New AP® Course Proposal

Geographic Information Science and Technology



COURSE ASSESSMENT

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This section of the AP GIS&T proposal includes a recommended approach to the assessment of the knowledge, skills, and abilities developed in the proposed course. The proposal committee's recommendation for AP GIS&T assessment is based on a review of assessment methods currently used in introductory undergraduate GIS&T courses. This was done to ensure that students who take the AP GIS&T course are assessed for content knowledge and skills that are equivalent to the college course for which credit would be offered.

The proposal committee also reviewed assessment types and methods commonly used in similar AP courses. This information was used to align AP assessment types and methods with those practiced in introductory undergraduate GIS&T courses.

The proposal committee's recommendation for AP GIS&T assessment also takes into account the evolving movement to make STEM-based learning more inquiry-oriented, as well as the latest academic literature on summative assessment (or measures) of geospatial skills.

METHODS OF ASSESSING KNOWLEDGE, SKILLS, AND ABILITIES DEVELOPED IN UNDERGRADUATE GIS&T COURSES

To identify the methods by which college faculty assess undergraduate knowledge, skills, and abilities in GIS&T, the proposal committee analyzed the sample of 30 introductory GIS&T courses used to develop the AP GIS&T course description. It is important to note that the content and requirements of the introductory GIS&T courses were broadly consistent across all types of institutions (community colleges, liberal arts colleges, and universities) despite the differences in course numbering. For 2-year colleges, the introductory course was usually a 100-level geospatial-related course, whereas in 4-year undergraduate programs these courses were most often found at the 200 and 300 levels. Similarly, the introductory courses largely used comparable types of assessment.

In its analysis of introductory GIS&T courses, the committee observed four common assessment types:

- 1. Formal tests and exams are used to assess undergraduate knowledge, skills, and abilities in GIS&T. Test items include the following formats: multiple choice, grid-in, free response (short answer), and free response (formal essay).
- 2. Geospatial reasoning and mapping exercises are used to evaluate student proficiency in the use of GIS mapping software tools and applications such as QGIS or ArcGIS.
- 3. Portfolios and projects are used to provide evidence of the ability of students to apply GIS&T knowledge and skills to create a product, perform a spatial analysis, or solve a geographic problem (including group collaborative work).
- 4. Computer lab assignments are used as a measure of how well students perform a variety of GIS mapping and analytical operations.

With regard to these four types of assessment, the committee found that:

- All programs in the sample require students to complete map projects in a computer lab.
- All programs in the sample require students to create maps and/or complete a spatial analysis using GIS software.
- 87% of colleges in the sample require some kind of formal testing.
- 70% of colleges in the sample require students to create a portfolio or complete a final digital GIS project.

REVIEW OF AP ASSESSMENT TYPES

The majority of AP courses have a summative exam given annually in May. These summative assessments are traditional written exams, with both multiple-choice questions and free-response written elements. Some AP courses also include oral components (e.g., Music Theory, World Languages), while other AP courses feature through-course assessment elements that are submitted during the school year (e.g., Computer Science Principles, Studio Art, and the Capstone courses). In some of these AP courses, multiple assessment types are used to calculate a student's final AP score. These 'hybrid assessments' might include both a summative exam and work completed during the course.

The proposal committee identified four AP courses that were similar to the approaches to assessment practiced in introductory undergraduate GIS&T courses:

- 1. AP Human Geography: This course uses a traditional summative exam with a section of multiple-choice questions and a section of free response questions. Similar approaches will work to assess student knowledge of GIS&T information, concepts, and principles.
- 2. AP Computer Science Principles: This course uses a hybrid assessment with both a summative exam and portfolio elements. This hybrid assessment model is similar to most of the introductory GIS&T undergraduate courses analyzed by the committee. The AP CSP course also includes a cooperative learning element, which was observed in about 15% of the college GIS&T courses analyzed.
- **3. AP Studio Art:** This course uses a portfolio exam with students submitting work that has been completed as they proceed through the course. This exam format is applicable to the AP GIS&T course because many undergraduate courses require students to create a portfolio and/or final digital GIS project.
- **4. AP Capstone:** The two Capstone courses rely mostly on through-course assessment elements involving a research project. AP Seminar also includes a summative exam. GIS&T courses also support student-led data collection for research and applied projects.

