

An Outsider's View of GIS Education

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EDUCATION at CNSI

UCSB *Affiliates* friends linking campus and community **SCIENCE LITE**
Small Wonders in Our Future
 Umesh Mishra
 Professor, UCSB Department of Electrical & Computer Engineering
 First in a three-part series of lectures on the science (and art) of miniaturization and how it affects our lives

CNSI Education Programs



Research experiences for high school students



NSF-funded research experience program that taps talents from Community Colleges



NSF-funded program, linking CNSI with junior high & high schools, giving undergraduates and graduate students experience in teaching



Newest NSF program to recruit & retain graduates in STEM (science, technology, engineering and math)

New CNSI course, 'The Practice of Science', first offered Winter and Spring 2004 (cross-listed between ECE and Physics)

Expanding Pathways to Science, Education and Mathematics



NSF STEP program to recruit & retain graduates in science, engineering and math



- intensive 2-week summer residential institute with graduate & undergraduate mentors
- learning about campus resources, career opportunities, problem-solving
- 4-day lab research experience
- continued-follow up with programs during the academic year



National Science Foundation GK-12 program:



- Fellowships for Graduate Students and Senior Undergraduates in science and engineering
 - Fellows work with teachers in Grades 8 and 9 classrooms and afterschool clubs
 - Fellows reduce effective class size, helping overcome problems lack of resources. Fellows work with small student groups to facilitate learning through hands-on investigation and discovery.



Outsider

- Design and direct science education projects / teaching credentials
- Evaluate GIS education projects / cognitive psychology background
- How and where can GIS make a difference in teaching and learning?

HERE

THERE

It's a simple
model, but it
works for me





GI S&T Body of Knowledge

University Consortium for Geographic Information Science

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UCGIS Education Committee

Model Curricula Project

GI S&T Body of Knowledge

[Click here to order the GIS&T Body of Knowledge](#)



Knowledge will be useful as:

The **Model Curricula** is a vision of how higher education should prepare students for success in the variety of professions that rely upon geospatial technologies. Central to that vision is a comprehensive **Body of Knowledge** that specifies what aspiring geospatial professionals need to know and be able to do. Since 1998, scholars from many of the more than 80 institutions that UCGIS represents have contributed to the Geographic Information Science and Technology (GIS&T) Body of Knowledge.

[Published by the Association of American Geographers](#) in 2006, the GIS&T Body of Knowledge includes ten knowledge areas, 73 units, 329 topics, and over 1,600 formal educational objectives. The GIS&T Body of

Undergraduate GIS

- Extensive GIS course offerings
 - Early uptake of NCGIA Core curriculum in early 90's
 - Specialist courses in specific disciplines by 2000
 - Model curricula by UCGIS
- Education for professionals

Undergraduate social sciences

■ SPACE

- response from a wide range of disciplines to summer workshops
- Research faculty looking to integrate spatial analysis tools and perspectives
- www.csiss.org



Discipline goals

■ **Political science**

- “I focus on how spatial thinking and data may contribute to the study of social, environmental, and natural resource policy issues.”

■ **Communications**

- “The implementation, adoption, and spread of various technologies throughout society, as well as the cognitive mapping of cyberspace are prime topics of interest, and lend themselves easily to spatial approaches.”

GIS meets K-12 trends

- Inquiry Learning

- Global Learning and Observations to Benefit the Environment - NASA

- Students collect and transmit data



GIS meets K-12 trends

EASTinitiative

- Students construct understanding
 - Environmental And Spatial Technologies
- Students collect and represent data to explore community issues





Beyond the Classroom

- *"The project is giving us teachers the motivation, resources, and skills to truly integrate technology and literacy into our classrooms."*

David Mann, Santa Maria HS

- Summer professional development, teacher teams, site-based technology support
- 2 counties, 9 districts, 13 schools, 18 teachers, 3 school levels (approximately 2,500 students)
- Full time evaluation to document progress and promising practices:
 - *GIS provides disciplinary context*

