

Developing an Advanced Placement Course for Geographic Information Science & Technology (GIS&T)

**Douglas Richardson
Executive Director
American Association of Geographers**

**National Geospatial Advisory Committee Meeting
National Conservation Training Center
Shepherdstown, WV
September 27, 2016**

Advanced Placement for GIS&T

The American Association of Geographers (AAG) is leading an effort to develop and implement a new Advanced Placement (AP) course for students in the field of Geographic Information Science & Technology (GIS&T).



Advanced Placement for GIS&T



Advanced Placement Human Geography (APHG) has proved to be one of the most successful and fastest growing AP courses. In 2016, nearly 180,000 high school students took the APHG exam.

The AAG believes that an AP course in GIS&T is needed and would be equally successful for the following reasons:

Advanced Placement for GIS&T

- GIS&T has rapidly become a vibrant component of education, research, and innovation in the United States and internationally. As a key element of STEM education, GIS&T is a major field of research and teaching with a strong presence in U.S. higher education.
- Several hundred academic programs offer undergraduate and graduate-level coursework in GIS&T, and they prepare students for exciting and lucrative careers across a wide array of public and private sector organizations.

Advanced Placement for GIS&T

- Access to geospatial technologies has never been greater. GIS, GPS, virtual globes, satellite imagery, geographic visualizations, and other spatial technologies are available to display, manage, and analyze geographic data. Mapping apps and locational tools are now ubiquitous in mobile devices, cars, and computers.
- Educators in schools enjoy free access to numerous web mapping and open-source geospatial software. More than 3,000 educational institutions have brought GIS into their classrooms.

Advanced Placement Courses for GIS&T



Advanced Placement for GIS&T

- The GIS&T industry is rapidly growing and evolving. A recent study from UK-based economic consultant Oxera estimates the value of the GIS&T industry's global services at \$150–\$270 billion per year. The demand for a geospatially trained workforce is forecasted to grow considerably in the future.
- Current U.S. DoL projections call for faster than average or much faster than average growth in jobs for geographic information scientists, technicians, and analysts, with upwards of 15,000 additional employees needed annually through 2022 and beyond.