Of these four AP courses, the committee found that the AP Computer Science Principles hybrid assessment (summative exam plus a portfolio requirement) most closely reflects the assessment practices of college-level GIS&T courses.

RECOMMENDATIONS FOR AP GIS&T ASSESSMENT

The committee recommends that AP GIS&T follow the hybrid assessment model. This hybrid assessment would include a summative assessment in the form of an exam (multiple-choice and free response) and a final digital GIS project. The final digital GIS project, which would include written and visual elements, is intended to support the inquiry-based approach to learning favored in STEM disciplines.

The summative assessment would include items based on research conducted in the area of spatial cognition. The research literature in GIS&T education offers a variety of assessment tools that measure different aspects of spatial thinking. These tools are especially valuable for measuring student attainment of spatial analytical and reasoning abilities. For example, Lee and Bednarz (2012) developed an *AAG Spatial Skills Test* that consists of eight types of multiple-choice questions. The Spatial Skills Test was validated through formative testing with a sample of 532 junior high, high school, and university students. Factor analysis using principal components extraction was applied to identify underlying spatial thinking components and to evaluate the construct validity of the test items.

Another example of a geospatial assessment is the *Geospatial Thinking Scale* (Huynh and Sharpe, 2013). This instrument measures participant understanding of spatial relations within a geographic context. The instrument is a test consisting of thirty question items designed to measure the geospatial knowledge, thinking skills, and characteristics typical at different levels of competency.

A third resource is the *Geospatial Reasoning Instrument* (Chung, Cannady and Kremer, 2015). This instrument may be used to determine the extent to which children and adults are learning spatial reasoning skills.

EXAMPLES OF SUMMATIVE EXAM QUESTIONS

Below are examples of assessment questions that illustrate the type of open choice and free response questions which might be included on a summative exam for AP GIS&T.

Example multiple-choice items

(1) Which of the following are 1-dimensional in spatial extent?

- (A) Point phenomena
- (B) Line phenomena
- (C) Areal phenomena
- (D) Volume phenomena

Answer: B

(2) The map below shows annual precipitation of Texas. If you draw a graph showing change of Texas annual precipitation between A and B, the graph will be _____ (choose closest one).



Answer: C

(3) You are standing at the peak of mountain C looking south. Name in clockwise order the other mountain(s) you can see:



(4) Saraya is planting an orange grove in California's San Joaquin Valley. Below is a map of California and the San Joaquin Valley.



Oranges cannot tolerate temperatures below 30 degrees Farenheit. What additional map or layer may help her determine the best part of the Valley to plant oranges?

- (A) Minimum Temperature Map
- (B) Average Temperature Map
- (C) Maximum Temperature Map
- (D) Today's Temperature Map

Answer: A

Example free-response items

(1) Single Free Response (Principles of Map Design):

When designing a map why is it important to consider the purpose of the map and the intended user? Provide at least one example as part of your answer.

(2) Multiple-response:

Define the term projection.

Identify three different map projections and discuss a situation in which you would use each projection.

Identify and explain one issue that will arise if you use the wrong projection to solve a GIS question or decision.

Example final digital project

The committee recommends that the assessment for AP GIS&T include a final digital GIS project. The college courses analyzed by the proposal committee include a cumulative assessment in the form of an applied spatial analysis using GIS. Digital assessment elements are a component of AP courses that make use of various technologies (e.g., Computer Science Principles). As a cumulative assessment, the final digital GIS project would serve as an authentic assessment of the knowledge, skills, and abilities students have developed over the course (e.g., in labs) and with formative feedback from teachers.

REFERENCES

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