Teaching GIS Using the Geospatial Technology Competency Model

A framework for an introductory GIS course for professionals

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What We'll Talk About Today

- Background about Penn State Online Geospatial Education
- What is the GTCM?
- How is it used to design an introductory GIS course?
- More about the course – content and structure wrt to GTCM
- Your thoughts & questions

Key Points of Discussion

- Designing an introductory GIS course for professionals has unique challenges
- Geospatial Technology Competency model offers an organized and up-to-date framework to structure course content
- Geog 482: Making Maps that Matter with GIS provides a variety of assessments centered around the GTCM to meet varying skill levels
- Identify and describe core components of the Geospatial Technology Competency Model
- Consider how your job duties/skills correspond to skills in the model
- Share your thoughts and opinions on the content of online GIS courses for adult learners

Penn State…in Austin?!

- Penn State Online Geospatial Program started in 1999 **(25 years!)**
- > ~4000 graduates
- > ~300 students currently
- Courses are fully online & asynchronous

5 Certificates

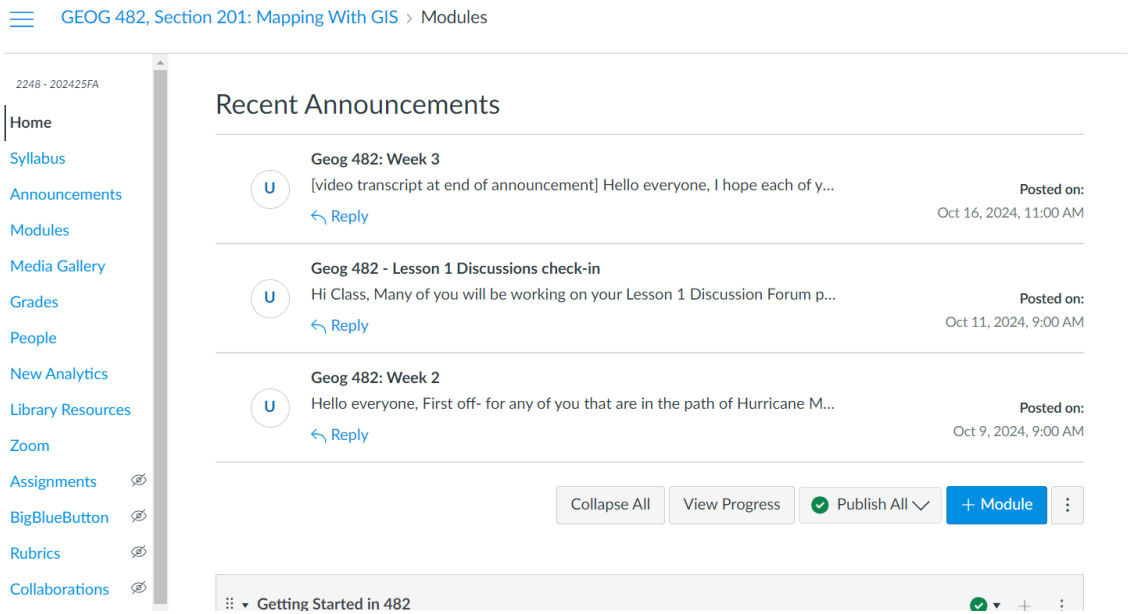
- GIS
- Remote Sensing
- Geospatial Intelligence
- Web Mapping / Geospatial Programming
- Spatial Data Science

