Efficacy of Small Group Study in Large Lecture Classes
(With Apologies to Robert Bjork and Tina Hartley)

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I really appreciated the assignments given in this class. I.e. concept maps and mastering Biology. I believe I was consistently active in the course.

The group tests were also a great way to judge how prepared I was for the upcoming exams.

Mastering biology was really helpful if you actually took the time to sit down and do it. I did not think the concept maps helped that much.

Group exams were very helpful.

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Concept summaries and mastering were very helpful. Also, the group tests were great practice.

I really appreciate the group exams. They were an excellent study tool and made me a lot more confident about this course.

Thank you for a great first semester of Biology! :-)

(By the way, you say "industrial quantities a lot. " :)

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I know now without a shadow of doubt, that Biology is not for me.
The human memory system is characterized by a remarkable symbiosis of forgetting, learning, and remembering …

• But human memory is also characterized by equally remarkable misunderstandings, by users of the system, as to how the system works.
• We carry around a flawed mental model of how we learn and remember, or fail to learn and remember.
• Our judgments of whether we have learned and will remember later are unreliable; at times dramatically wrong.
• We manage our own learning in far-from-optimal ways and our misunderstandings become coupled with some counterproductive attitudes and assumptions about how we learn.
The practical problem:

- Conditions of instruction that make performance improve rapidly often fail to support long-term retention and transfer,
  
  …whereas

- Conditions of instruction that appear to create difficulties for the learner, slowing the rate of apparent learning, often optimize long-term retention and transfer
Examples of manipulations that introduce “desirable difficulties” for the learner

- Varying the conditions of learning (where you study)
- Distributing or spacing study or practice sessions (how often you study)
- Using tests (rather than presentations) as learning events
- Providing “contextual interference” during learning (e.g., *interleaving* rather than *blocking* practice)

Varying the environmental context of learning (Smith, Glenberg, & Bjork, 1978)

Memory & Cognition, 6, 342-353.
Distributing or spacing study or practice sessions: the *spacing effect* (versus "massed" study)

**Example:** Baddeley and Longman (1979)

Spacing practice sessions reduces "learning" time

## Distributing/Spacing of Practice

Baddeley & Longman (1979)

<table>
<thead>
<tr>
<th>Training Schedule</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 1 hr</td>
<td>2 x 1 hr</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hours to Learn Keyboard</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>34.9</td>
<td>42.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mean Satisfaction Rating</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Very Satisfactory) to 5 (Very Unsatisfactory)</td>
<td></td>
</tr>
<tr>
<td>2.40</td>
<td>1.86</td>
</tr>
</tbody>
</table>
Tests versus presentations as learning events

- Testing as pedagogy versus testing as assessment
  - Retrieving information or procedures is a learning event
    - The information/procedures recalled become more recallable in the future than they would have been otherwise;
    - Recalling is substantially more powerful event than is being presented the information (inflatable life vest example)
  - Tests provide far better feedback as to what has or has not been learned/understood (vs. presentations)
  - Tests enhance the effectiveness of subsequent study
The power of tests as learning events: Roediger and Karpicke (2006)

- To-be-learned text passage on the sun or on sea otters (about 30 idea units per passage)

- Three conditions
  - SSSS: four consecutive 5-min study (S) periods
  - SSST: three study (S) period plus a test (T) of recall for the passage
  - STTT: one study (S) period plus three consecutive tests (T) of recall for the passage
Table 5

*Mean proportion of idea units recalled on the retention tests and forgetting scores in Experiment 2*

<table>
<thead>
<tr>
<th>Retention Interval</th>
<th>Condition</th>
<th>5 min</th>
<th>1 week</th>
<th>Forgetting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSSS</td>
<td>.83</td>
<td>.40</td>
<td>.43</td>
</tr>
<tr>
<td></td>
<td>SSST</td>
<td>.78</td>
<td>.56</td>
<td>.22</td>
</tr>
<tr>
<td></td>
<td>STTT</td>
<td>.71</td>
<td>.61</td>
<td>.10</td>
</tr>
</tbody>
</table>

Is massing is superior to spacing?

Wedge $V = \frac{r^2 h \pi}{2}$

Spheroid $V = \frac{4r^2 h \pi}{3}$

Spherical Cone $V = \frac{2r^2 h \pi}{3}$

Half Cone $V = \frac{7r^2 h \pi}{3}$

Is massing is superior to spacing for generalizing concepts and categories after exposure to multiple exemplars?
Where’s the Gentoo?
Hypothesis (Kornell & Bjork, 2008): Induction is one situation where massing is superior to spacing. This turned out to be incorrect!

- Blocking/massing allows the learner to notice characteristics that unify a category
- Interleaving/spacing makes doing so difficult
Results

Easy species to induce

Hard species to induce

Which Order Is Optimal?

Doing the Readings
Then
Attending Lecture

OR

Attending Lecture
Then
Doing the Readings
What Do You Do?

34%  
66%

Which Is More Effective?

67%  
33%

Which Is More Difficult?

66%  
34%
What does this mean for you?
What are effective study skills?
How do you know what you know?

1. **Use your textbook.** Reading material that will be covered in lecture before lecture makes the lecture a learning opportunity.

2. After lecture, **review your lecture notes** within 72 hrs. Use the book if you don't understand something in your notes. Clean up your notes so that you can use them regularly to learn/review material from class.

3. **Review material at regular intervals** prior to the exam. Cramming the night before a test is less effective than regular, spaced review for long-term learning.

4. **Test yourself regularly to assess learning.** There are quiz questions at the end of Campbell chapters and in Mastering Biology. Use them! Write your own test questions on flash cards. Share test questions with others- use study groups as "testing" opportunities.
5. **Make charts, diagrams and graphs.** Use your concept diagrams - one of your weekly homework assignments - to organize ideas presented in lecture and in MB assignments.

