

Appendix 4. Pre-and post-module assessment tools for student performance of learning outcomes from Table 1.

Survey 1

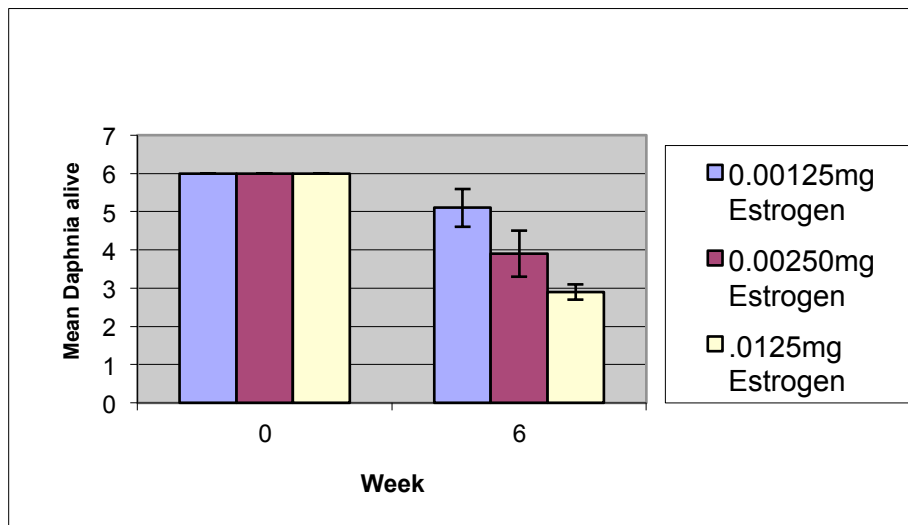
Part I. Assessment of student performance in experimental design and data analysis.

After studying relevant scientific papers, a student hypothesized that "Estrogen concentrations affect *Daphnia* lifespan." To test this experiment, he proposed the following experimental design to his faculty advisor for comment. The advisor liked his hypothesis, but she was concerned about the experimental design.

1. Explain why his advisor may be skeptical.

Proposed experiment: The researcher would place equal numbers of *Daphnia* into 15 beakers with equal volumes of lake water. Three treatments would be established with 5 beakers each containing the following estrogen amounts: 0.00125 mg, 0.0025 mg, and 0.0125 mg. *Daphnia* sizes and sexes would be randomly distributed among the beakers. Each week, he would record how many *Daphnia* were alive in the beakers, and then replace those that died with the same number of healthy *Daphnia*. The student predicts that *Daphnia* reared in environments containing lower estrogen concentrations will live longer than those reared in higher estrogen concentrations.

2. Based on this figure from the experiment described above, what additional information is needed to draw meaningful conclusions?



Average number of *Daphnia* at beginning and end of six-week estrogen exposure.

Part II. Assessment of student confidence in experimental design and data analysis.

Please rate your **SKILL** in the following areas. Use the following scale:

1	2	3	4	5	6
none	very low	low	moderate	high	very high

3. State a testable hypothesis
4. Determine if samples should be taken randomly or systematically
5. Set up appropriate controls
6. Determine whether experimental replicates are independent
7. Determine the number of sample replicates that should be taken for each treatment
8. Conduct an independent t-test
9. Conduct a paired t-test
10. Conduct an ANOVA
11. Interpret a p-value
12. Draw conclusions based on experimental results

Part III. Assessment of student attitudes towards statistics.

13. Which of the following STATISTICS courses have you taken? (Check all that apply.)
14. Do you anticipate taking statistics courses in the future?

Survey2

Part I. Assessment of student performance in experimental design and data analysis.

1. Researchers hypothesized that *taking melatonin supplements influences the proportion of sleep time that American adults experience Rapid Eye Movement (REM) sleep*. **Identify weaknesses in the experimental design described below. Explain your rationale.**

Proposed experiment: After a small pilot study suggesting that REM sleep time correlated negatively with self-reported stress, researchers next contacted 60 people (with varying ages, occupations, etc.) who responded to an advertisement to participate in the melatonin supplement study. Twenty of the participants were randomly assigned to take a 1 mg dose of melatonin, while 20 were assigned to a 3 mg dose, and 20 were assigned to take a 6 mg dose. All participants were instructed to take their assigned dose before bed at home for 2 weeks, and then spent one 7-hour night asleep in the lab, when scientists monitored the length of time that each subject spent in REM sleep after taking the assigned dose. They planned to compare the mean length of REM sleep per 7-hour night, number of sleepers who recalled bad dreams, and number of leg movements during sleep among the three treatment groups (sample size = 20 for each melatonin dosage group).

2. **Name an appropriate test** for researchers to compare mean REM length/night among the three groups.

Part II. Assessment of student confidence in experimental design and data analysis.

[Same ten questions as survey 1.]

Part III. Assessment of student attitudes towards statistics. [Same two questions as survey 1.]