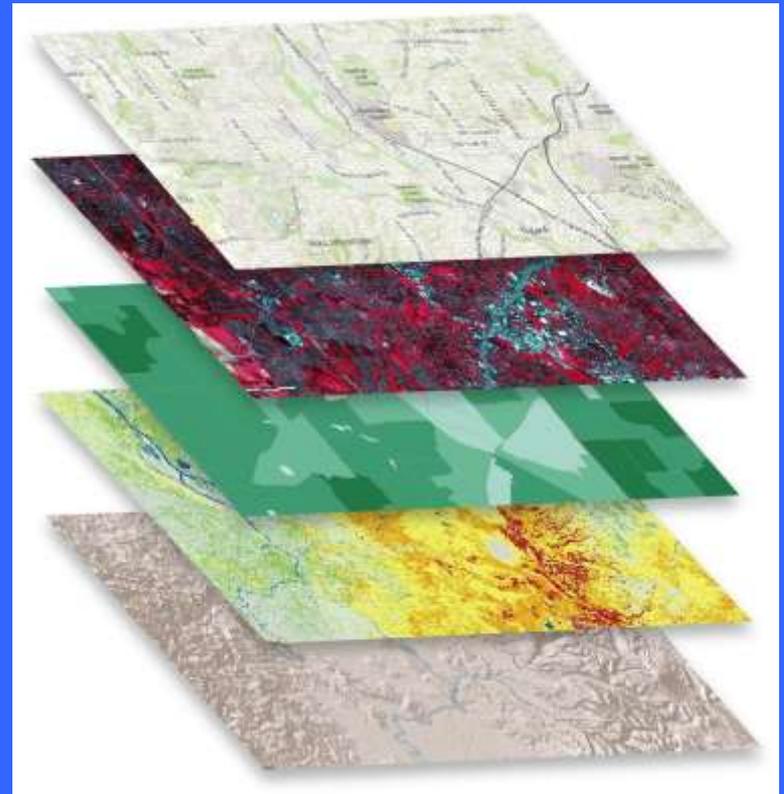
Advanced Placement for GIS&T

- GIS&T is an ideal context for interdisciplinary learning. An AP GIS&T course would have broad appeal and connect with high school subjects across the curriculum, including geography, biology, history, math, social studies, computer science, environmental studies, and earth science.
- AP GIS&T would dramatically advance the capacity of American schools to enhance the geographic literacy and proficiency of high school students.

Advanced Placement for GIS&T

The AAG is working with college and university departments to ensure that college credit will be granted for AP GIS&T.

We are also collaborating closely with high schools across the nation to encourage them to offer this important learning opportunity.



Advanced Placement for GIS&T

- The AP GIS&T program will be an unparalleled opportunity for high school students to experience one of the most dynamic, innovative, and transformative scientific fields of the twenty-first century.
- Along with APHG, AP GIS&T can serve a vital role in providing students with the geographic knowledge, skills, and abilities they need to make sense of a rapidly changing planet.

College Board Proposal Requirements

- **Course Description:** Statement of knowledge, skills, and abilities developed in the college course that will be the basis of AP GIS&T.
- **Assessment:** Description of how knowledge, skills, and abilities are assessed at college level, including formats and evidence of learning.
- **Teacher Professional Development:** Types of PD that will be required to teach AP GIS&T.
- **Letters of Attestation:** Minimum of 100 colleges/universities willing to offer credit for AP GIS&T exam, and 250 high schools with capacity to offer AP GIS&T.



Example Endorsements

- American Geosciences Institute
- ASPRS
- Cartography and Geographic Information Society
- Coalition of Geospatial Organizations
- Environmental Defense Fund
- Esri
- Geographic and Land Information Society
- GeoTech Center
- GIS Certification Institute
- Google
- International Association of Assessing Officers
- Management Association for Private Photogrammetric Surveyors
- National Society of Professional Surveyors
- National States Geographic Information Council
- National Wildlife Federation
- North American Cartographic Information Society
- Open Source Geospatial Foundation
- Uber
- United States Geospatial Intelligence Foundation
- University Consortium for Geographic Information Science
- Urban and Regional Information Systems Association
- WILD Coast



ADVANCED PLACEMENT
**GEOGRAPHIC
INFORMATION
SCIENCE & TECHNOLOGY**
A PROPOSED NEW AP COURSE FOR HIGH SCHOOLS

**Learn more and register
your support at *apgist.org***

Thank you!

ADVANCED PLACEMENT

GEOGRAPHIC INFORMATION SCIENCE AND TECHNOLOGY



AP GIS&T Proposal Development

GENIP: Development grant to AAG
in June 2015

Writing Committee: *Ola Ahlqvist* (Ohio State University), *Dorothy Cassetta* (Carroll High School), *Jacque Housel* (Sinclair Community College), *Niem Tu Huynh* (Concordia University), *Jolene Keen* (AAG), *Candice Luebbering* (AAG), *Adriana Martinez* (Southern Illinois University-Edwardsville), and *Rich Schultz* (North Park University).

Advisory Committee: *Chris Bunin* (Albemarle High School), *Joshua S. Campbell* (Sand Hill Geographic), David DiBiase (Esri), *Allison Hunt* (University of Louisville / Jefferson County Public Schools), *Bob Kolvoord* (James Madison University), *Ming-Hsiang Tsou* (San Diego State University), *John Van Hoesen* (Green Mountain College), *Beth Walton* (University of South Florida), and *May Yuan* (University of Texas – Dallas).



