



# Geoscience Success Lessons: Creating a Psychologically Wise Intervention for Geoscience Students to Change Their Working Hypotheses on Learning

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## Abstract

The geoscience discipline struggles to attract and retain majors, and women are underrepresented in geoscience careers. Research indicates that this struggle is, in part, due to negative attitudes toward math/science. But many students misunderstand the learning process and fail to consider the role of affect in learning. Changing students' working hypotheses about learning to include affective components can improve their geoscience engagement. Psychologically wise interventions could effectively change these hypotheses, but it is a daunting task to develop interventions that align with the ideas of psychological wisdom. This presentation describes the process, challenges, and implications of creating psychologically wise interventions for geoscience.

## Introduction

- Careers in geoscience are increasing in demand and with high salaries (AGI, 2014), but the discipline struggles to attract majors (McConnell & van der Hoeven Kraft, 2011).
- Women are underrepresented in the discipline despite above average grades (Wolfe & Riggs, 2017).
- This could be due to negative attitudes toward math/science (Jameson & Sexton, 2016) that influence their beliefs about learning.
- Students' working hypotheses about learning influence their decisions, behaviors, and choices.
  - Students' working hypotheses about learning can be inaccurate, which leads to ineffective strategies (Claxton, 2013).
  - Changing working hypotheses about learning to incorporate affective factors from a self-regulatory perspective can lead to increased learning, interest, and attraction to the field.
- To change working hypotheses, we should use **psychologically wise interventions**. These interventions aim to impact ubiquitous societal problems and are characterized by five principles:

**Principle 1. Alter students' specific meaning and promote change in their thoughts, attitudes, and behaviors**

**Principle 2. Align with an understanding that students' meaning operates within complex systems**

**Principle 3. Stimulate students to change their behaviors**

**Principle 4. Are methodologically rigorous**

**Principle 5. Are ethically sound**

Walton & Wilson (2018)

- The five principles guided the creation of our psychologically wise interventions to change geoscience students' working hypotheses about learning to include self-regulatory affective components.

The Math You Need, When You Need It  
 math tutorials for students in introductory geoscience

Promoting confidence in Earth Sciences  
 Confidence and Learning  
 Show What You Know: C&L  
 Metacognition and Learning  
 Math Anxiety and Learning  
 Interest and Learning  
 Stereotypes and Learning  
 Goals and Learning

**Confidence and Learning: Do you think you can do it?**  
 This lesson will explain how your own confidence can help (or hurt) your learning.

**Learning Stories**  
 Below are 2 stories about student attitudes and learning. These may be students just like you. Read on to learn about how their confidence might help or hurt their learning.

**Isabelle's story: I can do it!**  
 "I'm an undeclared major. I'm not really sure what I want to do, but I'm thinking maybe business. I'm taking geology this semester for general education credits. I've never taken geology before, but I did pretty good in my science classes in high school. I also did well in the astronomy class I took my freshman year of college. My mom always thought I would be a scientist because I love watching science programs. My roommate took geology last semester and did well. I know I can do it, and I'm actually feeling pretty excited to learn some new science stuff. I'm confident that I'll do well in my geology class this semester."

**David's story: I don't think I can do it...**  
 "I'm a history major. I've always loved history, and my family has always joked that I have the best memory for history information. I have always gotten A's in all of my history classes. I was never much into science though. The last science class I took was in high school and I got a D. I was hoping to avoid taking another science class, but I have to take one now that I'm in college. I asked my friends and they said to take geology. I figure that since my friends passed it, I probably can too but we'll see. I mean, I don't think I can do it. I'm really dreading taking another science class."

**What do you think?**  
 1. Do you identify more with Isabelle or more with David?  
 2. Do they think they will be successful in their geology class?  
 3. What are the reasons they have different ideas about how well they will do in their geology class?

**How does confidence impact learning?**  
 Confidence in your ability to do well in class is called **self-efficacy**. Your level of confidence (or self-efficacy) can actually help or hurt your learning.

**Learners with high confidence (self-efficacy):**

- have higher interest in the topic.
- view challenges, such as a difficult assignment, as problems to overcome.
- have higher motivation and commitment to learn the topics in class.
- recover quickly from setbacks or disappointments, such as a lower grade on an assignment.
- get to work more quickly on class assignments and tasks.

**Learners with low confidence (self-efficacy):**

- have less interest in the topic.
- view challenges, such as a difficult assignment, as reasons to quit or evidence that you are not good at the topic.
- have lower motivation and commitment to learn the topic in class.
- recover slowly, or not at all, from setbacks or disappointments.
- procrastinate on class assignments and tasks.