3 Master's Degrees

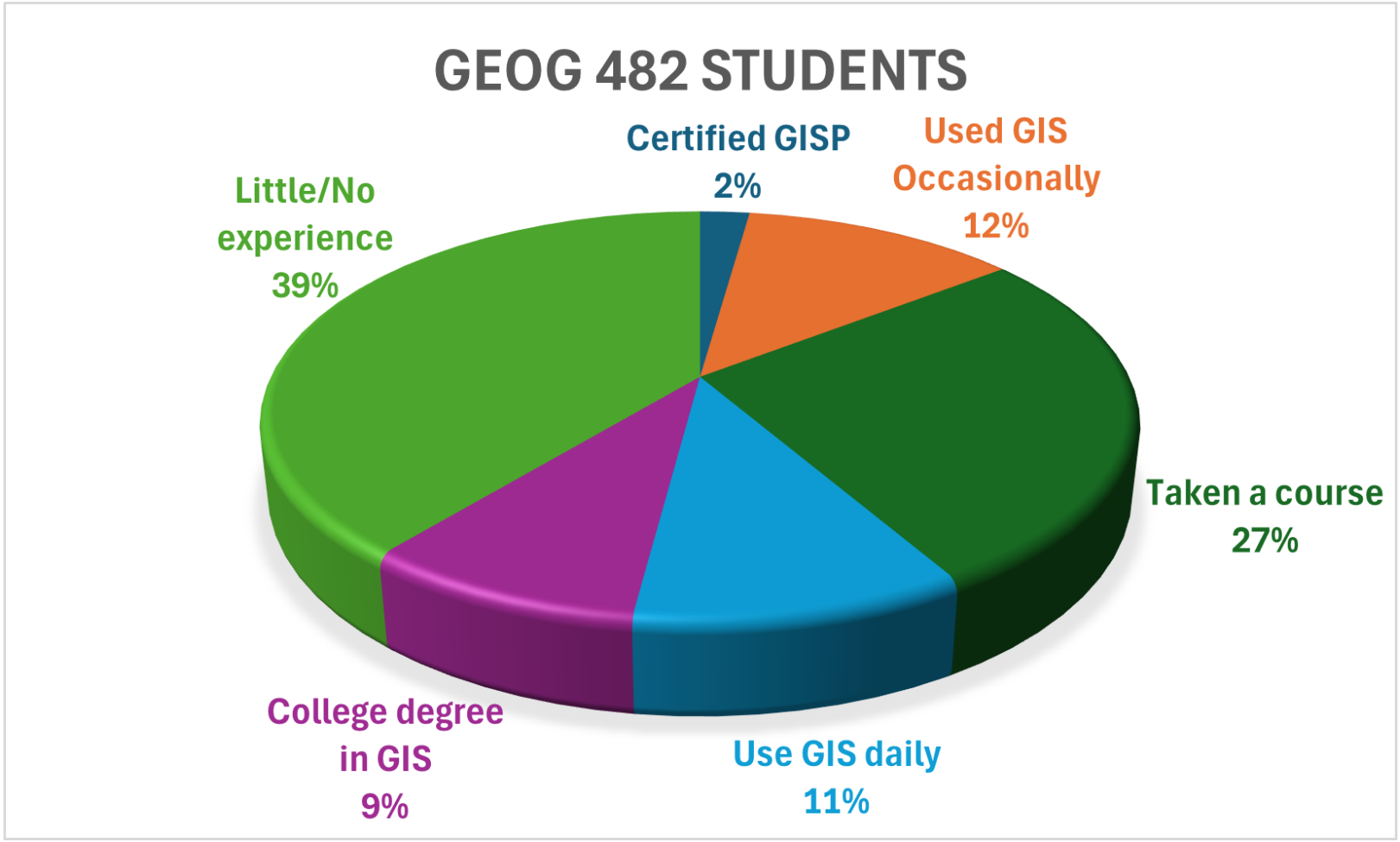
- GIS
- Spatial Data Science
- Homeland Security

Quick Facts About the Course

- Geog 482: Making Maps That Matter With GIS
  - First (and required) course for GIS Certificate
  - Started in 1999, rewritten in 2017, updated in 2024
  - Over 200 students/year; 5 offerings a year



Who is the Geog 482 student?



Geog 482: Making Maps that Matter with GIS

Learning Outcomes

- Self-knowledge of individual strengths and weakness in relation to the foundational, academic, and industry-specific competencies specified in the **U.S. Department of Labor's Geospatial Technology Competency Model** (GTCM)
- Familiarity with key topics that span the **three industry sectors** of the GTCM
- **Lifelong learning skills**, including the ability to investigate topics independently, the ability to work in teams, and the ability to communicate effectively;
- The ability to use maps and geospatial technology as a **story-telling** medium
- Readiness to use **case studies** to make compelling arguments on how and why GIS matters.

