

Applet #3 Activities: Instructor Guide

Learners studying introductory statistics usually find concepts relating to the sampling distribution of a statistic difficult to understand. One reason for this is that how a statistic varies over multiple samples is not easy to convey in a textbook or traditional lecture. A variety of methods have been proposed for aiding learning about sampling distributions, one being on-line simulation-based tools, or *applets*, that permit visualisation of multiple samples from a distribution and how their statistics vary. Research suggests that how students engage with such applets can impact the learning obtained, as without structure to their interactions with a visualisation tool learners may miss important concepts.

Prof. Mike Whitlock (in the Department of Zoology, University of British Columbia) has developed a suite of applets for use in introductory courses. The third of these, “Confidence intervals of the mean”, allows the learner to explore how confidence intervals vary with parameter values and sample size when sampling from a Normal distribution. The accompanying activity aims to assist the learner in their engagement with the applet, helping to focus attention on key learning goals. The activity may be used as an in-class activity (say as part of a lab-based tutorial) or outside class as a homework assignment. The activity has been tested on over two hundred students at the University of British Columbia. There follows an instructor guide to the activity.

The activity will likely work best if the learner has previously engaged with the first applet, and although that is not strictly necessary some familiarity with the concepts of sampling distribution and the example used will be helpful. The first part of the activity does not involve the applet, and is attended to review prior knowledge of the Normal distribution and the distribution of the sample mean from a Normal. This part may be omitted if an instructor is either confident the learner will have such knowledge or the concepts will be reviewed elsewhere.

Part 2 introduces the applet and invites the learner to complete the tutorial. The question of why the population standard deviation σ is not used in computing the confidence intervals appears difficult for most learners. Note the “Show Calculations” button reveals how the computations are performed, and can help with part 3.

In part 4, the learner creates twenty confidence intervals and, it is hoped, looks carefully at how they behave. Two questions focus attention: do the

widths vary and (in 5) how many include μ ? In part 6 variation with the sample size n is also explored, but this time with enough samples to ensure the proportion of “successful” intervals will be close to 0.95. Note that exactly 95% success rates could never be assured even with huge sample sizes, and so it is thought best to show the learner that the proportion is variable but does not systematically change with n .

Two multiple choice questions follow the simulations from part 6. It should be obvious to an attentive learner that the confidence intervals narrow as the sample size increases. Learners tend to struggle with the second question, apparently thinking that the chance a 95% confidence interval captures μ will increase with n ; the activity targets this misconception explicitly.

Part 9 is similar to 6, though this time with the standard deviation changed from $\sigma = 30$. The learner should see the intervals are wider, and concepts that were encountered in part 6 - 8 are reviewed. Finally the learner is invited to repeat part 9 with a smaller σ in part 10, and clarify how the interval width changes as σ increases. The more pedantic may wish to reword this slightly, as the width of a confidence interval is a random variable determined here by the sample standard deviation s .