Unlocking the potential of your introductory geoscience course

AGI/AGU Heads and Chairs webinar

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What is the potential of introductory geoscience courses?

What we know:

They enroll a LOT of students from across the university → *Reach, university service, $$*

They are an important pathway for recruiting students into the geosciences → *Department stability, growth, $$*

They are likely the only geoscience class that many students will take → *Earth literacy, long-term impact*

What is the **potential** of introductory geoscience courses?

What if every student…:

…gained skills and confidence in analyzing and interpreting Earth data?

…felt curious and that they could contribute their own ideas?

…recognized the relevance of their skills and knowledge to their everyday lives?

…made use of and shared their skills, curiosity, and knowledge in their workplace and career?

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…made use of and shared their skills, curiosity, and knowledge in their workplace and career?

*Collectively, introductory geoscience courses have the potential to develop students who are **ready to change the world!***

What is the **potential** of YOUR introductory geoscience courses?

Waterfall question: Directions

1. We will put a question up.
2. We'll give you a minute or two to type your answer in the chat, but DON'T HIT RETURN.
3. Once enough time has passed, we'll tell you to hit return, and we will all read through and summarize the responses.

Think big, long-term, blue sky:

What is the potential for YOUR introductory geoscience course?

You might already be on your way to achieving it, you might not.

What do you envision?

What gets in the way

Inertia: Think about who is involved in teaching your largest, most popular introductory course over a year. Instructors, adjuncts, teaching assistants, learning assistants, instructional techs….

In the chat, enter how many people total are involved.

“The system”: Raise your hand if you feel hamstrung by…

- *Tradition*
- *Classroom size and/or layout*
- *“Lecture” vs “lab” and all that means*
- *Articulation agreements (IYKYK)*
- *Even more things*

These challenges are real.
And transformation is still possible!

Overcoming inertia takes deliberate, concerted effort that involves all stakeholders.

Working within ”the system” might involve creative solutions.

Transformation can be, in fact, *transformative*, for both instructors and students.

There is help to make it happen.

Guiding principles and the TIDeS effort

Individual experience

Some research

Opportunities for you

Guiding principles for transformation

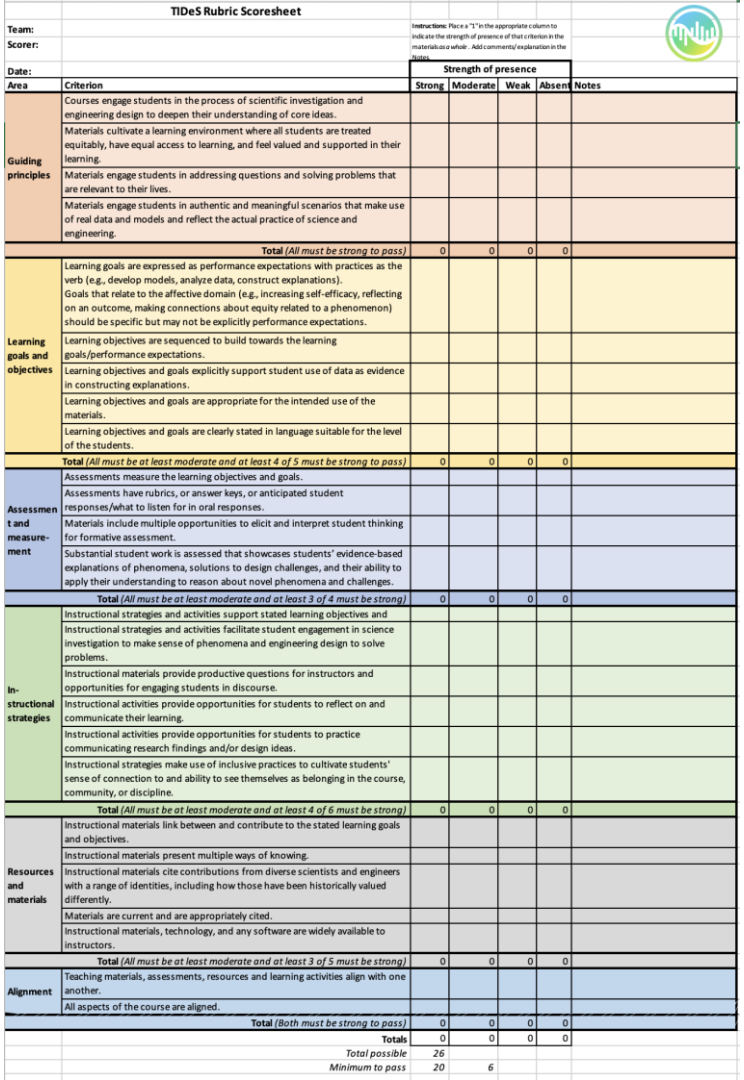
- Students will *engage in scientific investigation and engineering design* to deepen their understanding of core ideas.
- Instructors and the curricular materials they use will cultivate a learning environment where *all students* have equal access to learning and feel valued and supported in their learning.
- Students will *engage in addressing questions and solving problems* that are *relevant* to their lives.
- Students will *engage in authentic and meaningful scenarios* that make *use of real data and models* and reflect the actual practice of science and engineering.