Writing committee members

College Board Proposal Requirements

- **Course Description:** Statement of knowledge, skills, and abilities developed in the college course that will be the basis of AP GIS&T.
- **Assessment:** Description of how knowledge, skills, and abilities are assessed at college level, including formats and evidence of learning.
- **Teacher Professional Development:** Types of PD that will be required to teach AP GIS&T.
- **Letters of Attestation:** Minimum of 100 colleges/universities willing to offer credit for AP GIS&T exam, and 250 high schools with capacity to offer AP GIS&T.





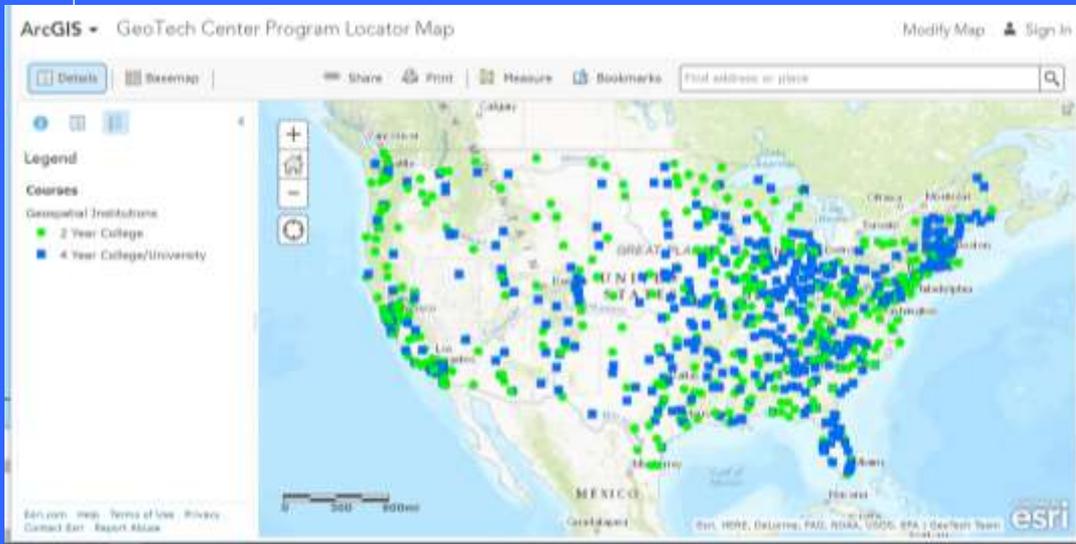
Course Description

“A description of the standard, commonly offered college course upon which the proposed AP course will be modeled, with a focus on the knowledge, skills, and abilities developed in the course and descriptions of the ways this course produces in students such knowledge, skills, and abilities. In addition, the description should specify the prerequisite knowledge, skills, and abilities required for success in the course.” (College Board, 2014, Memorandum: New AP Course Development)

- Information collection from existing, introductory level, higher education courses around the U.S.
- Knowledge, skills, and abilities expressed using *GIS&T Body of Knowledge*.

Course Description

- 451 higher education institutions with GIS programs identified
 - Sources: AAG Directory of Online Geography Courses, AAG Program Guide 2014-2015, National GeoTech F2015 Certificate Programs
- Stratified random sample (n=30)



Characteristics of the n=30 sample

	Program Sample (n=30)	Program Database (N=451)
<i>Geographic Context of Undergraduate GIS&T Programs</i>		
Northeast	4 (13%)	66 (15%)
Midwest	10 (33%)	145 (32%)
South	7 (24%)	126 (28%)
West	9 (30%)	114 (25%)
<i>Institutional Context of Undergraduate GIS&T Programs</i>		
Number of 4-year Bachelor's degree programs	21 (70%)	284 (63%)
Number of 2-year Associate degree programs	9 (30%)	167 (37%)
<i>Disciplinary Context of Introductory GIS&T Course Offerings</i>		
Geography department or hybrid department with a geography or geospatial information science curriculum	25 (83%)	370 (82%)
Other (e.g., architecture, biology, civil engineering, computer science, drafting & design, economics, geoscience, forestry & natural resources, geology, political science, and urban affairs & planning).	5 (17%)	81 (18%)