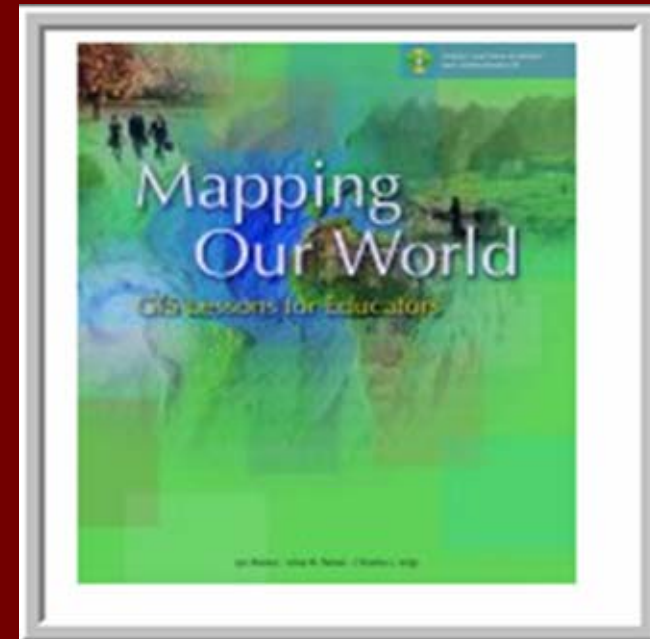


GIS meets K-12 trends

- Student-centred learning
 - group projects motivate teamwork
 - group projects encourage problem solving and skill development – ‘need to know’
 - students investigate topics that cut across discipline boundaries
- Students develop analytic thinking.....

Mapping our World

- ESRI collection of case studies
 - guide for early adopters
 - showcase products
 - community interest
- Mapping as the compelling medium and metaphor for education?



“Do you want students to ...

- Engage constantly in critical thinking?
- Integrate knowledge from multiple subjects?
- Build a rich grasp of global topics?
- Work on community-based investigations?
- Use the same advanced technology now employed by business and government?”

Critical opportunity

- Current projects in GIS focus on technology and career potential
 - but no systemic K-12 curriculum impact?
- Ever-increasing use of digital technology such as GPS and Google Earth
 - will these remain in the black box ?
- Can we exploit this phase to develop enhanced visual and analytic skills for spatial literacy and global citizenship?

Multiple Intelligences

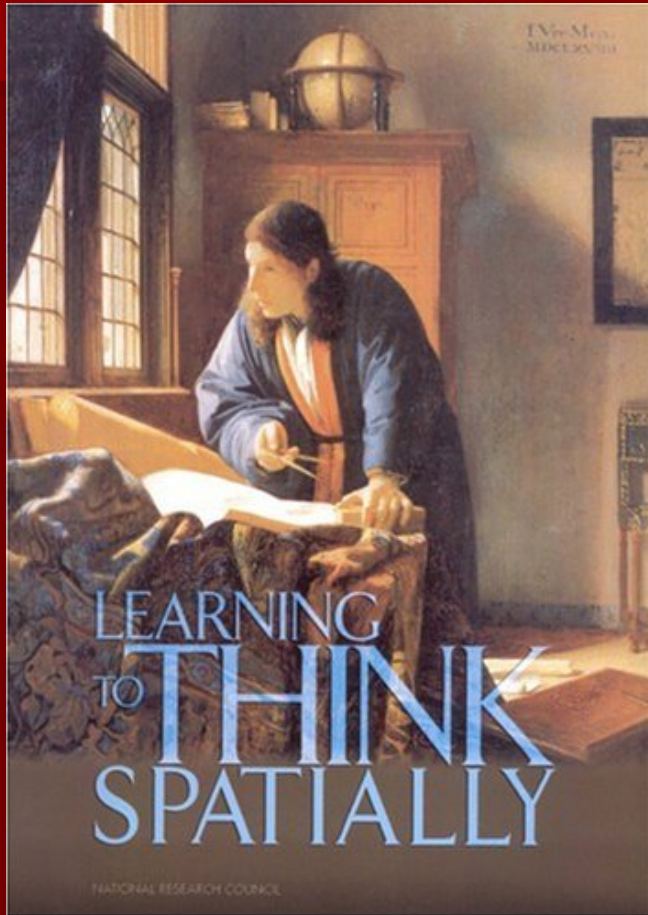


- Howard Gardner
 - MIT
 - “**Spatial intelligence** involves the potential to recognize and use the patterns of wide space and more confined areas.”
 - one of seven types of intelligence

Cognitive demands for GIS

- SPACE participants, also outsiders
 - frustration about student preparation – reflecting on their own experience.....
 - _ importance of scale, neighborhood, territory, route-finding, and topography
- Advocate for a pre-GIS course module about visual and mental representations and transformations in measurement and topography?

What is Spatial Thinking?



Three aspects of spatial ability:

- **Spatial knowledge**

- symmetry, orientation, scale, distance decay, etc.

- **Spatial ways of thinking and acting**

- using diagramming or graphing, recognizing patterns in data, change over space from change over time, etc.

- **Spatial capabilities**

- ability to use tools and technologies such as spreadsheet, graphical, statistical, and GIS software to analyze spatial data

What is Spatial Thinking?