Teaching with Investigation and Design in Science (TIDeS)

Support teams of instructors in developing and implementing curricular materials that meet the guiding principles as established in a rubric

Assess the impact on instructors and students

Disseminate and support implementation by others



TIDeS Rubric Scoresheet

Team:
Scorer:
Date:

Instructions: Place a "1" in the appropriate column to indicate the strength of presence of that criterion in the materials as a whole. Add comments/explanation in the Notes.

Area	Criterion	Strength of presence: Strong	Moderate	Weak	Absent	Notes
Guiding principles	Courses engage students in the process of scientific investigation and engineering design to deepen their understanding of core ideas.					
	Materials cultivate a learning environment where all students are treated equitably, have equal access to learning, and feel valued and supported in their learning.					
	Materials engage students in addressing questions and solving problems that are relevant to their lives.					
	Materials engage students in authentic and meaningful scenarios that make use of real data and models and reflect the actual practice of science and engineering.					
	Total *(All must be strong to pass)*	0	0	0	0	
Learning goals and objectives	Learning goals are expressed as performance expectations with practices as the verb (e.g., develop models, analyze data, construct explanations). Goals that relate to the affective domain (e.g., increasing self-efficacy, reflecting on an outcome, making connections about equity related to a phenomenon) should be specific but may not be explicitly performance expectations.					
	Learning objectives are sequenced to build towards the learning goals/performance expectations.					
	Learning objectives and goals explicitly support student use of data as evidence in constructing explanations.					
	Learning objectives and goals are appropriate for the intended use of the materials.					
	Learning objectives and goals are clearly stated in language suitable for the level of the students.					
	Total *(All must be at least moderate and at least 4 of 5 must be strong to pass)*	0	0	0	0	
Assessment and measurement	Assessments measure the learning objectives and goals.					
	Assessments have rubrics, or answer keys, or anticipated student responses/what to listen for in oral responses.					
	Materials include multiple opportunities to elicit and interpret student thinking for formative assessment.					
	Substantial student work is assessed that showcases students' evidence-based explanations of phenomena, solutions to design challenges, and their ability to apply their understanding to reason about novel phenomena and challenges.					
	Total *(All must be at least moderate and at least 3 of 4 must be strong)*	0	0	0	0	
Instructional strategies	Instructional strategies and activities support stated learning objectives and					
	Instructional strategies and activities facilitate student engagement in science investigation to make sense of phenomena and engineering design to solve problems.					
	Instructional materials provide productive questions for instructors and opportunities for engaging students in discourse.					
	Instructional activities provide opportunities for students to reflect on and communicate their learning.					
	Instructional activities provide opportunities for students to practice communicating research findings and/or design ideas.					
	Instructional strategies make use of inclusive practices to cultivate students' sense of connection to and ability to see themselves as belonging in the course, community, or discipline.					
	Total *(All must be at least moderate and at least 4 of 6 must be strong)*	0	0	0	0	
Resources and materials	Instructional materials link between and contribute to the stated learning goals and objectives.					
	Instructional materials present multiple ways of knowing.					
	Instructional materials cite contributions from diverse scientists and engineers with a range of identities, including how those have been historically valued differently.					
	Materials are current and are appropriately cited.					
	Instructional materials, technology, and any software are widely available to instructors.					
	Total *(All must be at least moderate and at least 3 of 5 must be strong)*	0	0	0	0	
Alignment	Teaching materials, assessments, resources and learning activities align with one another.					
	All aspects of the course are aligned.					
	Total *(Both must be strong to pass)*	0	0	0	0	
	Totals	0	0	0	0	
	Total possible	26				
	Minimum to pass	20	6			

How are **these** curricular materials different?

More of…	Less of…
Students *doing* stuff	Instructors talking about stuff
A focus on building skills in investigation	A focus on building content knowledge
Fewer topics in greater depth	Touching on lots of topics
Students seeing themselves as scientists	Science being done only by other people

They have all been used by instructors in a wide range of institutional settings, and they share their experiences of implementation, including overcoming some of the challenges.

Two courses: TIDeS Teaching Materials

Earth Science

In this introductory Earth Science for pre-service teachers course, students will examine Earth processes through the lenses of geology, meteorology, oceanography, and astronomy. This course provides students with opportunities to engage with science content in ways that will help them teach it to their future students.

Physical Science

In this physical sciences course for future teachers, students explore typical concepts of energy, power, heat engines, pressure, density, buoyancy, fluids, projectile motion, and Newton's laws of motion. This is an active learning class with very little time spent in a traditional lecture setting.

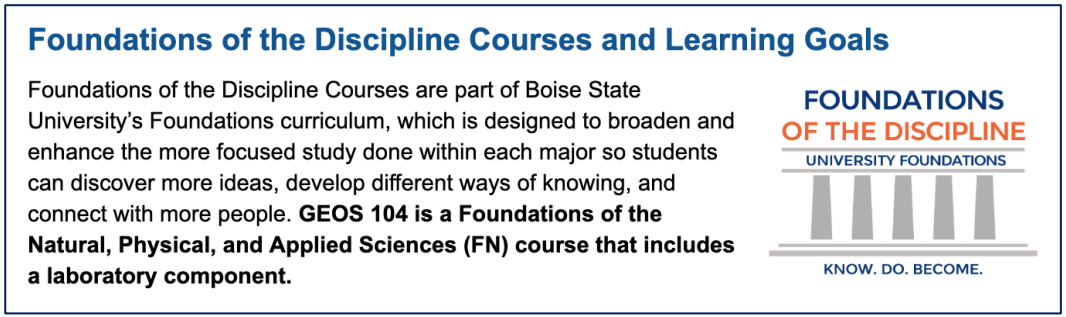
TIDeS Earth science course implementations

