

Baseline Data on Motivation and Learning Strategies of Students in Physical Geology Courses at Multiple Institutions: GARNET Part 1, Overview

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GARNET: Geoscience Affective Research Network

Affective Domain

The feelings, emotions, and general moods a learner brings to a task or that are generated in response to a task¹.



affective domain

Image by Karin Kirk, SERC

Cognitive Domain

Addresses inaccurate student conceptions and learning skills.

Typically addressed through a variety of pedagogical interventions.



cognitive domain

Educational psychology research reveals that **student adoption of cognitive strategies** may be **influenced** by **affective factors** such as motivation, attitudes, feelings and emotions.

Students leaving STEM fields often cite **affective factors** such as **loss of motivation** or **interest in topic** or development of **interest in another field**².

¹ Ormond, J., 2006, Essentials of Educational Psychology; ² Seymour & Hewitt, 1997, Talking about leaving: Why undergraduates leave the sciences.

Theories of student motivation to learn¹

Overlapping theories that seek to account for affective drivers of student learning

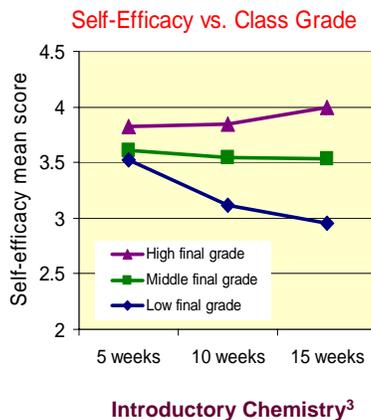
1. **Social-cognitive theory** – confident students (**self-efficacy**), show more effort, persistence, and use better learning strategies.
2. **Attribution theory** – students who believe they can learn to understand material, work harder and are more engaged (**control of learning beliefs**).
3. **Goal theory** – students employ mastery goals (**intrinsic** interest) and/or performance goals (related to **extrinsic** drivers).
4. **Expectancy value theory** – students who see value to succeeding in a task (e.g., learning a new skill; **task value**) show more effort and persistence.
5. **Self-determination theory** – students believe they can complete assignments, work with peers (**control of learning beliefs, peer learning**).
6. **Self-worth theory** – students may work to be successful (**intrinsic goals**) or engage in ineffective behaviors as an excuse for failure (**extrinsic goals**).

¹ Ormond, J., 2006, *Essentials of Educational Psychology*

Self-efficacy vs. Student Performance

Self-efficacy

- The confidence in one's capabilities to organize and execute the course of action required to do well in a course.
- **Poor learning strategies**
→ declining self-efficacy
- **Good learning strategies**
→ enhanced self-efficacy



³ Zusho, Pintrich, and Coppola (2003), *International Journal of Science Education*, v. 25, p. 1081-1094



Workshop on Student Motivations and Attitudes: The Role of the Affective Domain in Geoscience Learning⁴

GARNET (Geoscience Affective Research Network)

Goal: project developed to examine the connection between affective factors and geoscience learning outcomes.

Participating Institutions

University of Colorado, Boulder
University of North Dakota
North Carolina State University
California State University, Chico
North Hennepin Community College
Macalester College

**Advisory Board, Classroom Observations
Data Analyses & Evaluator**

Carleton College, SERC
Mesa Community College
SUNY College, Oneonta
University of New Mexico
University of Akron
Williams College

⁴ <http://serc.carleton.edu/NAGTWorkshops/affective/workshop07/>



GARNET Project

Hypotheses:

- ✓ The affective domain is a major control on student learning.
- ✓ What we do in our classrooms can significantly change students' affective behavior.

Goals:

- ✓ To use a common instrument (MSLQ) to investigate how aspects of the affective domain vary for students in physical geology courses at six institutions.
- ✓ Identify if and how those aspects vary with instructor, learning

First data of its kind to compare a diverse array of student values, beliefs, and learning strategies across multiple general education geoscience courses.



