Implementing Practices to Enhance Student Consciousness of Their Learning

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**Recommended Citation**

Scharff, Lauren; Rolf, James S.; Robinson, Sarah; and Scoville, James, "Implementing Practices to Enhance Student Consciousness of Their Learning" (2012). *SoTL Commons Conference*. 27.  
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Implementing Practices to Enhance Student Consciousness of Their Learning

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Disclaimer: The views expressed in this document are those of the authors and do not reflect the official policy or position of the U. S. Air Force, Department of Defense, or the U. S. Govt.
Benefits of **Metacognition**

- Pierce, 2003
- Gamma, 2004
- Spruiell, 2008

“I started studying differently when I realized I wasn’t studying effectively...I realized this by reflecting.”

“The reflections were vital for my success in this class. I would continuously alter my study habits after completing the assessments.”

Student quotes from a Calculus Metacognition SoTL project 2009-2010
A more complete (and less rosy) picture...

The Calculus metacognition project was very time and labor intensive (multiple in-class reflections and discussions), and not all students saw the benefit...

“They somewhat helped, however, if someone is not dedicated enough to improve on their own, reflections are worthless!”

“It helped me realize doing homework was essential to succeed, however, it didn’t provide other ‘specific’ study strategies.”

“They did not help. More MATH/less talking...”
The following 3 projects used “low-cost”, course-goal-specific ways to make students aware of aspects of the learning process that they might otherwise tend to overlook.

We think the results are promising (and thought-provoking...) Join us in thinking about how might we improve upon them, use them in other courses, etc.
Example #1: Dr. Jim Rolf

• **Goal:** Students prepare some *before* coming to Discrete Mathematics Course

• **Method:** Just-in-Time-Teaching (JiTT)
  – Read some before class
  – Do a problem or two online
  • “What is the order of precedence of logical operators?”
Incorporating Metacognition

• Would “thinking about thinking” impact completion rates and/or perceived value of pre-class assignments?

• Would this also impact performance on quizzes, exams, etc.?
Protocol

• Both groups:
  – Did pre-class assignments.
  – Had *optional* pre-class problems.
  – Completed surveys on their use of the pre-flights

• Experimental group:
  – had class discussions about benefits of pre-class assignments and short, reflective surveys.

  *Start selecting your answers on the handout!*
Example Survey questions

1. By completing the pre-class assignments in this class I feel better prepared for class.

2. I notice that my instructor has read the pre-flight responses prior to class and has tailored class based on those responses.

3. Please reflect on your experiences with the pre-flight process in this class and give a specific example of how it impacted (positively or negatively) your learning experience in this class.

Select your answers on the handout!
Impact on Completion Rates

• Experimental group that had discussions on “Thinking about thinking”
  – Completed more of the Pre Flight questions ($p=.0039$)
  – Did more Optional Pre-Flight questions

Figure 1: Declining completion rates for both experimental and control groups based on data from 1) lessons 1-16 and 2) lessons 17-40.
Impact on Performance and Perceptions

Experimental group that had discussions on “Thinking about thinking” had:

• A strong correlation between completion rates and exam performance (p<.0038), while control group showed only a strong trend (p=.0755).

• A stronger agreement (p=.02) to the question “Pre-flight assignments prepare students so they can learn more during the related lesson.”

• Reported strongly tended to agree more with the statement “I personally value the incorporation of the pre-flight process in this class.” (p=.063)
Impact on More Student Perceptions

- Across the semester, experimental students showed a stronger increase in their perceptions that their instructors utilized pre-flights to create meaningful learning experiences. (p = .053)

**Figure 2:** 1 = Strongly Disagree and 6 = Strongly Agree
Interpretation

Short in-class feedback that forces students to “think about thinking” can significantly impact student value of learning-related activities, which, in turn, can impact behaviors, and learning!
Example #2: Concept Mapping in an Electricity & Magnetism Physics Course

Capt James A. Scoville

Department of Physics

United States Air Force Academy, CO
The question: Is it possible to develop an expert-like knowledge structure in novices through concept mapping?