Institution type	Weekly course schedule	Number of students
MS-granting public university (regional comprehensive)	Three 55-min sessions OR two 85-min sessions	75-120
Two-year college	Two 180-min sessions	10-30
Two-year college	Two 80-min sessions + one 3-hour lab	24
PhD-granting high research public university	Two 75-minute sessions + one 2-hour lab	30
PhD-granting very high research public university*	Two 75-minute sessions	115
PhD-granting public regional comprehensive university*	Three 50-minute sessions	45

** Non-author implementer*

Implementation at Boise State University

- GEOS 104 is open to all students, but attracts a lot of elementary education and special education majors (enrolls ~30 students)
- “Lecture” meets twice per week for 75 minutes, “lab” meets once per week for 2 hours
- In reality, lecture and lab are integrated– similar activities, just lab lasts longer and students turn in assignments for grading
- 1 graduate teaching assistant is assigned



TIDeS Earth science course

Unit 1 Anyone Can Be a Scientist

Unit 2 Are We Moving Towards Another Supercontinent?

Unit 3 Where Do We Find the Resources We Need?

Unit 4 Are You Prepared for Severe Weather?

Unit 5 How Do You Prepare for Floods and Landslides?

Unit 6 How Do We Explore Planets in Our Solar System?

- Driven by relevant questions
- Focus on the process of science
- Data-based investigations in geology, meteorology, oceanography, space science
- TILT (Transparency in Learning and Teaching) model and template
- Scientist spotlights

TIDeS approach: Relevance

Unit 1 Anyone Can Be a Scientist

Unit 2 Are We Moving Towards Another Supercontinent?

Unit 3 Where Do We Find the Resources We Need?

Unit 4 Are You Prepared for Severe Weather?

Unit 5 How Do You Prepare for Floods and Landslides?

Unit 6 How Do We Explore Planets in Our Solar System?

Make observations about a place of interest using Google Earth

Investigate plate motions (directions and rates) at your current location

Identify objects you deem necessary, and determine the key geological resources within those objects

Prepare your campus for localized severe weather

Design a flood-resilient housing development

Create a scientist spotlight for yourself, a NASA scientist

TIDeS approach: Process of science

Students reflect on the practices they are using….

- …in individual activities
- …through an an ”exit ticket" at the end of each unit

Step	Description of what you did	Which SEP does this step use?
1	Asked questions: Where will the oceans and continents be in the future? Are we headed toward another supercontinent?	Asking questions and defining problems
2		
3		

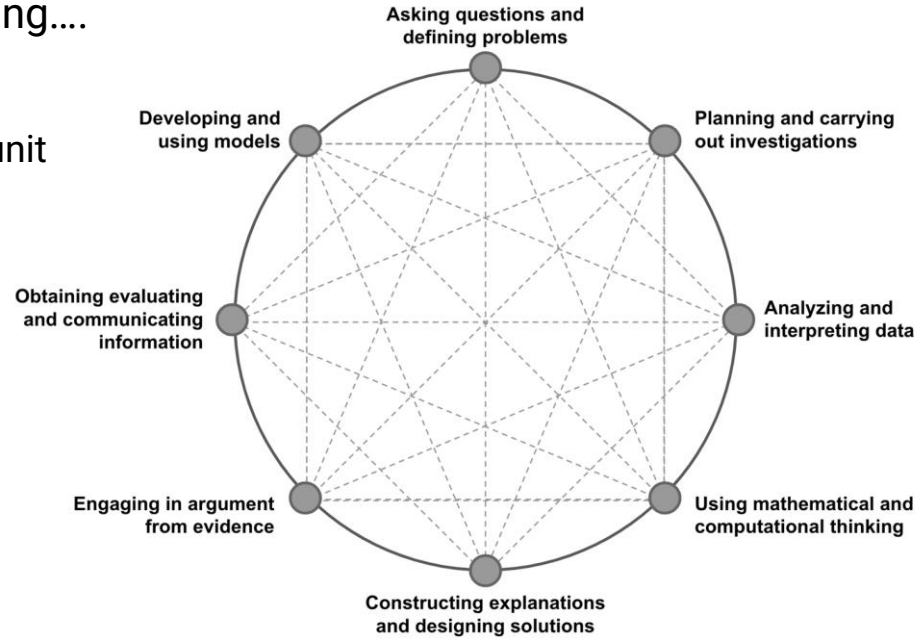
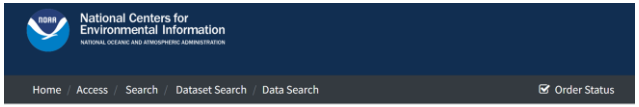