GARNET Research Questions

- What is the change in cognition and motivation over length of class? (**Part 1**)
- How do these changes vary between classes, student groups? (**Parts 1,2**)
- How do demographics shape motivation? (**Part 2**)
- How does instructor and pedagogy influence student affect scores? (**Part 3**)
- How are MSLQ factors related to student performance? (**Part 4**)



GARNET Part 1

Baseline MSLQ data collected from physical geology classes at:

- University of Colorado, Boulder
- University of North Dakota
- North Carolina State University
- California State University, Chico
- North Hennepin Community College*
- Macalester College*

Matched data from 10 classes with 10+ students each (340 students)

Fall 2008

- University of Colorado, Boulder; University of North Dakota (3); North Carolina State University

Spring 2009

- University of Colorado, Boulder (2); University of North Dakota; California State University, Chico (2)

* small class sizes and less than 10 matches excluded from data set for matched analyses



MSLQ Instrument

Motivated Strategies for Learning Questionnaire⁵ (MSLQ) used to investigate how aspects of the affective domain varied for students.

Motivated Strategies for Learning Questionnaire		
Categories	Subcategories	Subscales (# of questions)
Motivation Scales	Value	Intrinsic goal orientation (4)
		Extrinsic goal orientation (4)
		Task value (5)
	Expectancy	Control of learning beliefs (4)
		Self-efficacy (8)
Affect	Test anxiety (5)	
Cognitive Scales	Cognitive strategies	Rehearsal (4)
		Elaboration (5)
		Organization (4)
		Critical thinking (5)
	Metacognitive strategies	Metacognition (12)
	Resource Management	Time/study management (8)
		Effort regulation (4)
		Peer learning (3)
Help seeking (4)		

⁵ Pintrich, P.R., Smith, D.A.F., Garcia, T., and McKeachie, W.J., 1991, NCRIPTL Report 91-B-004



MSLQ Instrument

Motivated Strategies for Learning Questionnaire⁵ (MSLQ) used to investigate how aspects of the affective domain varied for students.

Cognitive Strategies: Organization

Rate the items on a 7-point scale where **1 = Not at all true of me** to **7 = Very true of me**.

When I study the readings for this course, I outline the material to help me organize my thoughts.	1 2 3 4 5 6 7	3.98
When I study for this course, I go through the readings and my class notes and try to find the most important ideas.	1 2 3 4 5 6 7	5.30
I make simple charts, diagrams, or tables to help me organize course material.	1 2 3 4 5 6 7	3.66
When I study for this course, I go over my class notes and make an outline of important concepts.	1 2 3 4 5 6 7	4.23

⁵ Pintrich, P.R., Smith, D.A.F., Garcia, T., and McKeachie, W.J., 1991, NCRIPTL Report 91-B-004



GARNET Part 1

- What is the change in cognition and motivation over length of class?
- How do these changes vary between classes, student groups?

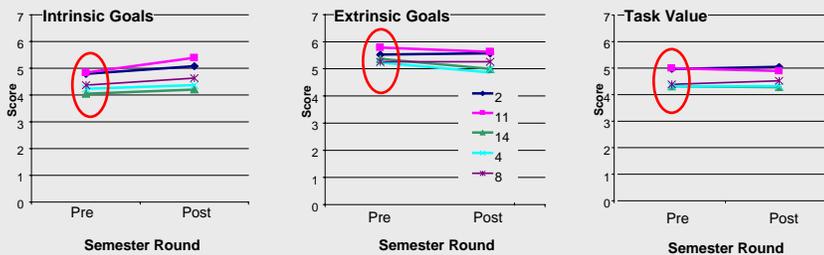
Data: Matched pre/post MSLQ, demographic surveys, and performance data for 340 students (>36,000 data points)

- Pre/post survey data – 81 questions
- Demographic survey – 24 questions
- Performance data – class scores, SAT scores[†], GPA data