6. **Think about varying where you study.** Try different locations.

7. **Interleave rather than block study.** Exams will jump between topics and you should feel comfortable doing this while studying.

8. **Make use of study groups.** Think of these as "testing opportunities" where members of the group test one another as part of learning. Sit with your study groups during lecture so that you can work together to answer iclicker questions.

9. **Learn to recognize what you know and don't know** so that you can use your study time effectively. Self-testing and study groups are helpful in assessing what you understand.
Group Exams in LIFE 102

ACKNOWLEDGEMENT:
Dr. Tina Hartney, Cal Poly Pomona
“Using Many Minds to Enhance Learning”
BLC 2010
Group Exams address some of my goals for encouraging "learning" in LIFE 102.

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9. **Learn to recognize what you know and don't know** so that you can use your study time effectively. Self-testing and study groups are helpful in assessing what you understand.
SYLLABUS INFORMATION FOR GROUP EXAMS (2010)

EXAMS: Individual exams will be given on the dates listed above. In addition, it is possible to take a “group exam” for extra credit over the same material on the following class period.

Here are the rules for “group exams”.
1. To be eligible for the “group” exam, you must participate in an “official study group”. This group must consist of 3-7 students who are registered in LIFE 102, sec. 02. The entire group must meet on at least two separate occasions after the preceding exam and prior to the scheduled exam date.

2. The group must submit at least two fully completed “Group Meeting Rosters” at the time of the group exam. A copy of this form is attached to the syllabus and is also available on RamCT.

3. Each group member must participate in taking the “group exam” to receive credit.

4. If the group meets these requirements, the group will receive one copy of the group exam and individual answer sheets for each group member. Both the exam and individual answer sheets will be turned in at the end of the exam period.

Grading of group exams (extra credit): A - 7 points; B - 6 points; C - 5 points; D - 4 points; F - 3 points

There are some “not so obvious” rules:
1. Your informal study group sets its own agenda. You can study material from lectures, study guides, Mastering Biology, etc. The more your group knows, the better the group will do on the group exam.
2. You are not committed to having the same group for each group exam. Groups can be formed, reconstituted or dissolved before each exam. If your group is not effective, form a new group!
CONCLUSIONS FROM YEAR 1
(Group Exam AFTER Individual Exam)

- Students with the highest overall class average also received the most extra credit for group exams.

- Students who had any participation in group exams had higher overall class averages.

- Some increase in overall average is from extra credit for group exams. That is shown as the expected overall average in Table III.

- This increase in overall class averages is greater than can be accounted for by the addition of extra credit points.
Data Analysis from Fall, 2012
Sequence: Group Exam -> Individual Exam

Approximately 160 students participated in each group exam.
Students participating in each group exam had higher overall class grades than students who did not participate in group exams.
CONCLUSIONS FROM YEAR 3  
(Group Exam AFTER Individual Exam)  
- Students with the highest overall class average also received the most extra credit for group exams.  
- Students who had participated in at least two group exams (>10 points) had higher overall class averages.  
- Some increase in overall average is from extra credit for group exams. That is shown as the expected overall class grade below.  
- This increase in overall class averages is greater than can be accounted for by the addition of extra credit points (actual overall class grade versus predicted class grade).

<table>
<thead>
<tr>
<th>Group Exam Extra Credit</th>
<th>Exam 1</th>
<th>Exam 2</th>
<th>Exam 3</th>
<th>Overall Class Grade (81.0 ± 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-30 points (+ 4%) (n = 31)</td>
<td>83.4 ± 15.9</td>
<td>82.0 ± 14.9</td>
<td>81.9 ± 14.5</td>
<td><strong>92.6 ± 7.3</strong> (88.6% predicted)</td>
</tr>
<tr>
<td>20-25 points (+ 3%) (n = 57)</td>
<td>76.6 ± 16.8</td>
<td>69.6 ± 18.8</td>
<td>71.9 ± 18.9</td>
<td>85.6 ± 10 (82.6% predicted)</td>
</tr>
<tr>
<td>15-20 points (+ 2.5%) (n = 51)</td>
<td>75.7 ± 16.4</td>
<td>70.3 ± 16.3</td>
<td>70.8 ± 17.1</td>
<td>84.2 ± 9.4 (81.7% predicted)</td>
</tr>
<tr>
<td>10-15 points (+ 1.9%) (n = 23)</td>
<td>72.1 ± 16.1</td>
<td>71.1 ± 16.9</td>
<td>65.6 ± 23.6</td>
<td>77.1 ± 15.5 (75.2% predicted)</td>
</tr>
<tr>
<td>0-10 points (+ 1.2%) (n = 39)</td>
<td>73.4 ± 16.4</td>
<td>67.8 ± 15.5</td>
<td>69.3 ± 17.5</td>
<td>74.6 ± 17.8 (73.4 predicted)</td>
</tr>
<tr>
<td>No Group Exam EC (0%) (n = 112)</td>
<td>75.3 ± 18</td>
<td>69.5 ± 19.2</td>
<td>73.6 ± 27.9</td>
<td><strong>77.1 ± 14.8</strong></td>
</tr>
</tbody>
</table>
Conclusions
We return to Bjork's practical problem:

Conditions of instruction that make performance improve rapidly often fail to support long-term retention and transfer,

\[ \text{…whereas} \]

- Conditions of instruction that appear to create difficulties for the learner, slowing the rate of apparent learning, often optimize long-term retention and transfer.

Acknowledgements: TILT support allowed me to implement a LIFE 102 course redesign in Fall, 2012. I could not have done this without input and assistance from TILT staff. Thank you!