Minds On GIS: Encouraging Spatial Thinking in an Introductory GIS Lab

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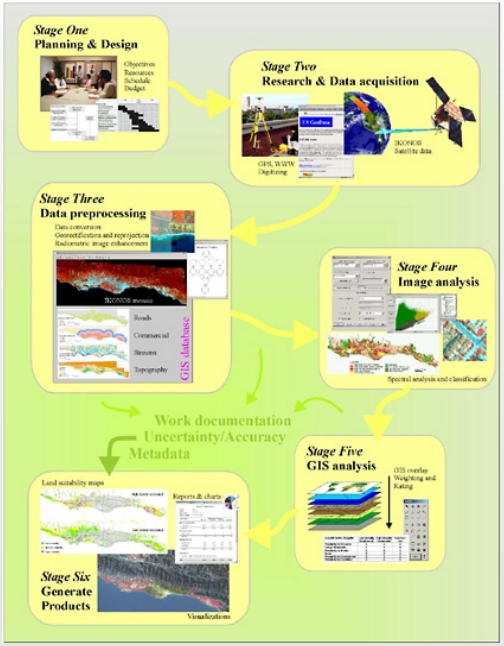
Typical GIS Labs

- Match the teaching style with the learning style
  - Cookbook labs: Behavioral form of teaching/learning
- Restructure labs to emphasize a more constructivist bent
- Model

Model



Question -> Question

Prediction -> Reflection

Prediction -> Revision -> Decision

"The Body of Knowledge is a resource for specifying course content, for designing educational activities, and for assessing courses' effectiveness in achieving intended outcomes." – BOK

10 Knowledge Areas

73 Units

330+ Topics

http://www.aag.org/bok/

CF. Conceptual Foundations
CF1 Philosophical foundations
CF2 Domains of geographic information
CF3 Cognitive foundations
CF4 Geographic foundations
CF5 Social foundations
CF6 Theoretical models
CF7 Imperfections in geographic information

CV. Cartography and Visualization
CV1 History and trends
CV2 Data considerations for cartography and visualization
CV3 Principles of map design
CV4 Graphic representation techniques
CV5 Map production
CV6 Map use and evaluation

DA. Data Analysis
DA1 Academic foundations of geospatial data analysis
DA2 Query operations and query languages
DA3 Geometric operations on spatial objects
DA4 Modeling relationships and patterns
DA5 Analysis of surfaces
DA6 Spatial statistics
DA7 Geostatistics
DA8 Spatial econometrics
DA9 Data mining
DA10 Network analysis
DA11 Operations research

DE. Design Aspects
DE1 Applications as models
DE2 Project definition
DE3 Resource planning
DE4 Database design
DE5 Analytic model design
DE6 Application design
DE7 System implementation

DM. Data Modeling
DM1 Basic storage and retrieval structures
DM2 DBMS and the relational model
DM3 Tessellation data models
DM4 Vector data models
DM5 Multiple scale representation/models
DM6 Object (oriented) and object based models
DM7 Temporal representation/models
DM8 Metadata
DM9 Data exchange and operability

DN. Data Manipulation
DN1 Data format conversion
DN2 Generalization and aggregation
DN3 Transaction management of geospatial data

GC. Geocomputation
GC1 History and trends in geocomputation
GC2 Uncertainty
GC3 Computational aspects and neurocomputing
GC4 Fuzzy sets
GC5 Cellular automata (CA) models
GC6 Heuristics
GC7 Genetic algorithms
GC8 Agent-based models
GC9 Activity analysis

GD. Geospatial Data
GD1 Earth geometry
GD2 Land partitioning systems
GD3 Coordinate systems
GD4 Datums
GD5 Map projections
GD6 Data quality
GD7 Land surveying and GPS
GD8 Digitizing
GD9 Field data collection
GD10 Aerial surveys and photogrammetry
GD11 Satellite and shipboard remote sensing
GD12 Data standards and infrastructures

GS. GI S&T and Society
GS1 Legal aspects of GI S&T
GS2 Economic aspects of GI S&T
GS3 Public use of geospatial information
GS4 Control of geospatial information
GS5 Dissemination of geospatial information
GS6 Coordinating organizations
GS7 Ethical aspects of GI S&T
GS8 Critical GIS

OI. Organizational and Institutional Aspects
OI1 Historical and future trends in organizational and institutional aspects
OI2 Managing the GI system operations and infrastructure
OI3 Organizational structures and procedures
OI4 GI S&T workforce themes
OI5 Institutional aspects
OI6 Coordinating organizations

Example Questions:
Knowledge Area - Conceptual Foundations

Unit CF3 Domains of geographic information (Core Unit)

Topic CF3-1 Space

- Define the four basic dimensions or shapes used to describe spatial objects (i.e., points, lines, regions, volumes)
- Differentiate between absolute and relative descriptions of location
- Differentiate between common-sense, Cartesian/metric, relational, relativistic, phenomenological, social constructivist, and other theories of the nature of space
- Discuss the contributions that different perspectives on the nature of space bring to an understanding of geographic phenomenon
- Justify the discrepancies between the nature of locations in the real world and representations thereof (e.g., towns as points)
- Select appropriate spatial metaphors and models of phenomena to be represented in GIS
- Develop methods for representing non-Cartesian models of space in GIS
- Discuss the advantages and disadvantages of the use of Cartesian/metric space as a basis for GIS and related technologies

Key readings – Conceptual Foundations

Berry, B. J. L. (1964). Approaches to regional analysis: a synthesis. Annals of the Association of American Geographers, 54, 2-11. (Units CF3-CF4)