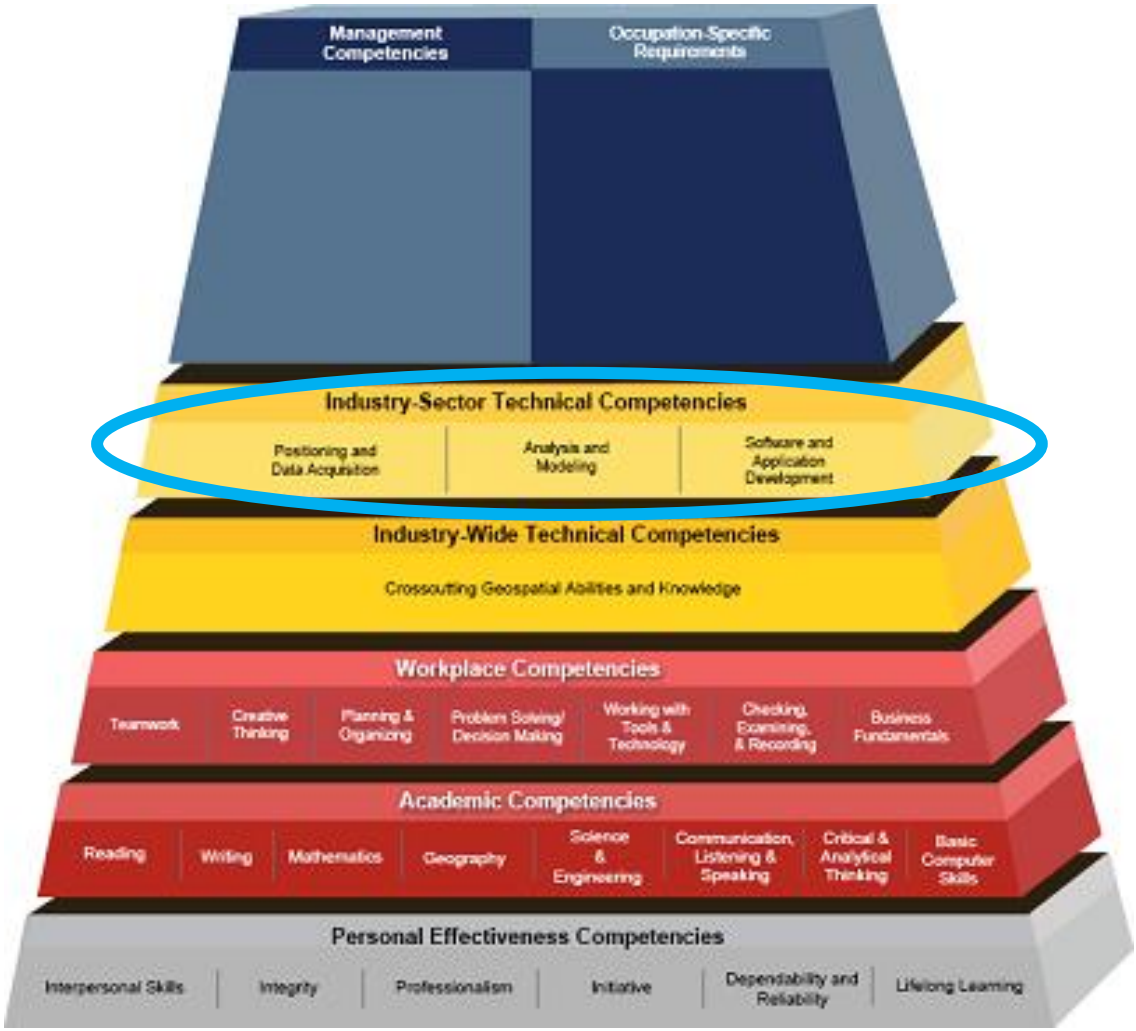
What is a competency model?