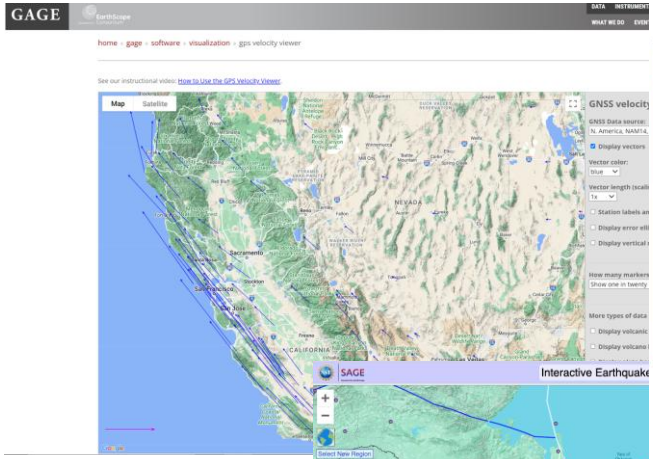
Figure from Nyman & St. Clair (2016)

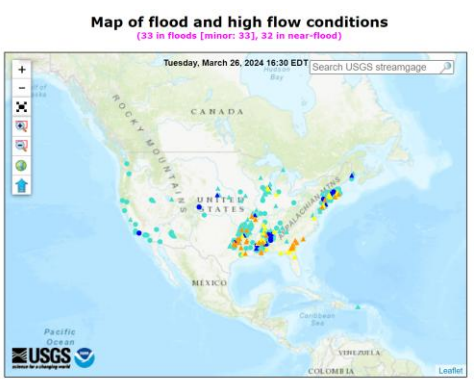
TIDeS approach: Using real data

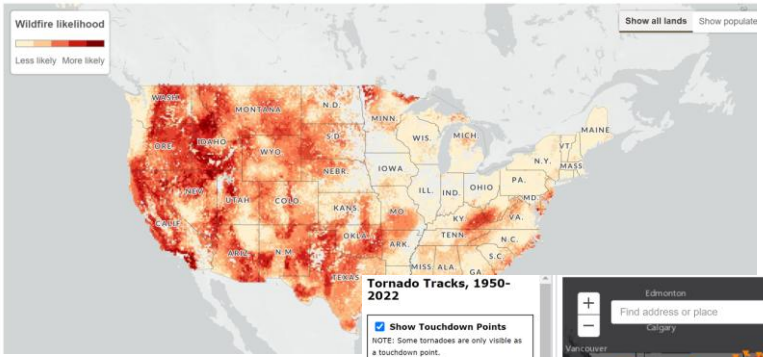
Students investigate using online databases



U.S. Climate Normals 2020: U.S. Daily Climate Normals (1991-2020)