Couclelis, H. (1992). People manipulate objects (but cultivate fields): Beyond the raster-vector debate in GIS. In A. U. Frank, I. Campari, & U. Formentini, (Eds.),Theories and methodsof spatio-temporal reasoning in geographic space.(65-77). Berlin: Springer Verlag (Unit CF4)

Egenhofer, M.J. (1991). Reasoning about binary topological relations. Lecture Notes in Computer Science,525, 144-160. (Unit CF5)

Frank, A. (1998). Different types of "times" in GIS, in M. Egenhofer & R. Golledge (Eds.), Spatial and temporal reasoning in geographic information systems(40-62). New York: Oxford University Press. (Unit CF3)

Hägerstrand, T. (1970).What about people in regional science? Papers, Regional Science Association,24, 1-21. (Units CF3, CF4)

Lakoff, G. (1987). Women, fire, and dangerous things.Chicago: University of Chicago Press. (Units CF1, CF2)

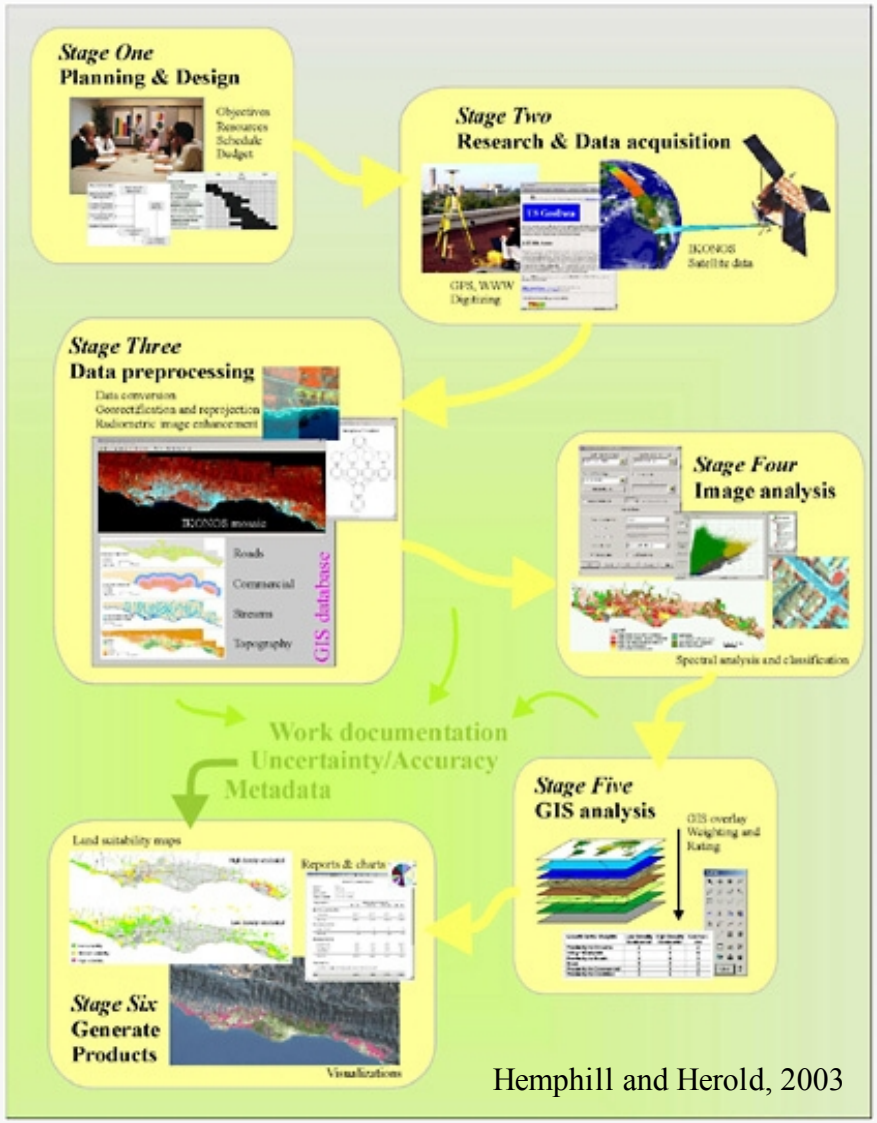
Egenhofer, M., & Mark, D. M. (1995). Naive geography. In A. Frank & W. Kuhn (Eds.), Lecture

Mark, D. M., & Freundschuh, S. M. (1995). Spatial concepts and cognitive models for geographic information use.In T.L. Nyerges, D.M.Mark, R.Laurini, & M.Egenhofer (Eds.), Cognitive aspects of human-computer interaction for geographic information systems.(21-28). Dordrecht: Kluwer Academic Publishers: (Unit CF2)

Mennis, J. L., Peuquet, D.J., & Qian, L. (2000). A conceptual framework for incorporating cognitive principles into geographical database representation. International Journal of Geographical Information Science, 14, 501-520. (Units CF2, CF4)

Teaching Format

- Question-Question
  - Ask it early!
- Prediction-Reflection
  - Self-assessment
- Prediction-Revision-Decision
  - Policy/problem solving



Multistage analysis in a pictorially based GIS

GIS Research Model

Integrate stages into labs from the beginning

Emphasize the process

What's Next?

- Consult with GIS faculty.
  - Make available online.
- Take cognition and learning courses.
- Submit as student paper to 2008 UCGIS Summer Assembly
  - Publication?

- Other projects:
  - Create GIS workshop for grad students.
  - Design a GIS course for pre-service social science teachers.

Thank You

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