Mapping course syllabi to BoK (2006)

BoK_CourseMapping.xlsx - Excel

Ola Ahlqvist

A1

	South	Northwest	Northeast	Midwest	West
UCGIS Body of Knowledge - areas and units	N/A				
Knowledge Area AM. Analytical Methods	N/A spec specifics				
Unit AM1 Academic and analytical origins					
Unit AM2 Query operations and query languages					
Unit AM3 Geometric measures					
Unit AM4 Basic analytical operations					
Unit AM5 Basic analytical methods					
Unit AM6 Analysis of surfaces					
Unit AM7 Spatial statistics					
Unit AM8 Geostatistics					
Unit AM9 Spatial regression and econometrics					
Unit AM10 Data mining					
Unit AM11 Network analysis					
Unit AM12 Optimization and location-allocation modeling					
Knowledge Area CF. Conceptual Foundations					
Unit CF1 Philosophical foundations					
Unit CF2 Cognitive and social foundations					
Unit CF3 Domains of geographic information					
Unit CF4 Elements of geographic information					
Unit CF5 Relationships					
Unit CF6 Imperfections in geographic information					
Knowledge Area CV. Cartography and Visualization					
Unit CV1 History and trends					
Unit CV2 Data considerations					
Unit CV3 Principles of map design					
Unit CV4 Graphic representation techniques					
Unit CV5 Map production					
Unit CV6 Map use and evaluation					
Knowledge Area DA. Design Aspects					
Unit DA1 The scope of GI S&T system design					
Unit DA2 Project definition					
Unit DA3 Resource planning					
Unit DA4 Database design					
Unit DA5 Analysis design					
Unit DA6 Application design					
Unit DA7 System implementation					
Knowledge Area DM. Data Modeling					
Unit DM1 Basic storage and retrieval structures					

Current BoK structure | New BoK2.0 structure

READY 70%

Content Recommendation

- **I. Analytical Methods:**

- A. Basic Analytical Operations. (AM3)

- B. Basic Analytical Methods. (AM4)

- **II. Conceptual Foundations:**

- A. Domains of Geographic Information (CF3)

- B. Elements of Geographic Information (CF4)

- **III. Cartography and Visualization:**

- A. Data Considerations (CV2)

- B. Principles of Map Design.(CV3)

- C. Map Use and Evaluation.(CV6)

- **IV. Data Modeling:**

- A. Database Management Systems (DM2)

- B. Tessellation Data Models.(DM3)

- C. Vector and Object Data Models.(DM4)

- **V. Geospatial Data.**

- A. Georeferencing Systems (GD3)

- B. Map Projections.(GD5)

- C. Data Quality (GD6)

- D. Satellite and Shipboard Remote Sensing. GD11)

- E. Metadata, Standards, and Infrastructures. (GD12)

- **VI. GIS & Society.**

- A. Ethical aspects of geospatial information and technology (GS6)

Assessment

- A description of how knowledge, skills, and abilities in this discipline are assessed at the college level.
- What formats would be needed for the assessment?
- Is any special evidence (e.g., a portfolio, audio/visual samples) required?