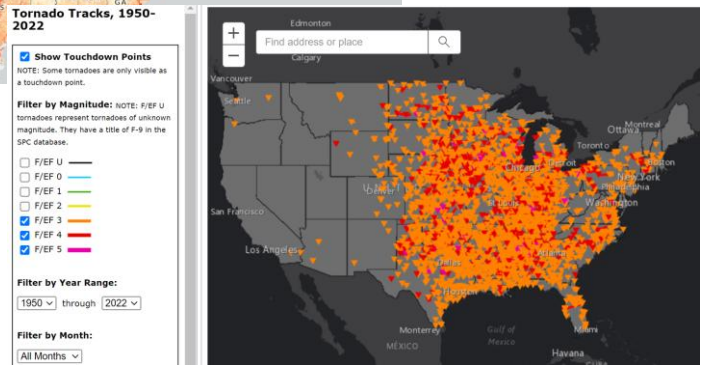


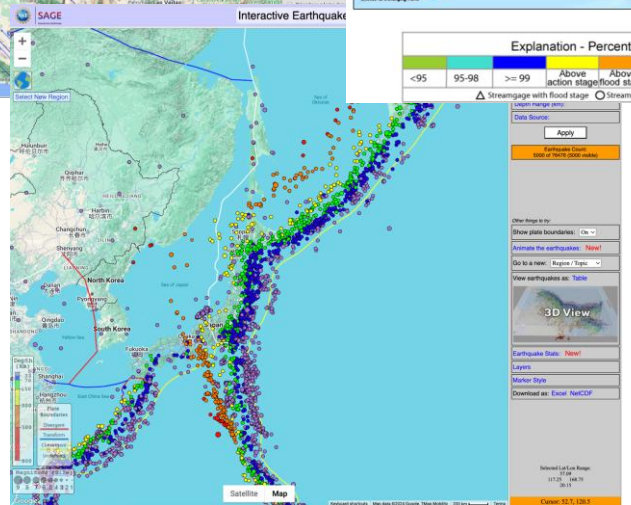




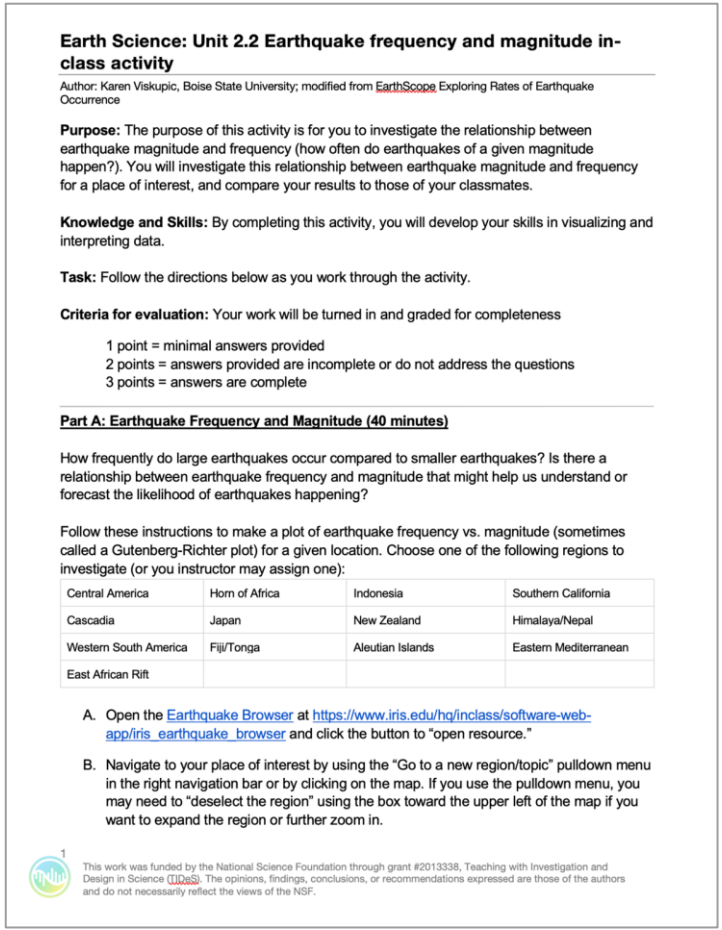
Wildfire likelihood

Populated areas in Agoura Hills have, on average, greater wildfire likelihood than 93% of communities in the US.





TIDeS approach: TILT



Earth Science: Unit 2.2 Earthquake frequency and magnitude in-class activity

Author: Karen Viskupic, Boise State University; modified from EarthScope Exploring Rates of Earthquake Occurrence

Purpose: The purpose of this activity is for you to investigate the relationship between earthquake magnitude and frequency (how often do earthquakes of a given magnitude happen?). You will investigate this relationship between earthquake magnitude and frequency for a place of interest, and compare your results to those of your classmates.

Knowledge and Skills: By completing this activity, you will develop your skills in visualizing and interpreting data.

Task: Follow the directions below as you work through the activity.

Criteria for evaluation: Your work will be turned in and graded for completeness

1 point = minimal answers provided
2 points = answers provided are incomplete or do not address the questions
3 points = answers are complete

Part A: Earthquake Frequency and Magnitude (40 minutes)

How frequently do large earthquakes occur compared to smaller earthquakes? Is there a relationship between earthquake frequency and magnitude that might help us understand or forecast the likelihood of earthquakes happening?

Follow these instructions to make a plot of earthquake frequency vs. magnitude (sometimes called a Gutenberg-Richter plot) for a given location. Choose one of the following regions to investigate (or you instructor may assign one):

Central America	Horn of Africa	Indonesia	Southern California
Cascadia	Japan	New Zealand	Himalaya/Nepal
Western South America	Fiji/Tonga	Aleutian Islands	Eastern Mediterranean
East African Rift			

A. Open the Earthquake Browser at https://www.iris.edu/hq/inclass/software-web-app/iris_earthquake_browser and click the button to "open resource."

B. Navigate to your place of interest by using the "Go to a new region/topic" pulldown menu in the right navigation bar or by clicking on the map. If you use the pulldown menu, you may need to "deselect the region" using the box toward the upper left of the map if you want to expand the region or further zoom in.

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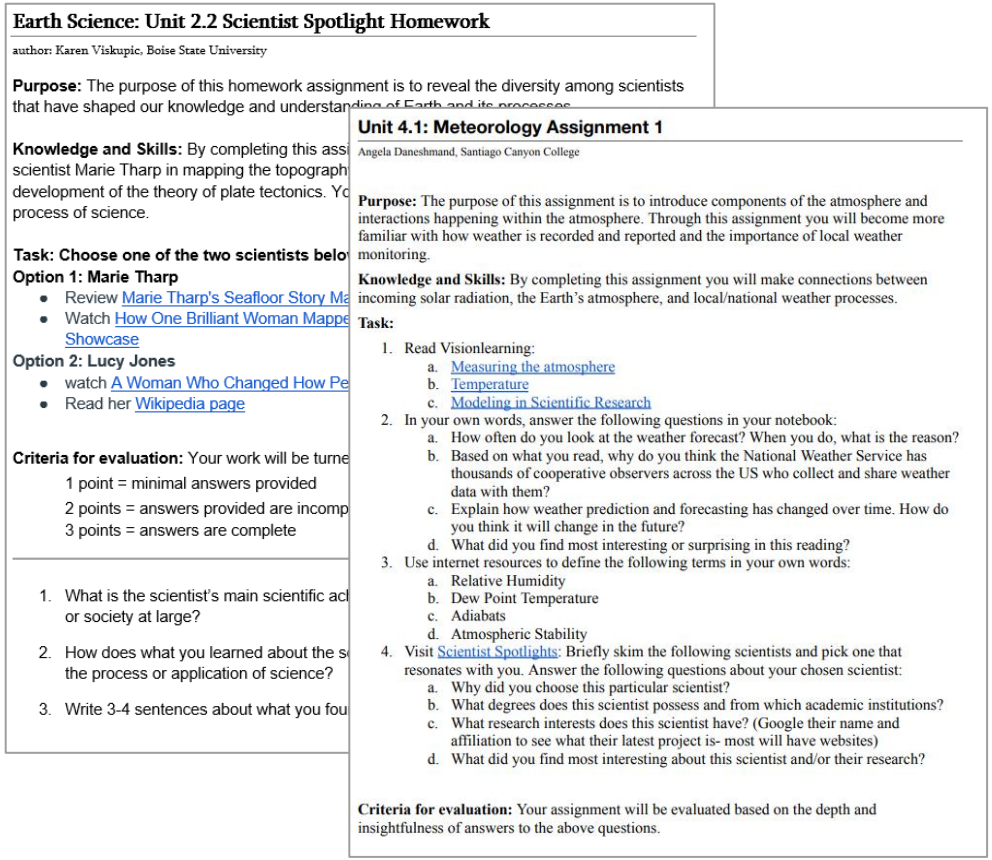
"The Transparency in Learning and Teaching project aims to advance equitable teaching and learning practices that reduce systemic inequities in higher education"

