

Assessment of Student Motivation & Learning Strategies in an Undergraduate Engineering Course

Rachel E. Horenstein

rachel.horenstein@du.edu



BACKGROUND

PROJECT GOALS

Pilot a mastery-based learning (MBL) system in the University of Denver Statics course in order to:

1. Create a learning environment that normalizes failures and values learning from mistakes, in order to...
2. Ensure students master fundamental technical skills, while...
3. Using a validated tool to assess and compare student mindset and learning strategies before and after completing a MBL course.

Why? Research shows that students who are confident in their ability to complete a task are more likely to persist and overcome challenges than students who do not hold this same belief.¹

WHAT IS STATICS?

- A 10-week course taken by all undergraduate engineering students studying at the University of Denver during the Fall quarter of their second year.
- It effectively unlocks the rest of the mechanical engineering curriculum, serving as a pre-requisite for subsequent core courses.

Instructor Observations:

- Many students perceive Statics to be the first challenging engineering course they encounter; it is common for students to struggle as they adjust to the rigorous coursework.
- An increasing number of students are faced with challenges due to a non-solid understanding of pre-requisite topics necessary for success.
- Awarding partial credit within a traditional grading system fosters a student mindset focused on short-term rewards (e.g., a good grade on an assignment) in lieu of long-term knowledge gains (e.g., developing study habits that include self-reflection and learning from mistakes).

WHAT IS MASTERY-BASED LEARNING (MBL)?

- MBL is a teaching approach that focuses on whether students learn material without placing emphasis on when.
- There is no partial credit, however students have an unlimited number of chances to demonstrate their knowledge until the course ends.

WHAT ARE THE BENEFITS OF MBL?²

- Offers flexibility in time to master content
- Promotes deep foundational understanding
- Normalizes failure
- Encourages students to learn from their mistakes

RESEARCH QUESTION

How does student mindset and use of learning strategies change throughout a 10-week MBL structured course?

REFERENCES

1. Pintrich, P. R. & DeGroot, E. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, 82, 33-40.
2. Clark, D., & Talbert, R. (2023). *Grading for Growth: A Guide to Alternative Grading Practices that Promote Authentic Learning and Student Engagement in Higher Education* (1st ed.). Routledge. <https://doi.org/10.4324/9781003445043>

METHODS

IMPLEMENTATION OF MBL

- Course Structure:** Course content was divided in 13 distinct "skills." Students had weekly opportunities to demonstrate mastery of skills by completing quiz questions with near-perfect solutions
- Grading Policies:** Student work was evaluated as either "Met" or "Not Yet." Final course grades were determined by the number and complexity of skills students met by the end of the course.
- Student Enrollment and Support:** 83 students, 3 graduate teaching assistants, 1 course instructor
- Weekly Course Schedule:** 3 x 50-min lectures; 1 x 50-min skills testing period; 4 x 110-min small group coaching sessions; additional instructor-led and GTA-lead coaching sessions (3.5 and 2 hrs/week, respectively)

ASSESSMENT OF MINDSET & LEARNING STRATEGIES

What is the MSLQ?

- The **Motivated Strategies for Learning Questionnaire**¹ (MSLQ) is a validated, widely used assessment tool that consists of 44 items rated on a 7-pt Likert scale (1 = not at all true of me, 7 = very true of me).
- It provides a quantitative assessment of 5 factor sub-scales:
 1. **Self-Efficacy**, i.e., Can I do this task?
 2. **Intrinsic Value**, i.e., Why am I doing this task?, Do I think this task interesting?, Do I think this task is important?, Do I want this task to challenge me?, Do I embrace learning new things?
 3. **Test Anxiety**, i.e., Does worrying about poor performance interfere with my ability to successfully complete this task?
 4. **Cognitive Strategy Use**, i.e., Do I implement strategies to help myself remember and organize the information I am learning?
 5. **Self Regulation**, i.e., Do I self-reflect on my learning? Do I persist with tasks despite obstacles?

Implementation of MSLQ

Survey Distribution:

- The MSLQ was distributed to students via an online Qualtrics survey at 3 time points:
 - After the first skills testing period (Week 2 out of 10)
 - After multiple testing opportunities (Week 8 out of 10)
 - After the final skill testing opportunity (Week 11 out of 10)
- MSLQ surveys were required participation assignments, however student responses were analyzed only if they agreed to participate in the IRB-approved study. 60 students agreed to participate, 44 of whom responded to the survey at all three time points.