	Post-Secondary	A-D (Quizzes/E xams	F: Digital artifacts	G: Written Answers	H: Portfolio /Final Project	I: Team Project	Labs	Labs as percent of evaluation
Midwest	Clark State CC	Yes	Yes		Yes	Yes	Yes	40%
	Depaul University Lincoln Park	Yes	Yes		Yes		Yes	16%
	U of WI Oshkosh	Yes	Yes		Yes		Yes	30%
	Lakeland CC	Yes	Yes		Yes		Yes	NA
	Macalester College	Yes	Yes		Yes		Yes	30%
	Missouri Western State University	Yes	Yes		Yes		Yes	30%
	North Central Michigan	PAGE NOT FOUND	NA	NA	NA	NA	NA	NA
	U of Nebraska Lincoln	Yes	Yes	yes			Yes	25%
	Southern Illinois U Carbondale	Yes	Yes		Yes		Yes	25%
	Ohio State	yes	Yes				Yes	45%
Northeast	Cape Cod CC	Syllabus does not detail evaluation	NA	NA	NA	NA	NA	NA
	Dartmouth College	Yes	Yes		Yes		Yes	35%
	Cayuga CC	Not Found	NA	NA	NA	NA	NA	NA
	U of New Hampshire	Yes	Yes	Yes	Yes		Yes	20%
West	Antelope Valley CC	Yes	Yes		Yes		Yes	NA
	Brigham Young University	Yes	Yes		Yes		Yes	75%
	Cal State - Fresno	Not noted	Yes		Yes		Yes	90%
	Foothill College	Yes	Yes		Yes	Yes	Yes	NA
	Lane CC	Yes	Yes		Yes		Yes	50%
	University of Washington	Yes	Yes		Yes		Yes	50%

Assessment Recommendation

- Hybrid assessment model that includes a summative assessment in the form of an **exam** (multiple-choice and free response) and a **final digital GIS project**.
- Assessment based on three considerations:
 - 1) a review of assessment methods currently used in introductory undergraduate GIS&T courses;
 - 2) a review of assessment types and methods commonly used in AP courses; and
 - 3) the evolving movement to make STEM-based learning more inquiry-oriented.

Professional Development

- How does the course differ from the current high school course?
- What new or additional knowledge, skills, and abilities do high school teachers need to deliver the college-level course?
- What types of professional development will be needed?

Professional Development Recommendation

- **Knowledge:** Teachers will need to know fundamental principles and concepts of geographic information science (as outlined in the AP GIS&T course description). Teachers will need to have an understanding of what constitutes spatial data, how spatial data are collected, and sources of error affecting the accuracy and utility of spatial data. Teachers must also be able to work with spatial data and perform an analysis using GIS. Additionally, teachers should learn the principles of analytical methods, data modeling, and geovisualization.
- **Skills:** Teachers will need to master a variety of geospatial skills to teach AP GIS&T. For example, teachers should be comfortable employing and demonstrating various GIS graphical user interfaces (GUI), particularly those associated with their GIS software platform of choice. It is important for teachers to have the ability to create, query, and manage databases (e.g., data entry, editing, and conversion). Teachers should have general cartographic skills, including knowledge of the use of map elements and projections. To answer geographic questions, teachers will need to use a GIS to analyze data, including, but not limited to, carrying out vector analysis (e.g. overlays) and raster manipulation (e.g. raster calculations).
- **A GIS&T Summer AP Institute**, with a training agenda framed around 30 hours of training over a consecutive number of days (5-8 days), should provide the necessary amount of professional development for teaching AP GIS&T.

Endorsements (as of July 22)

- American Geosciences Institute
- Cartography and Geographic Information Society
- Environmental Defense Fund
- Esri
- Geographic and Land Information Society
- GeoTech Center
- GIS Certification Institute
- Google
- International Association of Assessing Officers
- Management Association for Private Photogrammetric Surveyors
- National Society of Professional Surveyors
- National States Geographic Information Council
- National Wildlife Federation
- North American Cartographic Information Society
- Open Source Geospatial Foundation
- Uber
- University Consortium for Geographic Information Science
- Urban and Regional Information Systems Association
- WILDCOAST

Attestations

AAG needs to collect the following attestations:

- At least 250 High Schools, indicating interest and capacity for AP GIS&T.
- At least 100 Colleges/Universities, indicating willingness to offer credit for AP GIS&T exam (proficiency).

Questions

Proposal and Attestation Forms
available in August 2016:

www.apgist.org