Transforming your introductory course to be more **equitable** and **effective**

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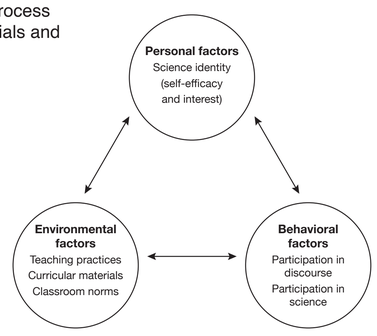
TIDeS
Teaching with Investigation and Design in Science

Introductory courses are **really** important

Introductory science courses at the undergraduate level serve as entry points into a wide range of science, technology, engineering, and math (STEM) majors, build science literacy through general education, and are likely the only science course that an elementary or middle-school teacher will have in a discipline. In all of these roles, introductory courses have the potential to be **profound experiences** that impact how students perceive science not only during the course but as they continue through college and into their careers.

Abundant evidence demonstrates that teaching strategies that actively engage students in disciplinary learning, leverage students' diverse identities, interests, and goals, and acknowledge the social and cultural context of learning produce better outcomes for a greater proportion of students than those that focus on delivery of a certain amount of content. Effective transformation of introductory courses requires attention to not only teaching practices, however, but the curricular materials, classroom norms, and expectations for students.

This is what the TIDeS project set out to achieve, using an iterative, rubric-based design process to develop and test new curricular materials and professional learning for instructors.



The reciprocal determinism model, modified from Bandura (1986), is a theoretical framework that describes the reciprocal interactions and influences of personal, environmental, and behavioral factors.

The TIDeS project modified environmental factors and explored the impact of those changes on students' science identity and their participation.

Guiding principles for transformation

Students will **engage in scientific investigation and engineering design** to deepen their understanding of core ideas.

Faculty and the curricular materials they use will **cultivate an equitable 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 use real data and models** and reflect the actual practice of science and engineering.

New materials and practices

Teams of faculty developed, implemented, revised, and published two full courses of materials that are freely available, along with the stories of how and why they made changes to their course within their institutional context.

Earth Science Course

Course Overview

Recurring Themes and Assignments

Unit 1 Anyone Can Be a Scientist

Unit 2 Are We Moving Toward 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?

Instructor Stories

Characteristics that promote an equitable learning environment

Substantial time actively engaged in authentic disciplinary work. Course units are motivated by questions of interest and relevance. Students engage with relevant phenomena, explore authentic data and models, and communicate results.

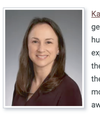
Focus on building science skills: Students design investigations, analyze and interpreting data, and reflect on the practices they have used and how their skills have developed.

Small group and whole-class discussions: Prompts for discussion with guidance for instructors facilitate sharing of ideas and building understanding collectively, recognizing the value of multiple perspectives.

Representation of diverse scientists: Repeated activities make use of scientist spotlights to highlight the diversity of scientists and prompt students to develop their own identity as a scientist in a way that integrates with their other identities.

Instructor stories

Angela Daneshmand at Santiago Canyon College. ERTH 121: Earth Sciences for Educators is a 4-unit lecture/lab combination course for education majors (pre-service teachers) that meets the physical science general education requirement. Students take my course because it is required for their major. Most students who take this course are education majors who feel that they cannot excel in science courses and are apprehensive about teaching science to their future students. In this course, students practice the process of science and learn foundational concepts in Geology, Astronomy, Oceanography, and Meteorology through an inquiry-based approach. With the TIDeS material, the course now builds students' confidence in their own ability to "do" science by incorporating student-focused content that is both interactive and relevant.



Karen Viskupic at Boise State University. GEOS 104: Geoscience and Society is an introduction to geoscience with a focus on the societal relevance of understanding Earth processes, history, and how humans interact with the Earth system. The goal of the course is to give students the opportunity to explore how the Earth system operates, the ways in which the scientific process allows us to understand the Earth system, and the many ways in which humans both depend upon, impact, and are impacted by, the planet. Increasing students' understanding of the practice of science, I think, helps them to develop more trust in the scientific community, and that is one of the most important things a student can take away from an introductory general education science course.

