The Student Cognition Toolbox:
Empowering Students to Become Better Learners

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APA-STP Address
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Applying the Science of Learning in Education
Presentation Overview

- How Students Study
- How Students Learn (effectively and efficiently)
- Applying Science of Learning with Course Activities/Assignments
- Teaching Students to Use and Transfer Effective Study Strategies: Student Cognition Toolbox
- SCT Demo
- Early Results and Future Directions
How Students Study


- **Re-reading**: 78%
- **Highlighting and Underlining**: 53%
- **Note-taking**: 30%
- **Using Flash Cards**: 53%
How Do Students Learn (effectively and efficiently)?
It Depends

What kind of knowledge do you want your students to attain?
- Facts?
- Concepts?
- Principles?

What kind of learning processes is required for your learning objective?
- Memory and fluency?
- Understanding and sense-making?
- Induction and refinement?

What kind of instruction will you provide to promote learning your objectives?
- Quizzing?
- Self-explanation?
- Problem solving?
A Decade of Applying Science of Learning with Course Activities/Assignments

Three examples of learning activities that promote student learning
Some Cognitively-based Learning Activities

- **Retrieval Practice** (Test Enhanced Learning)
- Elaborative Interrogation
- Self Explanation
- Spaced Practice
- Interleaved Practice
- Worked Examples
- Duel Coding
- Multimedia Principles and techniques
- Making Predictions
- SQ3R
- etc.
Retrieval Practice Outside the Classroom: Embedding Questions During Video Presentations to Benefit Learning

Course: Occupational Therapy Evaluation & Intervention for Children

N = 56

Quiz Question Conditions

- **Multiple-choice question**: Original question presented as-is
- **Study**: Original multiple-choice question converted into a summary statement
- **Not Asked**: Original multiple-choice question not asked. In its place is a Likert-type “Clarity question”
When we see a child demonstrate difficulty with actions during a task, when he is “doing something” we:

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>a.</td>
<td>Assume that there is a problem and can focus on that for further evaluation</td>
</tr>
<tr>
<td>b.</td>
<td>Document the difficulty in performing these actions for future goal writing</td>
</tr>
<tr>
<td>c.</td>
<td>Consider if the difficulties result in safety concerns or the need for assistance from another person</td>
</tr>
<tr>
<td>d.</td>
<td>Consider if the difficulties are typically seen for a child of that age</td>
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</table>

You observed Robby as he cut out a picture as part of a project in his kindergarten class. What would you consider when you interpret your observations of Robby’s difficulties during your performance analysis of his cutting task?

<p>| | |</p>
<table>
<thead>
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</thead>
<tbody>
<tr>
<td>a.</td>
<td>Robby’s fine motor development.</td>
</tr>
<tr>
<td>b.</td>
<td>If Robby needed support from his teacher or you had concerns for how safely he was using the scissors.</td>
</tr>
<tr>
<td>c.</td>
<td>The difficulty Robby had when cutting so you can use this information to write your goals for Robby.</td>
</tr>
<tr>
<td>d.</td>
<td>How Robby’s performance compared with that of other children in the class.</td>
</tr>
</tbody>
</table>
Comparing Question Conditions

RESULTS
Self-Explanation: Making sense and meaning of new information

A Reading Learning Activity in an Introductory Biology Course

N = 148

Overson, Benassi, Kordonowy, Richardson, In process
Self-explanation

- Constructive learning strategy
- Self-monitoring of evolving understanding
  - Review new material
  - Relate information to prior knowledge
  - Generate questions based on new understanding
- Mechanism
  - Identification of gaps in learning
  - Helps modify flawed, existing mental models
Student Learning Activity

• Read textbook chapter
• Responded to prompts after each chapter section
  – Describe the information that is new to you
  – How do these ideas work with what you already know?
  – Why do these ideas work together? Provide an example
  – List two “I wonder” questions you have as a result of reading this section
• Random assignment to one of two groups
  – Self-explanation group
  – Summary group
Summarize versus Self-explain Reading Activities

Mean Percent Correct

Summarize
Self-Explain
Diff

Error Bars: 95% CI
Spacing: Distributing Study Practice
Course-based replication of Kornell (2009) lab experiment