[†] SAT scores not available from some institutions



GARNET Results Fall 08



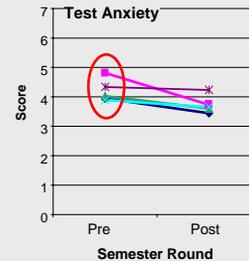
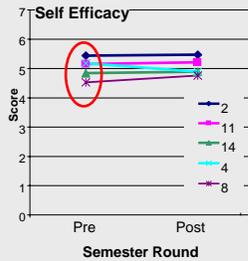
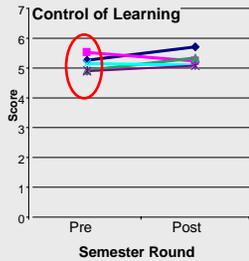
Motivated Strategies for Learning Questionnaire		
Categories	Subcategories	Subscales
Motivation Scales	Value	Intrinsic goal orientation
		Extrinsic goal orientation
		Task value
	Expectancy	Control of learning beliefs
		Self-efficacy
	Affect	Test anxiety

No large pre-instruction score differences in motivation scales

Similar trends in scores among institutions



GARNET Results Fall 08



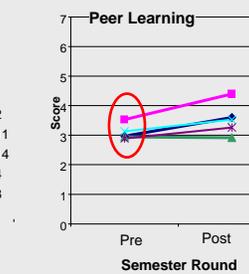
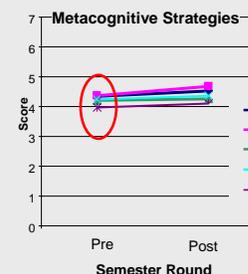
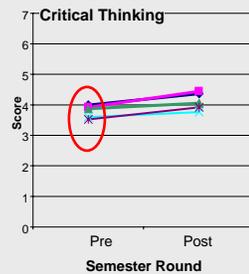
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		Extrinsic goal orientation
		Task value
	Expectancy	Control of learning beliefs
		Self-efficacy
	Affect	Test anxiety

No large pre-instruction score differences in motivation scales

Some variations in trends in different subscales



GARNET Results Fall 08



Motivated Strategies for Learning Questionnaire		
Categories	Subcategories	Subscales
Cognitive Scales	Cognitive strategies	Rehearsal
		Elaboration
		Organization
		Critical thinking
	Metacognitive strategies	Metacognition
	Resource Management	Time/study management
		Effort regulation
		Peer learning
Help seeking		

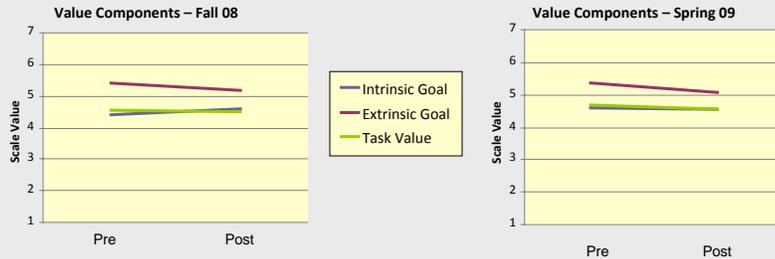
No large pre-instruction score differences in cognitive scales

Generally positive trends in adoption of learning strategies



GARNET Results Fall 08 vs. Spring 09

Some similarities in MSLQ scores between fall and spring populations, suggesting common student attitudes.



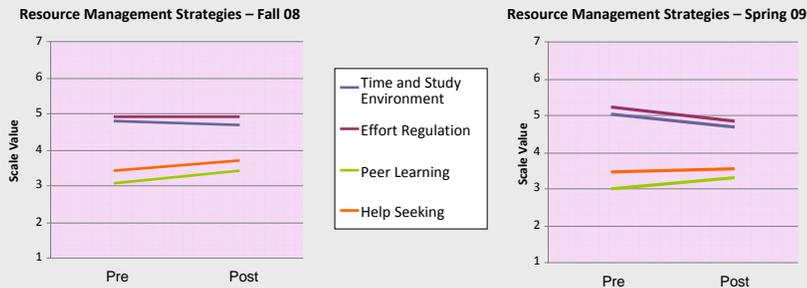
For example:

- Both populations showed a statistically significant decrease in **Extrinsic Goal Orientation** over the semester
- Only Fall students showed a collective increase in **Intrinsic Goal Orientation**



GARNET Results Fall 08 vs. Spring 09

Some differences in MSLQ scores between fall and spring populations, suggest some student attitudes may differ by semester.