**Expert’s knowledge structure**

- **Newton’s Laws**
  - Interactions
    - Forces
      - Gravity
      - Tension
      - Springs
    - Constraints
      - Strings
      - Pulleys
      - Supports
  - Motion
    - Velocity
    - Acceleration
    - Kinematic equations

**Novice’s knowledge structure**

- \( F_{\text{fric}} = \mu N \)
- Pulleys
- Energy?
- \( F = ma \)
- \( x = \frac{1}{2} at^2 \)
- Strings
My hypothesis: sure it is!

Or for the more fastidious:
Physics students in a class where new concepts are mapped (experimental group) will perform better exams than students who learn the same concepts but do not map them (control group).
Methods: The experimental groups used concepts maps during lessons, the control group did not.
What’s your prediction?

Students most receptive to the use of concept maps in the experimental sections had:
   a. High grades in the prerequisite class
   b. Average grades in the prerequisite class
   c. Lower grades in the prerequisite class

Which students had the highest test scores?
   a. Control group—no map used
   b. Experiment group—chose not to make a map
   c. Experiment group—chose to make a partial map
   d. Experiment group—chose to make a full map

Grades in the prerequisite course were a decent predictor of test scores. Which group shows the highest test scores when normalized for the prerequisite grade?
   a. Control group—no map used
   b. Experiment group—chose not to make a map
   c. Experiment group—chose to make a partial map
   d. Experiment group—chose to make a full map
Results – Semester 1

- **Prerequisite Course Grade**
  - No Map (Control)
  - No Map (Experiment)
  - Partial Map (Experiment)
  - Full Map (Experiment)

- **Total Semester Test Scores**
  - No Map (Control)
  - No Map (Experiment)
  - Partial Map (Experiment)
  - Full Map (Experiment)

- **Normalized Test Scores**
  - No Map (Control)
  - No Map (Experiment)
  - Partial Map (Experiment)
  - Full Map (Experiment)
Results – Semester 2

Prerequisite Course Grade

Total Semester Test Scores

Normalized Test Scores
Conclusion

• Students who struggled most in the prerequisite physics course were most likely to choose to make a concept map.

• Students who chose to make a concept map had the highest normalized test scores. In other words, they showed the most knowledge gain relative to their predicted potential.
Example #3: Student reflection on learning in Remote Sensing Lab Exercises

How can learning image processing lead to student metacognition?

Original Image

Derivative Image

Derivative Map

Sarah E. Robinson
Department of Economics and Geosciences
Lab redesign to incorporate metacognition

- **Three Low cost tools**
  - Feedback Forms
  - Checkpoint Answers
  - Reflection on Writing
## Lab Redesign

### Old Lab Format

<table>
<thead>
<tr>
<th>Content Questions</th>
<th>Turn in</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Answer Questions</td>
<td>Turn in</td>
<td>10%</td>
</tr>
</tbody>
</table>

### Redesigned Format

<table>
<thead>
<tr>
<th>Content Questions</th>
<th>Answers Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Paragraphs</td>
<td>Turn in</td>
</tr>
</tbody>
</table>

### Lab Assignments
- Exams
- Final Project
Example of Feedback

- **IS:** need intro statement...what are you trying to do? Give the reader some context before diving into the details.
- **EX:** It is clear you understand how the technique works, but you need to expand your explanation so the reader understands how the technique works. Also, address low values as well as high values (see comment).
- **EV:** Add evaluation.