Course: Introductory Biology
N = 176

Overson, Hall, Kordonowy, Pyburn, & Benassi, In preparation
Spacing vs. Massing

Introductory Biology Course

• 176 Students who completed all 4 flash card study days
• Within-subjects design
• 32 items to be studied randomly assigned to a condition
  – Spacing/Massing
  – Massing questions randomized to Study Day
    ➢ (1, 2, 3, or 4)
• Students completed study sessions on 4 consecutive days leading up to the exam
Massed Versus Spaced Practice Overall

Mean Percent Correct

Study Condition

Massed Overall

Spaced

Diff

Mean Difference

Error Bars: 95% CI
Teaching Students to Use and Transfer Effective Study Strategies:
The Student Cognition Toolbox
Original Cognitively-Based Study Skills Module

STUDENTS:

• reported on study strategies they typically use when studying for an exam
• viewed a cognitively-based study strategies slideshow
• compared their reported strategies with those on the module
• composed a 6-point plan for studying for next exam
THE STUDY
BEHAVIOR
INVENTORY
<table>
<thead>
<tr>
<th>Deep</th>
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<tbody>
<tr>
<td>I space out my study sessions in the time leading up to the exam</td>
</tr>
<tr>
<td>I relate what I am reading for the course to classroom sessions</td>
</tr>
<tr>
<td>I test myself on course materials without referring to my course</td>
</tr>
<tr>
<td>I plan effectively for study time between classes</td>
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<tr>
<td>I summarize in my own words information I learn from my study</td>
</tr>
<tr>
<td>I explain concepts to a classmate/friend</td>
</tr>
<tr>
<td>I create outlines, charts, diagrams, or tables, etc., to organize</td>
</tr>
<tr>
<td>and help me see patterns in course information</td>
</tr>
</tbody>
</table>
Shallow

I ask a classmate/friend to help me understand course material

I focus most of my studying to the time just prior to an exam

I ask my professor or TA to help me understand course materials

I read the required course materials more than once

I highlight and/or underline the most important information in my reading

I take care to organize my lecture notes

I try to learn the more difficult material first, when time is limited prior to an exam
EXAMPLE STUDENT REPORTS
The Student Cognition Toolbox
Advantages of the SCT

• Integrate with existing Academic Support Services
  – First-year orientation
  – Academic Success programs
  – First-year seminars for majors
  – Peer Assistance programs
• Provide for students experiential evidence of the learning benefits of using each strategy
• Can be used by teachers in an existing course
• Can be used by students on their own as independent learners
STUDENT COGNITION TOOLBOX
STUDY STRATEGIES
General Module Template

Study Behavior Inventory
- Deep
- Shallow

Part 1
- Exposure to material to learn
- Utilization of learning strategy during reading

Part 2
- Exposure to presentation on the study strategy
- Practice using strategy in a variety of contexts
- Assessment on how well students learned the study strategy
A Quick Tour of SCT Unit on Spaced Practice
Part 8 / Section I

Learning Objectives

- Describe spaced practice
- Identify learning circumstances appropriate for spaced practice
- Apply spaced practice to study material

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Spaced Practice Checkpoint  45
Reflecting on Spaced Practice  46
Part 8 / Spaced Practice Description

- Describe spaced practice
- Identify learning circumstances appropriate for spaced practice
- Apply spaced practice to study material
Spaced practice described:

Spaced practice is a study strategy that enhances the learning and retention of course material through separating study sessions across time. Rather than studying an item repeatedly without interruption (as in massed practice), spaced practice involves studying an item or concept across different times in the same learning session (for example, by going through a deck of flashcards at least twice) and/or across different learning sessions.

Spaced practice is easy to use and can be applied in a variety of ways throughout any course. Simply put, spaced practice is in a schedule of studying.

Spaced practice is not limited to one kind of practice and can include restudying material, retrieving information from memory, or practicing skills. For example, after class material has been read and/or discussed, instead of covering all of your study and consuming all of your time in a single study session, with spaced practice you can study the material for several periods of time across different days. In this way, each study session is broken up into smaller periods of time to spread out your practice. Spaced practice can even occur within the same day, as with the flashcard example, above.

In many cases, an instructor may build spaced practice into the class by presenting the same material across different classes. This may take the form of reviewing previous information before or during each class period. Overall, spaced practice can improve your ability to retain different kinds of information, such as declarative knowledge (for example, facts), procedural knowledge (for example, skills or abilities), and other academic requirements (for example, using codes or walking classifications).

