cousin of concept maps)
- Meets in two, three-hour blocks
- Pedagogy:
  - inquiry-based; heavy use of instructional technology:
    - WorldWatcher software
    - Web-based data, info, and activities
    - STELLA modeling software
      ("flow diagrams", cousin of concept maps)
  - student-led discussions of *Sci. Amer.* articles
  - small-group concept-mapping exercises
  - lecture (limited, intermittent)

II. A Concept Map for Instruction

- *Context*: Small-group, in-class activity; facilitated by instructor.
- *Objective*: Consolidate understanding of concepts & relations among them.
- *Task*: Fill in blanks in pre-structured map from list of concepts.
- *Format*: Cut out items from list, arrange them on blank map.
- *Scoring*: Not graded; verbal feedback from instructor.

Concept list:
1. Albedo of earth's surface
2. Angle of the sun above the h
3. Curvature of the earth
4. Degree of "spreading out" at earth's surface
5. Distance between earth and s
6. Distance traveled through earth' atmosphere
7. Ellipticity of the earth's orbit
8. Fraction of radiation absorbed/reflected in earth's atmosphere
9. Insolation at top of atmosphere, facing the sun
10. Insolation at earth's surface
11. Latitude
12. Revolution of earth around
13. Rotation of the earth
14. Seasons
15. Tile of earth's axis of rotation, and its constant orientation (relative to distant stars)
16. Time of day
17. Time of year



III. A Concept Map for Assessment

- *Context*: Students given brief intro to hierarchical concept maps; students construct maps individually (10-20 minutes) both pre- and post-course in *Planetary Climate Change* and in "controls" (non-major, upper & lower division geoscience courses).
- *Objective*: Answer the question, "*Do students learn connections among geosciences and among concepts about climate and climate change better than the do in other courses?*"
- *Task*: Prompted by five leading questions, construct a hierarchical concept map around central concept of "climate".
- *Format*: Pencil on nearly blank paper (example below).
- *Scoring*: Half a point for each of 12 specific concepts; one point for each of up to four coherent, labeled, hierarchical lines of connections related to the prompting questions; extra points for good cross connections between hierarchies. Two scorers; large differences reconciled between them; the two scores averaged.
- *Analysis and results*: Student-*t* and F-tests (p=0.05):
  - Are pre-course scores different among classes? Answer: *No*. (That is, students in all courses start out similarly.)
  - Are post-course scores higher than pre-course scores? Answer: *Yes* for *Planetary Climate Change*, but *no* for controls.
  - Is the increase in scores in *Planetary Climate Change* greater than the increase in the control courses? Answer: *Yes.*
- *An example*: One student's concept map before and after *Planetary Climate Change*:

Student map before the course… (Score: 0.25/10.0) **… and after the course (Score: 6.25/10.0)**