The Effect of Time Interval on Students Learning of Statistical Concepts

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Effect of Time Interval on the Learning Process

This study examines the effect on student learning of the time interval between classes. In a statistics class, direct experiences (e.g. rolling a die 100 times) and the corresponding demonstration of collective results (e.g. relative frequency approaching 1/6) can help students grasp basic concepts (e.g. the law of large numbers). No study has yet been done to examine carefully how to scaffold learners' relation-making between the experiences and the concept formation by reflection. The interval between classes can serve as the time for the reflection, but it can also make the relation-making harder. To clarify its effect, we compared two statistics classes with different intervals; a regular course met weekly and a more intensive course met daily. Comparing the results, we found that short intervals increased student learning, but long intervals combined with scaffolds for active relation-making did not inhibit learning.

Comparison of Two Classes and Activities

Taking the low of large numbers (hereafter "LofL") as an illustrative case, a typical curriculum develops as follows:
Step 1) Each student engages in an "experiment" such as rolling a die 100 times and counting each spot,
Step 2) Five to ten students form a group to tally their results, and a teacher gathers the results of the groups into one table,
Step 3) Students reflect on the resultant graph showing the collective pattern for several thousand trials, and
Step 4) The teacher or students find patterns such as convergence and tie them to statistical concepts such as LofL.

The teacher repeats this four-step cycle for several concepts during a semester through such units as:
Unit 1) rolling normal and deformed dice for LofL,
Unit 2) cutting 100 tapes to a certain length without measuring, yielding a histogram similar to the normal curve,
Unit 3) tossing ten coins 100 times to yield a binomial curve, and
Unit 4) rolling 100 dice at a time, removing the "1" spots, and repeating this process with the rest for an exponential curve.

The same teacher taught this class of the same contents to sophomores at the same college from 2000 to 2005. The levels of students' math ability were not quite different from each other at the beginning of each year. These conditions enabled us a meaningful comparison between years. Here we compared the intensive class of 2005 (Class 1) and the regular one of 2004 (Class 2) to determine the effect of intervals inserted in the steps above.

Results and Discussion

Table 1 summarizes the results for each unit described above. The intervals between Steps 2 and 3 are shown in the "Interval" column. "Ratio of Step 4" refers to the ratio of time spent in Step 4 (most mathematical step) to the total time for all four steps. Interval were shorter in Class 1 than in Class 2, but the ratios were almost the same. It indicates that the two classes differd little in structure except for the intervals between steps.

We compared the quality of verbal reports of the impressions collected at the end of every unit. Categorizing them into four levels in terms of their degree of conceptualization, we found that the ratios of the highest-quality reports (e.g. "If you roll the die infinitely, the ratio of getting the "1" spot approaches 1/6") were always higher in Class 1 than in Class 2. The scores of term-end examinations were also higher in Class 1.

Table 1: Intervals, verbal reports, and exam results

	Interval	Ratio of Step 4	Ratio of highest-quality reports	Exam scores
Class 1 (Year 2005, taught in a week)				
Unit 1	1 day	18.7%	20%	68.21
Unit 2	1 day		12.3%	
Unit 3	20 min.		55.3%	
Unit 4	No int.		25%	
Class 2 (Year 2004, taught in a semester)				
Unit 1	1 week	16.2%	12.5%	57.9
Unit 2	1 week		0%	
Unit 3	1 week		40%	
Unit 4	1 week		0%	

The overall pattern implies that shorter intervals help students learn. No matter how apparent the statistical concepts are to the eye of experts as teachers, dramatic demonstrations do not have the same impact on the students after a one-week interval. However, as Table 1 shows, there were some units, specifically Units 1 and 3 of Class 2, where students were able to grasp concepts in spite of the longer intervals. In these units, activities of Step 4 were distributed over two weeks. In the first week, students were asked to calculate and forecast the probability before "experiments," and in the second week, they were prompted to tie their results to statistical calculation. We believe that this kind of scaffold for active relation-making helps students gain durable understanding that lasts over time.

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