**Let's explore the Learning Stories**  
 How would you describe Isabelle's and David's confidence? What experiences have they had that influence their confidence? What actions will they take to study and prepare for class because of their confidence? **Who do you think is going to learn more, Isabelle or David?**

► Show me information from the Learning Stories

**Where does your confidence come from? The four sources of confidence**  
 Your confidence to succeed in science starts in early childhood as you interact with family, friends, and teachers and have experiences in and out of school. Your confidence continues to change as you get older and throughout your life as you interact with new people and have new experiences. You bring your confidence level (low, medium, or high) with you into your science class and lab. There are four main sources of your confidence.

**Previous personal experiences:**  
 Your past experiences in science classes are the single most important influence on your current confidence levels to do well in science.  
 ► Show me examples from Isabelle's and David's stories

**Observing others:**  
 Your confidence can be influenced by observing someone who is like you fail or succeed at tasks in a science class.  
 ► Show me examples from Isabelle's and David's stories

**Verbal comments:**  
 Your confidence can be influenced by comments you receive from others, especially from someone you consider to be trustworthy and influential.  
 ► Show me examples from Isabelle's and David's stories

**Interpretation of your emotional and physical status:**  
 How you interpret your emotions and physical reactions can affect your confidence.  
 ► Show me an example from Isabelle's and David's stories

**You can improve your confidence (and ability to learn) in science!**  
 It is really important to know that you can improve your confidence. Confidence in science (or any subject) is a skill that you can improve. Your confidence is not fixed (like your eye color). Improving your confidence will help you increase your success in science. Changing your confidence takes some effort, but there are some ways you can get started.

**Set easily attainable goals**

Introductory geology classes often contain a lot of new concepts and vocabulary words that can seem overwhelming. You can set a goal to create flashcards with separate concepts and vocabulary words and review them for 10 minutes every day.  
 ► Show me how to do this

Setting specific, relevant, measurable, and easily attainable goals will promote learning and progress.  
 ► Show me why this works

**Celebrate your victories**

You can celebrate the victory of earning a higher grade than you expected, successfully solving a problem in lab, or getting an assignment done early.  
 ► Show me how to do this

Celebrating and reflecting on your victories and successes changes you physiologically and psychologically. Victory doesn't just mean getting an "A".  
 ► Show me why this works

**Use positive self-talk**

When you have a setback, remind yourself that you can work harder or get help to increase your success.  
 ► Show me how to do this

Self-talk includes all the things you say to yourself (both positive and negative) about how you are doing. When you have a victory, remind yourself of the effort and success you achieved.  
 ► Show me why this works

**Principle 2: Learning stories show the complex systems of learning.**

**Principle 1: Easy-to-understand content helps alter students' meaning of learning.**

**Principle 3: Manageable and agentic suggestions stimulate students' change in behaviors.**

**Principle 4: Methodologically rigorous: developed and reviewed by experts, sought and incorporated user (instructor & student) feedback, developed with empirically-based best practices, pre- and post-intervention assessments and mixed methods evaluation process**

**Principle 5: Ethically sound: confidential data collection, beneficence at forefront of all decisions, advisory board and external evaluator**

## Challenges & Successes

### Challenges

- Simplifying psychological jargon for non-psychology students (e.g., self-efficacy)
- Selecting the most relevant and utilitarian processes to include in the interventions.
- Determining the best method of intervention implementation
- Challenging to gain engagement from geoscience faculty and students as the material "was not directly related with lab content..."

### Successes

- Developed six online and in-lab interventions that broadly introduce self-regulatory processes in layman's terminology.
- Selected: self-efficacy, interest, goal-setting, math anxiety, metacognition, and stereotype threat.
- Intervention aligned with best practices in flipped teaching techniques and based in pedagogical content knowledge.
- Did gain engagement from geoscience faculty and students because the interventions:
  - "...are applicable to things outside geology..."
  - "...gave me a bit more confidence when it comes to doing math in other subjects."
  - "...I love what you guys are doing...I have seen no other class do this...you are trying to get students to see how they can apply this to different life situations..."
  - "...you're making sure students realize this is bigger than just a class. This is something you can do for your entire life."

## Lessons Learned

- The existing intervention literature focuses on actions that faculty can take to develop students' affective domain, while a dearth exists in student agency in affection domain.
- Our psychologically wise interventions aimed to provide students with agency to change their working hypotheses of learning to incorporate affect.
- Science faculty may need training to learn how to implement psychologically wise interventions.
- Psychologically wise interventions are challenging to create but worth the effort.

## Contact Information and References

For further questions or for the complete reference list please contact Molly M. Jameson  
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