Each activity or assignment includes:

- Purpose
- Knowledge and skills
- Task
- Criteria for evaluation

https://www.tilthighered.com/

TIDeS approach: Scientist spotlights



Earth Science: Unit 2.2 Scientist Spotlight Homework

author: Karen Viskupic, Boise State University

Purpose: The purpose of this homework assignment is to reveal the diversity among scientists that have shaped our knowledge and understanding of Earth and its processes.

Knowledge and Skills: By completing this ass
scientist Marie Tharp in mapping the topograph
development of the theory of plate tectonics. Yo
process of science.

Task: Choose one of the two scientists belo

Option 1: Marie Tharp

- Review Marie Tharp's Seafloor Story Ma
- Watch How One Brilliant Woman Mappe
  Showcase

Option 2: Lucy Jones

- watch A Woman Who Changed How Pe
- Read her Wikipedia page

Criteria for evaluation: Your work will be turne

1 point = minimal answers provided
2 points = answers provided are incomp
3 points = answers are complete

1. What is the scientist's main scientific acl
   or society at large?
2. How does what you learned about the s
   the process or application of science?
3. Write 3-4 sentences about what you fou

Unit 4.1: Meteorology Assignment 1

Angela Daneshmand, Santiago Canyon College

Purpose: The purpose of this assignment is to introduce components of the atmosphere and interactions happening within the atmosphere. Through this assignment you will become more familiar with how weather is recorded and reported and the importance of local weather monitoring.

Knowledge and Skills: By completing this assignment you will make connections between incoming solar radiation, the Earth's atmosphere, and local/national weather processes.

Task:

1. Read Visionlearning:
   a. Measuring the atmosphere
   b. Temperature
   c. Modeling in Scientific Research
2. In your own words, answer the following questions in your notebook:
   a. How often do you look at the weather forecast? When you do, what is the reason?
   b. Based on what you read, why do you think the National Weather Service has thousands of cooperative observers across the US who collect and share weather data with them?
   c. Explain how weather prediction and forecasting has changed over time. How do you think it will change in the future?
   d. What did you find most interesting or surprising in this reading?
3. Use internet resources to define the following terms in your own words:
   a. Relative Humidity
   b. Dew Point Temperature
   c. Adiabats
   d. Atmospheric Stability
4. Visit Scientist Spotlights: Briefly skim the following scientists and pick one that resonates with you. Answer the following questions about your chosen scientist:
   a. Why did you choose this particular scientist?
   b. What degrees does this scientist possess and from which academic institutions?
   c. What research interests does this scientist have? (Google their name and affiliation to see what their latest project is- most will have websites)
   d. What did you find most interesting about this scientist and/or their research?

Criteria for evaluation: Your assignment will be evaluated based on the depth and insightfulness of answers to the above questions.

"His story further substantiates the argument that science is intrinsically based on cooperation."

"All science is very ongoing and active no matter the field."

"They were really cool to see and read what a scientist really does."

"Anyone, regardless of background can make… important contributions to science… diverse experiences improve scientific understanding."

"[Scientists] are just average people that come from all different backgrounds, and honestly how important that can be."

TIDeS approach: Multiple means of engagement

	Discussion	Think–pair–share	Jigsaw or gallery walk	Worksheet	Demo or model	Exit ticket, reflection	Homework
Unit 1	Group, Class	X	X	X		X	X
Unit 2	Group, Class		X	X	X	X	X
Unit 3	Group, Class		X	X			X
Unit 4	Group, Class	X	X	X	X	X	X
Unit 5	Group, Class	X	X	X	X	X	X
Unit 6	Group, Class		X	X	X	X	X

TIDeS approach: Scaffolded activities

	Presentations	Observations, interpretations	Graphing and calculations	Analyzing data	Working with spreadsheets
Unit 1	Activity report-out	X			
Unit 2	Informal	X	X	X	
Unit 3	Informal or formal	X		X	
Unit 4	Informal or formal	X	X	X	X
Unit 5	Activity report-out	X	X	X	X
Unit 6	Informal and formal	X		X	

TIDeS approach: How does change happen?