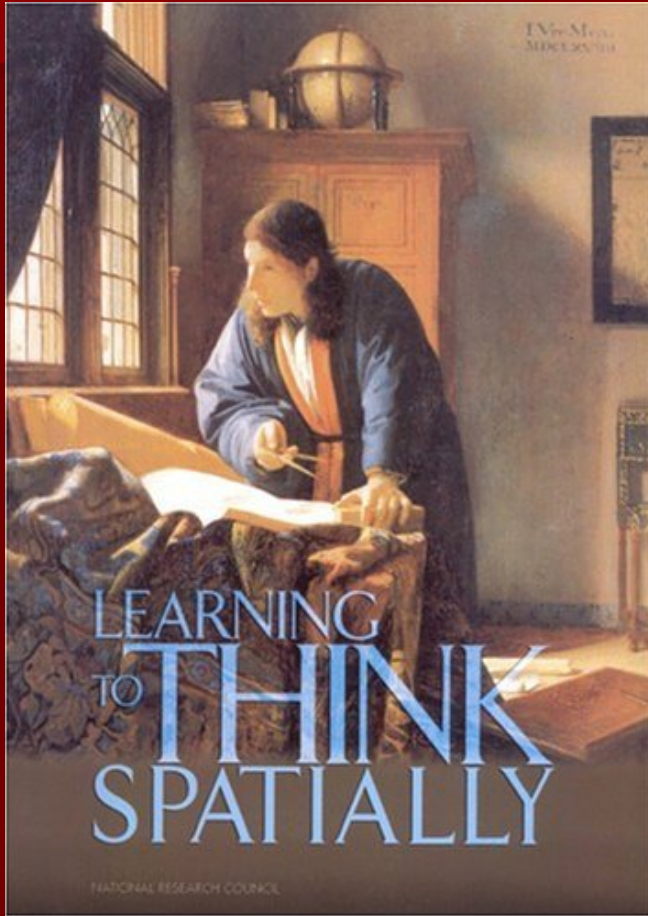
from NRC report on *Learning to Think Spatially*

- Concepts of space
 - relations among units of measurement, dimensionality, basis of coordinate systems, etc.
- Tools of representation
 - require understanding of relationships between orthogonal and perspective views, effects of geographic projections, etc.
- Processes of reasoning
 - ability to think about shortest distances in different ways (straight line vs. route), extrapolation and interpolation, etc.

Spatial Thinking Tasks?

- Extracting spatial structures (encoding)
 - perception and/or creation of representation
 - show the spatial or conceptual relationships between elements with respect to reference frame
- Performing spatial transformations
- Drawing functional inferences
 - complex spatial reasoning
 - combining representations and transformations to evaluate or predict situations or events

The Spatially Literate Student?



- Knows where, when, how, and why to think spatially
- Practices spatial thinking with
 - broad and deep knowledge of spatial concepts and representations
 - well-developed spatial capabilities for using supporting tools and technologies
- Adopts a critical stance to spatial thinking
 - can evaluate the quality of spatial data based on source, likely accuracy, reliability
 - can use spatial data to construct, articulate, and defend a line of reasoning in solving problems and answering questions

Cover Illustration?

- Does dynamic way of thinking -depicted as integral to math and science - contrast with visual image of traditional mapmaker?
- “everybody loves maps” (Give Geography Its Place GGIP; www.geointeractive.co.uk) will not resonate with naïve spatial learners
- Need to expand understanding of visual and spatial awareness by integration with current research in GIScience?



Research Experience for Teachers (RET)

- RET teachers participate for two consecutive years
 - Summer Year 1 - Teachers work on individual research projects with faculty
 - Summer Year 2 - Teachers develop classroom units
 - Academic Year 2 - Present units to peers
- www.mrl.ucsb.edu



Realistic strategy

- Negotiate with relevant disciplines like art, computer science, & mathematics (pp.117-8)
- Collaborate on innovative ways to teach overlap areas in curriculum
 - use the SPACE model to promote exchange
- Focus on early practical work in schools on local topography
- Promote a motivating icon....

Dora the Explorer

- Icon with backpack
 - explores with friends
 - asks questions about local terrain
 - uses maps when pertinent
- Dora develops spatial expertise by using new tools.....



Conclusions

- GIS as a tool appeals to early adopters
- GIS as a way of thinking has potential to make wider impact on curriculum
- Strategies to integrate spatial thinking into current disciplines
- Models for partnerships with teachers
 - what interests you?

Acknowledgments

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- National Science Foundation



*You cannot depend on your eyes when your
imagination is out of focus*

Mark Twain