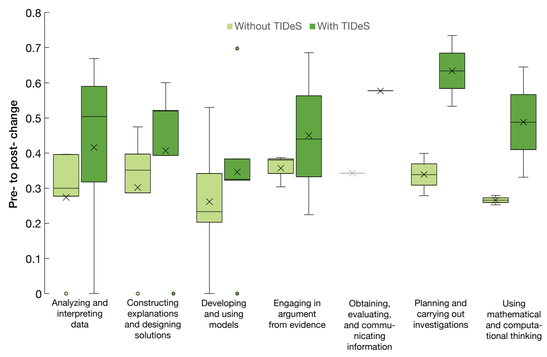
Mark Abolins at Middle Tennessee State University. GEOL 1030: Introduction to Earth Science is a course that helps students learn how scientists actually solve societal problems. The students investigate ways to design a habitable future. Students gain up-to-date knowledge about recent natural events and scientific discoveries. In doing so, students primarily investigate discoveries and events post-dating their birth and generally dating back less than 5-10 years.

Beth Dushman at Howard Community College. PHYS 106: Earth and Space Science is a combined lecture and lab introductory course that explores topics in geology, meteorology, and space science. The course fulfills a general education science class and is required for some education majors. The overall course goal is to improve students' comfort with science and for students to recognize the importance of Earth science in their everyday lives. With the TIDeS material, students engage with scientific practices, ask questions, and analyze data many times throughout the semester, helping them to build confidence in their ability as scientists and teachers.

Impact on students

Results from the Beliefs in Investigation and Design Survey (BIDS), a matched pre-/post-instruction survey we designed to assess changes in students' self-efficacy, interest, and beliefs in their own abilities.

Increased confidence in science skills



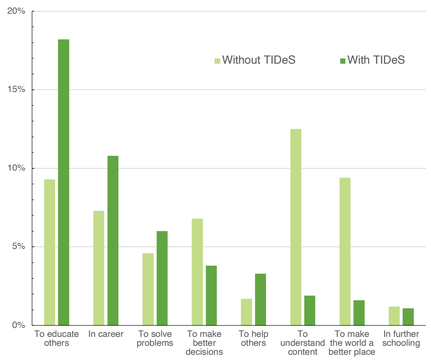
Students were presented with a set of 20 statements based on performance expectations from the Next Generation Science Standards designed to assess their confidence in their science skills. We grouped these by science and engineering practice. Although all students' confidence increased, those in courses where the TIDeS materials were used increased significantly more.

Increased science identity

Belief Statement	Hypothesized pre-to-post shift	Net change in hypothesized direction: Without TIDeS (n=555)	With TIDeS (n=215)	TIDeS – non-TIDeS
I do not feel comfortable voicing my own ideas in science class.	disagreement	3.2%	19.1%	15.9%
When I am asked to explain data, I don't really know how to start.	disagreement	13.9%	28.4%	14.5%
Science and engineering can address questions and problems in my everyday life outside of classes.	agreement	-0.5%	7.4%	7.9%
I can use my skills to figure out how to investigate a scientific question even if I don't know that much about the details.	agreement	3.4%	9.8%	6.4%
Similar approaches to conducting investigations are used in all science disciplines (biology, chemistry, Earth science, physics).	agreement	-0.9%	3.7%	4.6%
Everyone can contribute useful ideas in a scientific investigation or engineering design process.	agreement	-3.4%	0.0%	3.4%

Students were presented with a set of 13 statements to assess their beliefs in their own science abilities. We saw significant differences in six of these statements in courses where the TIDeS materials were used.

Increased intent to use skills



Responses to the open-ended, post-instruction survey question, "How do you envision using the skills you learned or practiced in this course to address questions and solve problems that are relevant to you, your family, or your community?" were more focused on education and career for TIDeS students.

Developing your practice

In addition to the curricular materials, the TIDeS project developed a set of resources support you in developing strategies that promote learning for all students in an equitable environment. The strategies are grounded in evidence from the research on teaching and learning.

Facilitating discussions for learning

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DOI | Cite this

For many instructors, "class discussion" may be the last thing that comes to mind when thinking about their introductory courses. You may feel that discussions take too much time, are inefficient, or that it's just too hard to get everyone to contribute. And yet, research highlights that **talking about ideas with peers, grappling with how to articulate concepts, and building conceptual understanding together through discussion promotes learning**—learning that lasts longer than memorizing what is heard in a lecture or read in a textbook. So how do we make those productive discussions happen in our introductory undergraduate classrooms? In the sections that follow, you can read more about:

- Laying the groundwork: Setting norms for discussion that promote equitable participation
- Strategies for integrating discussions that promote learning
  - In large classes
  - In small to medium classes
- Planning discussions around learning goals
  - Goal: Eliciting student thinking to plan for instruction
  - Goal: Making sense of data
  - Other goals
- Examples in the TIDeS materials

Discussion doesn't need to be intimidating—in fact, it can be inspiring, and an exciting component of any introductory course.