- Commit to it
- The work will take significant time and effort—be ready to support and facilitate
- Working with a group of instructors is helpful for sharing ideas and experiences, but you can make change with only one committed person too!
- May need to work around institutional constraints—be flexible and creative; talk to and learn from others
- Be inspired by the guiding principles and existing curriculum and support adaptations that make sense in your context

Cultivating a learning environment where all students have equal access to learning and feel valued and supported in their learning

Not just one thing will create this environment.

- Allow for and celebrate students and scientists as whole people
- Allow time for real learning to take place, sometimes through failure
- Be transparent and explicit about what you are doing and why
- Allow everyone to have a voice through discourse

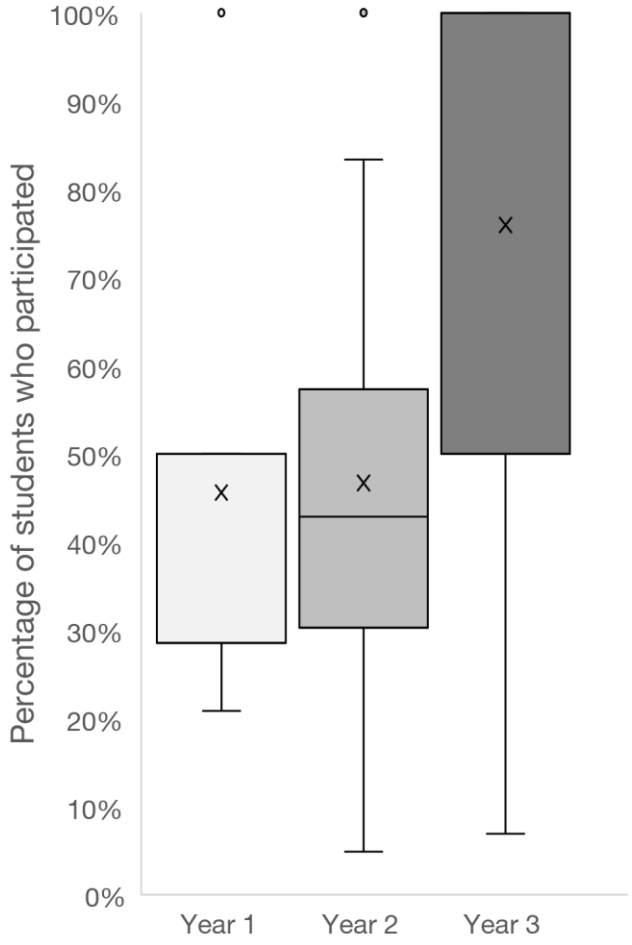
Documenting the change

	Teaching beliefs		Teaching practices		Student beliefs	Student practices
	Survey	**Interview**	**Syllabus analysis**	**Observations**	**Pre-/post-surveys**	**Observations**
Prior to materials development	x	x	x	x	x	x
During first implementation			x	x	x	x
After first implementation		x				
During second implementation			x	x	x	x
After final revision of materials	x	x				
	Likert-scale responses, more reformed to more traditional	Open-ended, coded into five categories	Rubric for learner-focused, transitional, content-focused	**COPUS**, coded to student behaviors **SDI** coded to frequencies	Likert-scale responses of agreement, Confidence scale	**COPUS**, coded to student behaviors **SDI** coded to frequencies

What is the impact?

Data from observations:

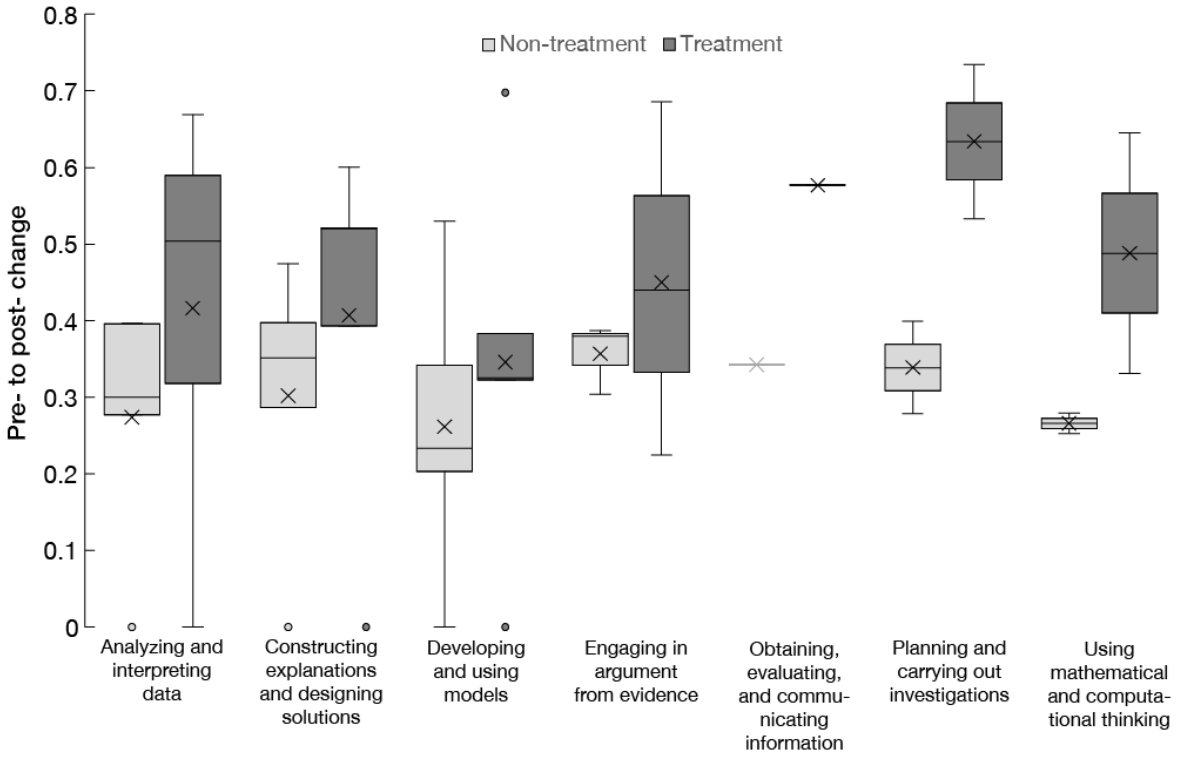
Students and instructors engage in more productive discourse—and more students participate more regularly