- “A competency model is a collection of skills and a knowledgebase that together define successful performance in a particular work setting……

- Industry competency models depict the common knowledge, skills, and abilities in an industry or industry sector. The resulting model forms the foundation on which career paths can be developed.”

- *https://www.careeronestop.org/CompetencyModel/BuildaModel/TAG.pdf*

GEOSPATIAL TECHNOLOGY COMPETENCY MODEL



Course Outcome	Student Activity/Assessment
Familiarity with Industry Sectors of GTCM	Lesson content & discussions Mapping exercises
Self-knowledge of skills outlined in GTCM	Self-assessments at the beginning and end of each section of the course
Lifelong learning skills	Research skills through discussion forums
Maps and geospatial technology for story telling	Story Map final project Other mapping exercises
Case studies for why GIS matters	Each lesson starts w/ a case study

Back to Model Pyramid

How To

- Download the industry model and worksheets in several formats

General Information

- The "Building Blocks"
- Frequently Asked Questions
- Competency Model Development and Use (PDF)

5.1 Positioning and Data Acquisition

Understanding and working with the unique geometric and thematic properties of geospatial data, the factors that affect data quality, and data production technologies, including: data collection, data capture methods, and technologies used to collect georeferenced observations and measurements.

Critical Work Functions

5.1.1 Use geospatial software to transform ellipsoid, datum, and/or a map projection to georegister one set of geospatial data to another.

5.1.2 Geocode a list of address-referenced locations to map data encoded with geographic coordinates and attributed with address ranges.

5.1.3 Interpret and use land records based on both systematic and unsystematic land partitioning systems.

5.1.4 Recognize that land records are administered differently around the world.

5.1.5 Explain the distinction between a property boundary and its representations, such as deed lines, lines on imagery, and boundary depictions in cadastral (land records) databases.

5.1.6 Digitize parcel data from a legal boundary description in a deed or plat.

5.1.7 Design a process for acquiring, processing, and integrating geospatial data from diverse sources.

5.1.8 Identify sampling strategies for field data collection, including systematic, random, and stratified random sampling, and describe circumstances favorable to

Course content

Industry Sector Competency	Associated Lesson
Positioning & Data Acquisition	Lesson 1: GIS & Public Health Lesson 2: A Global Geodetic Reference
Analysis & Modeling	Lesson 3: Everyday Spatial Analysis Lesson 4: A National Water Model for Flood Prediction & Response
Software & Application Development	Lesson 5: GIS Programming Introduction Lesson 6: Web GIS

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5.2 Analysis and Modeling

Understanding and applying the analytical functions ("exploratory" analyses as well as model-driven analyses) of geospatial software tools.

Critical Work Functions

5.2.1 Perform a buffer operation in GIS software.

5.2.2 Implement standard analytical procedures to perform common geospatial tasks, such as suitability overlay analysis.

5.2.3 Develop new analysis procedures to solve novel or unstructured geospatial tasks.

5.2.4 Use GIS software to identify an optimal route that accounts for visibility, slope, and specified land use or land cover.

5.2.5 Use location-allocation software functions to locate service facilities that satisfy given constraints.

5.2.6 Develop conceptual, logical, and physical models of a geospatial database designed in response to user requirements.

5.2.7 Recognize the impact of the Modifiable Areal Unit Problem on the apparent spatial and statistical patterns found in geospatial data.

5.2.8 Select, use, and interpret geospatial modeling techniques appropriately with respect to their characteristics.

5.2.9 Apply predictive models to study geographic patterns and processes.

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5.3 Software and Application Development

Design and development of geospatial software and applications, including GIS software products, applications for processing, analyzing, or adding value to remotely sensed data, and applications to automate routine tasks and customize end-user interfaces.

Critical Work Functions

5.3.1 Develop use cases for user-centered requirements analyses.

5.3.2 Perform a feasibility study and cost/benefit analysis.

5.3.3 Implement a geospatial system architecture that responds to user needs, including desktop, server, and mobile applications.