Data Processing:

- Individual subscale scores for each of the 5 factors were found by averaging the student's responses to the items in the corresponding subscale.
- For the initial analysis presented here, descriptive statistics were determined for each factor at the three time points.

INTERACTIVE SECTION

Curious about the 44 MSLQ items?

Access the survey here!



RESULTS

SE = Self-Efficacy; IV = Intrinsic Value; TA = Test Anxiety
CS = Cognitive Strategy Use; SR = Self-Regulation

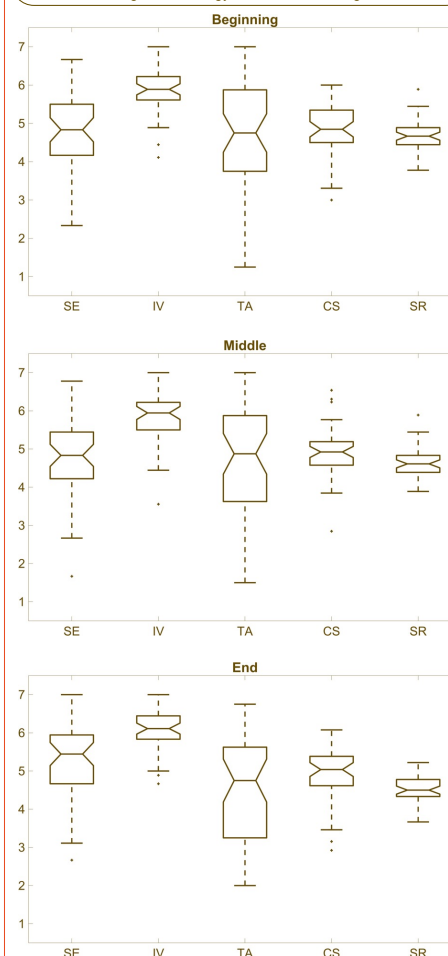


Figure 1. Boxplot distributions of student factor scores at each time point (beginning, middle and end of the course). Bottom and top box edges correspond to the 25th (Q1) and 75th (Q3) percentiles, respectively. Interquartile ranges, defined as (Q3-Q1), correspond to box heights. Medians are indicated by the lines inside the boxes. Whiskers indicate the range of data above Q3/below Q1 and extend to the largest/smallest non-outlier datapoints. Outliers, defined as values >1.5x(Q3-Q1) above Q3/below Q1, are indicated with the + symbol. Notches that do not overlap are suggestive of significant difference in median values (p<0.05), however post-hoc analysis is needed to confirm significance.

RESULTS (CONT.)

Table 1. Mean MSLQ factor subscale scores and standard deviations for the three time points. Higher values indicate higher levels of motivational beliefs / use of self-regulated learning strategies.

MSLQ Factor Sub-Scale	Time point		
	Beginning	Middle	End
SE	4.83 ± 1.00	4.78 ± 1.09	5.28 ± 0.98
IV	5.81 ± 0.63	5.83 ± 0.66	6.06 ± 0.58
TA	4.65 ± 1.55	4.59 ± 1.58	4.51 ± 1.36
CS	4.82 ± 0.68	4.91 ± 0.67	4.90 ± 0.69
SR	4.70 ± 0.45	4.65 ± 0.40	4.51 ± 0.37

Table 2. Interquartile ranges for each factor sub-scale at the beginning, middle, and end of the course. Higher values indicate a larger distribution of scores between the 25th and 75th percentiles. Test anxiety (TA) sub-scale scores had the largest distribution amongst the five factors.

MSLQ Factor Sub-Scale	Time point		
	Beginning	Middle	End
SE	1.33	1.22	1.28
IV	0.61	0.72	0.61
TA	2.13	2.25	2.38
CS	0.85	0.62	0.77
SR	0.44	0.44	0.44

LESSONS LEARNED

- Stay committed to your MBL teaching approach! Most students do not pass skills on their first attempt, which leads to student frustration and resistance. It helpful to reach out to trusted colleagues for support.
- Implement flexible deadlines so that students can complete homework assignments at a cadence that is aligned with and appropriate for their progress.
- Consider a course policy that requires the student to submit a self-reflection/test correction before re-attempting a skill quiz.
- Ask for strong GTA support – it is essential for success, especially with larger courses.
- Expect grading to be highly efficient.

FUTURE WORK

- The results presented here reflect a preliminary analysis utilizing summary statistics.
- Future work will include robust repeated measures and post-hoc analysis to determine statistical significance, or lack thereof, between the MSLQ factor sub-scale scores at each of the three time points (beginning, middle, and end of the course).

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