What is the impact?

Data from pre-/post-student surveys:

Students gain confidence in their skills and voicing their ideas in class

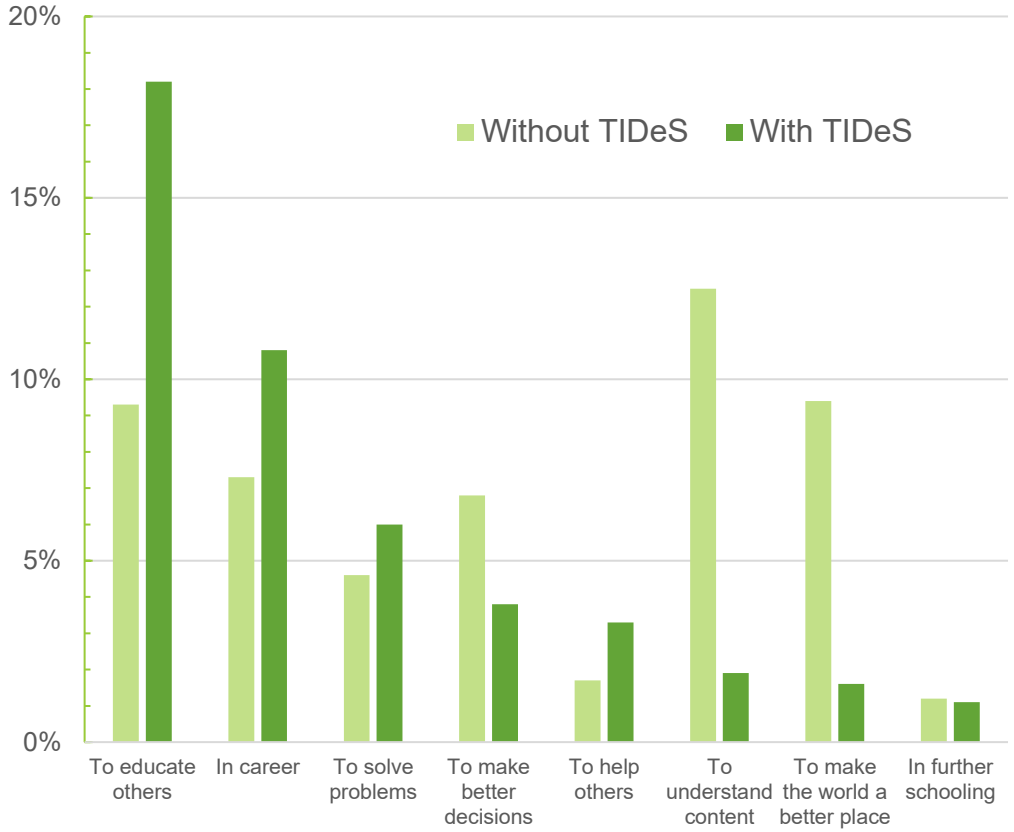


What is the impact?

Open response data from pre-/post- student surveys:

Students envision using their skills to educate others and in their careers…

…rather than just to understand content better



Was the potential unlocked?

- Pre-service teachers appreciate using Science and Engineering Practices language while learning science; they feel respected and valued
- Other students don't notice SEP language or aren't bothered by it (and they may appreciate it if they decide to become teachers!)
- Surprised by the impact of the scientist spotlights—I now use these in other classes
- Emphasis on exploration and practice helps students be comfortable sharing their ideas—focus is on thinking and the scientific process, not an answer
- Learning is loud. Start as you mean to go on.

Want to transform your introductory course?

TIDeS is partnering with NAGT's Traveling Workshops Program to offer workshops to facilitate transformation

The TWP brings facilitators to you for an in-person, two-day workshop

The regular fee is $5000 plus leader travel; the fee for this theme is $2000 for the 2025-26 academic year – there are THREE spots left!

- University of South Carolina, December 2024
- Rutgers University–Newark, January 2026
- ?
- ?
- ?

Want to transform your introductory course?

NAGT
Earth education for all

Check out the materials and instructor stories

Learn more about the TWP and request a workshop

Read data reports and look for research

Get in touch:
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