5.3.4 Communicate effectively with end-users to ensure that software applications meet user needs.

5.3.5 Optimize the performance of geospatial software applications.

5.3.6 Identify appropriate software development tools for particular end uses (e.g., web maps, mobile apps, desktop software).

5.3.7 Evaluate and choose the most appropriate means of communication (e.g., story maps, dashboards, web maps) for the intended audience, problem, and message.

5.3.8 Recognize potentially sensitive location-based data and follow appropriate procedures to protect that information from public misuse.

5.3.9 Ensure that software code complies with industry standards, such as those promulgated by the Open Geospatial Consortium (OGC).

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- GTCM Self Assessment

Student GTCM reflections

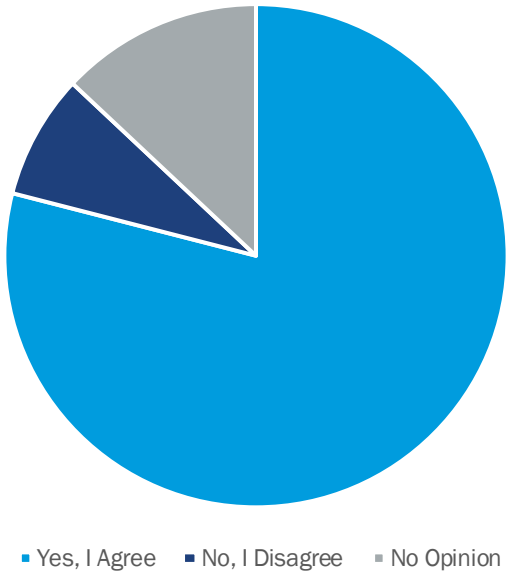
“Using this assessment tool to track my progress on geodesy topics leaves me feeling both proud that I'm **moving into the "I know what this means"** categories and humbled by how much I still have yet to learn. I look forward to looking back on this assessment when I am able to complete the skills listed on my own. Comparing my results with classmates reminds me that I am on track in my learning. ”

“I only answered "I don't know what this means" twice, and nearly half of the tasks I'd be able to at least attempt with a bit of guidance. I like **seeing my knowledge grow**!”

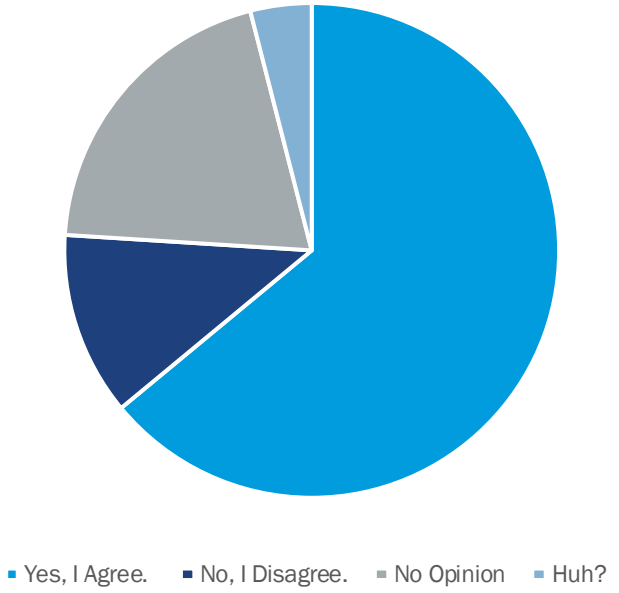
“I know extremely little about GIS software and apps, but at least I can now recognize most topics and terms. **Before this lesson, I had no clue** that there were so many GIS mapping and visualization services and companies.”

Student Survey

I found the Geospatial Technology Competency Model self-assessments a helpful way to assess my knowledge of the geospatial field.



I think the GTCM is a useful and effective way to organize an intro GIS course.