For example:

- Both populations showed a statistically significant increase in **Peer Learning** strategies
- Fall students showed an increase in **Help Seeking**
- Spring students showed a collective decrease in **Time and Study Environment** and **Effort Regulation**

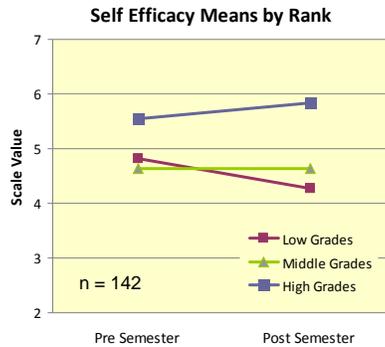


Student Motivation and Learning

Various subscale categories have different trends for high and low performing students.

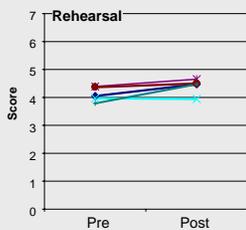
Self-efficacy

- The confidence in one's capabilities to organize and execute the course of action required to do well in a course.
- **Poor learning strategies** → declining self-efficacy
- **Good learning strategies** → enhanced self-efficacy



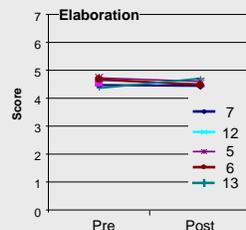
GARNET Results Spring 09

Within individual classes, students generally report little change in the study strategies they adopt over the length of the semester.



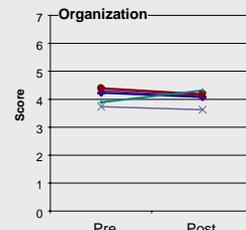
Rehearsal

- Reading class notes and textbook chapters over (and over again); memorizing key words.



Elaboration

- Writing brief summaries of the main ideas from readings and class notes; linking information from different sources (lectures, readings, discussions).



Organization

- Synthesizing readings and class notes to identify the most important ideas; construct charts, diagrams, or tables for key concepts.



Changing Affect

Factors such as **self-efficacy**, **test anxiety**, and **peer learning**, record significant pre/post changes ($p < 0.05$) in multiple classes across both semesters.

Motivated Strategies for Learning Questionnaire		
Categories	Subcategories	Subscales (# changes)
Motivation Scales	Value	Intrinsic goal orientation (1)
		Extrinsic goal orientation (7)
		Task value (0)
	Expectancy	Control of learning beliefs (3)
		Self-efficacy (4)
	Affect	Test anxiety (4)
Cognitive Scales	Cognitive strategies	Rehearsal (1)
		Elaboration (0)
		Organization (0)
		Critical thinking (2)
	Metacognitive strategies	Metacognition (2)
	Resource Management	Time/study management (2)
		Effort regulation (3)
		Peer learning (3)
		Help seeking (2)

Generally, students became **less confident**, **less anxious** in test situations, and were **more likely to seek help** from peers and instructors.



Changing Affect

Cognitive and metacognitive strategies and some value subscales showed changes in few classes in across both semesters.

Motivated Strategies for Learning Questionnaire		
Categories	Subcategories	Subscales (# changes)
Motivation Scales	Value	Intrinsic goal orientation (1)
		Extrinsic goal orientation (7)
		Task value (0)
	Expectancy	Control of learning beliefs (3)
		Self-efficacy (4)
	Affect	Test anxiety (4)
Cognitive Scales	Cognitive strategies	Rehearsal (1)
		Elaboration (0)
		Organization (0)
		Critical thinking (2)
	Metacognitive strategies	Metacognition (2)
	Resource Management	Time/study management (2)
		Effort regulation (3)
		Peer learning (3)
		Help seeking (2)



Changing Affect

Examples of potential strategies for increasing scores on selected affect subscales:

- Intrinsic goals – incorporate student interests into exercises, develop situational interest (variety, creativity, controversy).
- Task value – link tasks to real world relevance and development of personal/professional skills
- Self-efficacy – incorporate scaffolding strategies, formative assessment, multiple opportunities to complete work, few penalties for errors.
- Metacognition – encourage students to set specific learning goals, model effective strategies, provide opportunities for reflection on learning.
- Peer learning – create learning teams/communities in classes