"I chose the 5, 4, 6 combination for the Landsat 2000 image because, from looking at the spectral analysis graph, these three spectra had the most substantial differences of all the available spectra. I then chose 4 to represent green, because I felt it would make sense to make current vegetation green, and this spectrum had current vegetation with a much higher pixel value than the dead vegetation. I then used 5 and 6 as the remaining spectra to make the dead marsh area purple, which really makes the green stand out more."
Your Predictions

1. What percentage of students reported using the feedback provided on the labs to improve their next lab turn-in?
   a) >90%
   b) >70%
   c) >50%

2. If you provide answers to lab questions, how many students use those answers to self-check when they are no points associated with the questions?
   a) 25%
   b) 50%
   c) 75%

3. When you eliminate grades for the checkpoint questions, what happens to exam performance?
   a) Performance on exams **DECREASES**
   b) Performance on exams **STAYS THE SAME**
   c) Performance on exams **INCREASES**

4. Students can meaningfully self-assess changes in their writing across a semester.
   a) Agree
   b) Disagree
Feedback Forms

- Feedback forms allow students to assess their use of labs and instructor feedback

**Question D.**
The quality of the instructor feedback on a lab turn-in was useful for improving my next lab turn-in.

81% at midterm
94% at end of semester
Using Check-Point Answers

- Providing Check Point Answers allows students to self-assess their course knowledge

<table>
<thead>
<tr>
<th>50%</th>
<th>Checked Answers after Predicting</th>
</tr>
</thead>
<tbody>
<tr>
<td>37%</td>
<td>Checked Answers without Predicting</td>
</tr>
<tr>
<td>13%</td>
<td>Did not check/use answers</td>
</tr>
</tbody>
</table>
Using Check Point Answers

- Providing Check Point answers did NOT cause lower test scores

- Students who compared their answers to the checkpoint answers had a higher Average test score.

A one-way ANOVA was used to test GR score differences among the three uses of the checkpoints answers, $F(2, 13) = 3.64, p = .065$. 

![Test Scores on Checkpoint Questions](chart.png)
Reflection on Writing

Students comparing earlier and later lab paragraphs can meaningfully self-assess the changes in their writing.

**Reflection on Paragraphs:**
Instead of having you write new paragraphs for this lab, I would like you to reflect on the changes in your lab writing skills and understanding of how to write a convincing argument that you have experienced from the time you wrote your Lab 1 paragraph to the paragraph you just turned in for Lab 4 on your final project.
Specific Reflection Questions

• Describe the differences you see in the content and structure of your paragraphs between your Lab1 paragraph and your Lab 4 paragraph.

• Provide a concrete example to illustrate your reflections in the above questions by copy/pasting an example sentence from your Lab 1 paragraph and an example sentence from your Lab 4.

• Over the course of the 3 labs, you have received feedback on both those things you were doing well and those things that needed improvement in the paragraphs. Describe your use of these two types of feedback in how you write your paragraphs.

• How has the process of writing your paragraphs changed over the semester?
Why giving feedback on writing is worth it: Student reflection on writing

“My lab 1 paragraph is super long and wordy. My lab 4 paragraph is succinct and easy to read. It seems like I didn’t know what I was talking about which is why I rambled.”
Why giving feedback on writing is worth it: Student reflection on writing

“In lab 1, I did not know what I was doing in terms of writing my paragraph so I wrote everything I was thinking. Lab 4 is more concise and I say what is necessary in my paragraph.”
Why giving feedback on writing is worth it: Students' reflection on writing

“Lab 4 used more precise vocabulary relating the remote sensing while still being easier for a non-analyst to understand. Lab 4 included an assessment of how accurate I thought the technique to be while lab 1 did nothing to mention the accuracy.”
“Looking back on lab 1 it almost comical. I was recently trying to understand what was going on solely by reading the paragraph, and I ended up being more confused. I realized that it’s easier for the viewer/reader to follow along when the paragraphs are shorter and sweet, which is the new way I approach the paragraphs. I am definitely writing more confidently and efficiently. My writing process takes a more ‘head-on/direct’ approach rather than a ‘beat-around-the-bush’ approach.”
Lab redesign to incorporate metacognition

• **Three Low cost tools**
  – Feedback Forms
  – Checkpoint Answers
  – Reflection on Writing
Time for us to hear from you...

What are your thoughts and reactions to what we’ve shared?

Do you have practices that help students become more consciously aware of their learning?
Thank you!

Please contact us if you have further thoughts to share.