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Outcome: Lifelong learning skills

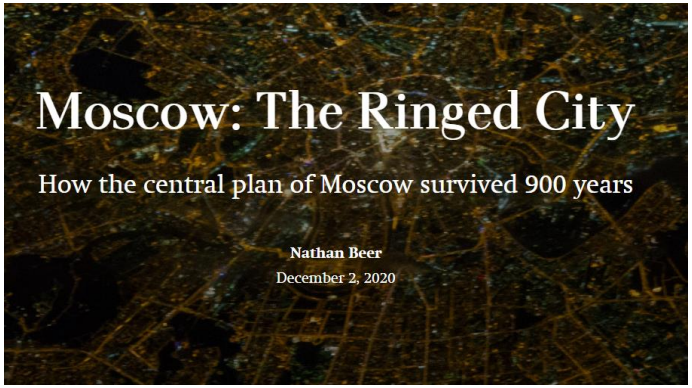
Next, investigate and report on *ONE* of the following topics and questions. Plan to spend one to two hours reading classmates' pos discovering and assessing sources, and drafting and refining your contribution.

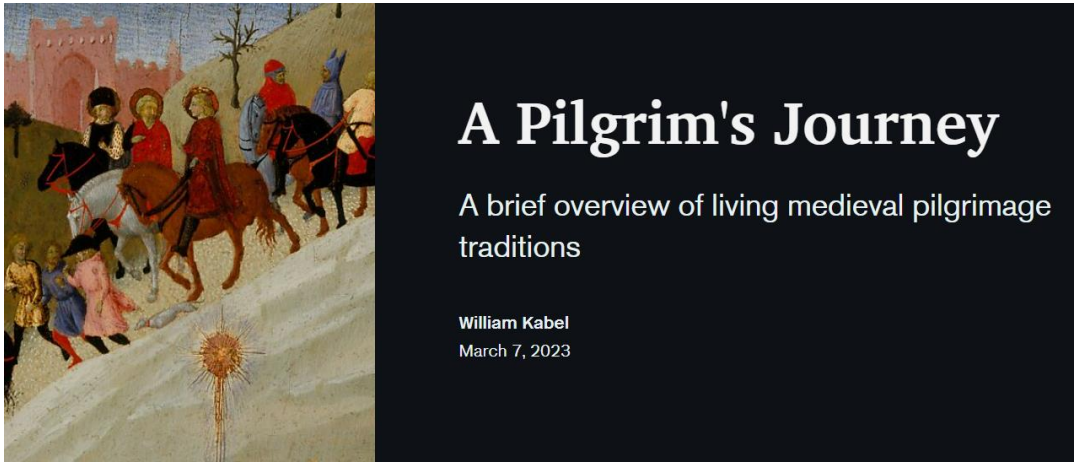
1. What do remote sensing systems measure?
2. Discuss the various meanings of the term "resolution" in relation to remotely sensed image data.
3. Discuss the relationship between scale and spatial resolution.
4. Explain the distinction between "passive" and "active" remote sensing, and provide an example of each.
5. What is "orthorectification"?
6. In the context of the polio eradication case study, discuss why remotely sensed image data were necessary but insufficient.
7. What geometric properties of imagery are needed for feature extraction?
8. Discuss the characteristics of vector data, including features and attributes. In the case study, what were some of the vector data
9. Discuss examples of phenomena that are best represented with rasters (fields), and others that are best represented with vectors
10. Describe the field of Photogrammetry.
11. What is the "state of the art" for deriving vector features from raster imagery?

Advice

- If this topic is unfamiliar to you, you might want to start with these entries in the *Geographic Information Science & Technology Body of*

Outcome: Maps & Geospatial Tools for Storytelling





Outcome: Case Studies for Why GIS Matters

- Case Study Examples
  - ***GIS & Public Health*** > GIS tools such as geocoding, image analysis
  - ***Sustainable Development*** > coordinate systems
  - ***Flood Analysis*** > GIS analysis and modeling
  - ***Profile of a GIS small business*** > programming & web GIS
  - ***Ethics*** > Case studies from GISEthics.org

Summary

- Designing an introductory GIS course for professionals has unique challenges
- Provide a variety of assessments to meet varying skill levels
- Geospatial Technology Competency Model offers an organized and up-to-date framework to structure course content
- Students respond positively to the GTCM framework for the course

Comments or Questions?

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