Representing the diversity of scientists

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Most scientists are well aware of the stereotypes of scientists in general, and the specific stereotypes for their particular field. Introductory courses provide an opportunity to address those stereotypes head on and help students see that *anyone* can be a scientist, and that a diversity of backgrounds, motivations, and approaches brings value to the scientific enterprise as a whole. One way you can do that is through the use of assignments that allow students to learn about and reflect on scientists as whole people, emphasizing modern scientists that students might relate to. This approach involves:

- Being explicit about the existence of limiting stereotypes about who scientists are and what they do;
- Considering all scientists as whole people who are part of communities and have interests, motivations, and challenges in their lives;
- Providing opportunities for students to learn about and reflect on a broad range of modern scientists and the work they do;
- Taking care to include scientists who represent diverse personal, social, and cultural identities.

The TIDeS materials incorporate repeated reflection assignments, which we call scientist spotlights, that make use of this approach. You can adopt these assignments as they are, or take a similar approach to modify them for your course. Read on to learn more about scientist spotlight assignments and sources for scientist profiles.

Incorporating readings that lead to discussion

Initial Publication Date: December 9, 2025
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Many instructors ask their students to read material before class, and are often frustrated when students either don't do the reading or don't focus on the "right" things if they do. Effectively incorporating readings requires a bit of preparation, but that work pays off when students can then engage in discussion and deeper learning in class. In the section below, read more about how to:

1. Select appropriate readings,
2. Assign a few thought-provoking questions that are due just before class,
3. Read, assess, and collate student responses before class,
4. Start class with a discussion based on their responses,
5. Repeat regularly to provide structure and transparency.

Designing a learner-centered syllabus

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For instructors of introductory courses, the syllabus may be the last thing they think about when preparing to teach, or may have been handed down over many years. For a student, however, the syllabus is likely to be the first encounter that they have with you and your course. As a result, it sets the tone for the course and plays a critical role in establishing their motivation and expectations. A thoughtfully-developed and learner-centered syllabus can signal your intent to offer an equitable and supportive environment.

Although the role of an introductory course is often perceived as an introduction to the *content* of a discipline, we envision it as an introduction to an *identity* and an opportunity to cultivate and nurture that identity through participation in the practices of a discipline. Recognizing that new identity starts with the syllabus: a learner-centered syllabus invites students into your course and helps them envision what they will experience. In a learner-centered syllabus, you:

- Set a positive, respectful, and inviting tone.
- Make learning goals a central, organizing element.
- Provide transparency and structure.

You can read more about how to do each of these things below. You can also assess your own syllabus using the Learning-Focused Syllabus Rubric created by Michael Palmer, Dorothe Bach, & Adriana Streifer at the University of Virginia, Center for Teaching Excellence, which inspired this work.

References and the research base

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The references below provide some of the key evidence that supports the use of equitable and effective teaching practices that underlie the TIDeS materials.

Getting everyone involved

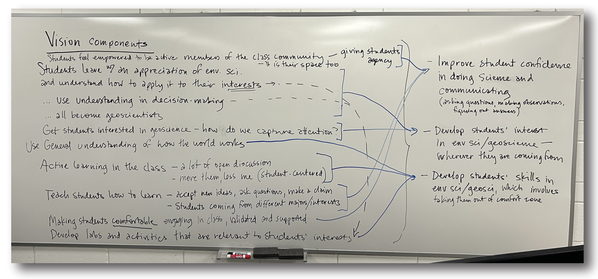
Introductory courses often involve more than one instructor, and transforming them effectively requires input and engagement from **everyone** involved in the course, including:

- Lead instructors
- Adjunct faculty
- Teaching assistants
- Lab coordinators
- Partners at nearby institutions

TIDeS partnered with NAGT's **Traveling Workshop Program** to develop a two-day workshop to support departments in transforming their introductory courses.

Over two days, your group will:

- **Develop a common vision** for your introductory course(s) that reflects your departmental goals and the nature of your students;
- Reflect on your use of **equity-focused teaching strategies** and determine where you can incorporate them;
- Learn about strategies for incorporating more **productive discussions** and activities that **build students' identities as scientists**;
- Work together to **develop an action plan** for transforming your introductory course to achieve your vision.



Learn more about the TWP and request a workshop

I have never participated in this kind of collective training. It is meaningful to the work that needs to happen (course redesign), and it facilitates building the team within the department.
–Workshop participant

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Read more about the TIDeS impact on students

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