Why is spaced practice effective? Spaced practice does not overload your attention like massed practice does - you do not get an overloaded while studying. This allows for greater focus and less “mind wandering” during studying. Spaced practice also provides multiple opportunities to recall the study material from long-term memory, which facilitates future attempts (such as with exams) at recalling the study material. In fact, in some cases, the more difficult it is for you to essentially recall the information during study, you will notice a greater improvement in your ability to recall that information in the future. In addition, spaced practice decreases students’ “feeling of knowing” where they believe they know the course material, but really do not.

When learning is spaced in one session, this can lead to the illusion that the information is known because the material has been repeated frequently over one period of time. However, the knowledge is frequently not as strongly held in memory as students think. Spaced practice does not produce false “feeling of knowing” that are common with massed practice, allowing for more efficient and effective study practices.

![Diagram](image-url)
Part 8 / Spaced Practice Video: Student Perspective

For a student perspective, watch the following video on spaced practice:

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learn by doing

How might you use spaced practice?

When studying for an exam you:

- [ ] study all of your material to-be-learned in one space of time
- [ ] use all of your cognitive "space" to try to learn the material
- [ ] answer practice quiz questions every other day
- [ ] set aside a single space of time to review the most challenging material before you move on to easier material.

---
You will now be asked to answer some questions about spaced practice.

When you click on the checkpoint, it will open in a new tab. Do not close this current tab while you are completing the checkpoint. Once you complete the checkpoint, you should return to this tab to continue with the remainder of this Module.
Part 8 / Reflecting on Spaced Practice

You have almost completed the study strategy Module for spaced practice. This study strategy is an excellent tool for reviewing many different types of course material.

Answer the following short answer questions to complete the spaced practice Module.

MY RESPONSE...

Answer the following questions regarding spaced practice:

Describe the information about the study strategy that is new to you.

Submit and Compare

How does this study strategy differ with or is it the same as how you studied before you read the module?

Submit and Compare
Additional Videos

Click here for the first additional video on spaced practice.

Click here for the second additional video on spaced practice.

Further Readings and Information

Click here for a poster that describes spaced practice.

Click here for a document that describes how to use spaced practice to boost learning.
Some Preliminaries

• Initial deployment of SCT: biology, chemistry, statistics, introductory psychology, PLTL Mentors

• Main focus was on obtaining feedback in terms:
  1. students’ performance on formative and summative assessments
  2. Students’ comments on the SCT
SOME INITIAL RESULTS
Study Behavior Inventory
Deep Processing Responses Pre and Post SCT

- I space out my study
- I relate what I am reading
- I test myself
- I plan effectively for study
- I summarize
- I explain concepts to a…
- I create outlines, charts,…

Error Bars +/- 1 Standard error
Predicting Post-Instruction Study Behavior
Deep Processing from Pre-Instruction
Deep Processing and Mean CheckPoint Quiz Scores

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<th>Model</th>
<th>(Constant)</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>Correlations</th>
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<td></td>
<td></td>
<td>Zero-order</td>
</tr>
<tr>
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<td>5.97</td>
<td>.001</td>
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<td>.55</td>
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<td>SBI Pre Deep</td>
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<td>SBI Pre Deep</td>
<td>.51</td>
<td>6.76</td>
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<tr>
<td></td>
<td>CPQ Mean Score</td>
<td>.23</td>
<td>3.03</td>
<td>.003</td>
<td>.27</td>
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</table>

a. Dependent Variable: SBI Post Deep

Model 1 $R^2 = .30$
Model 2 $R^2 = .35$
### Predicting Exam 2 Scores Controlling for Exam 1 Scores and Mean CheckPoint Quiz Scores

<table>
<thead>
<tr>
<th>Model</th>
<th>Standardized Coefficients</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>Correlations Zero-order</th>
<th>Partial</th>
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</thead>
<tbody>
<tr>
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<td>5.021</td>
<td>.001</td>
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<td>Exam1</td>
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<td>9.180</td>
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<td></td>
<td>Exam1</td>
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<td></td>
<td>CPQ Mean</td>
<td>.318</td>
<td>5.18</td>
<td>.001</td>
<td>.471</td>
<td>.366</td>
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</tbody>
</table>

a. Dependent Variable: Exam2

- **Model 1 R^2 = .33**
- **Model 2 R^2 = .42**
Student Cognition Toolbox Project Team

- Catherine Overson (PI)
- Victor Benassi (Co-PI)
- Lauren Kordonowyo
- Elizabeth Tappin
- Meghan Stark
- Christopher Williams

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