SAMPLE write-up of assessment of problem-solving techniques in a Biology class
(Note: This is a large and formal assessment – it is the write-up that is of interest – not the scope)

Introduction

We studied the effects of in-class formative assessment and feedback on learning in introductory biology courses (BIO 103 and 105). Students produced phylogenetic trees based upon morphological and molecular data. The trees were projected in class, feedback provided, and the process repeated twice with new data. Control groups were shown the same Powerpoint presentation, but were not allowed to work on the assignment themselves, and instead were just told the answer by the instructor. Both formative and summative tests were given to assess student learning. We tested the effectiveness of the module by assessing 577 students in six different lecture sections taught by five different instructors. Several of the lectures were videotaped and monitored by external reviewers.

Results

Formative Assessment. In the Test classrooms, groups of students were asked to draw phylogenetic trees in class, the drawings were collected, and scored using a standardized rubric that focused on Grouping, Ancestry, and Accuracy. In the first iteration, students tended to group the animals based upon either diet or habitat. Several common misconceptions appeared, such as living species serving as ancestors to other living species (Figure 1A). The trees were more accurate in the second iteration based on skeletal data, however, some misconceptions persisted (Figure 1B). By the third iteration based on molecular data, most trees were accurate, e.g., hippos were identified as the closest living land relative to whales and porpoises (Figure 1C). Quantitative evaluation of the diagrams showed the same trend. Group scores showed a statistically significant improvement in all three criteria as determined by Student t-test. The greatest gain was observed in Ancestry, in which 51% of the groups made at least one error in assigning modern species as ancestors to other modern species in the first iteration and only 7% made this error in the last iteration, for a total gain of 44%. Significant gains of 22% and 29% were also observed in Grouping and Accuracy, respectively.

Summative Assessment. The gains between individual students pre and post-test short answer scores were analyzed by repeated measures of analysis of variance. Three predictor variables were taken into consideration (Question Topic: Grouping or Ancestry, Course: BIO 103 or BIO 105, and Treatment: Test or Control). The analysis revealed a significant three-way interaction effect on test score gain by all three predictor variables ($P = 0.017$). Students in Test lectures showed significantly greater gains than did students in Control lectures in the short answer question in all groups with the exception of the BIO 103 Ancestry questions. The multiple choice scores were pooled by question topic (Grouping or Ancestry) and tested for difference in proportions. The gain in scores from Test lectures were statistically higher than Control lectures for BIO 105 Grouping and Ancestry questions, and for BIO 103 Ancestry questions. No significant gain was observed between Test and Control lectures for the BIO 103 Grouping questions.

Conclusion

In conclusion, there are several advantages to incorporating problem-solving assignments with formative assessment and feedback into large biology lectures. Students are more engaged in applying concepts from lecture to solving real problems. Students also receive critical feedback during the learning process, which supports the development of their understanding. An iterative process of student problem solving followed by formative feedback also leads to a deeper conceptual understanding of difficult biological theories.

The instructors in the classes were Scott Cooper*, Deb Hanmer*, Dan Sutherland, Anne Galbraith, Roger Haro and Tim Gerber. *Authors along with Bill Cerbin.

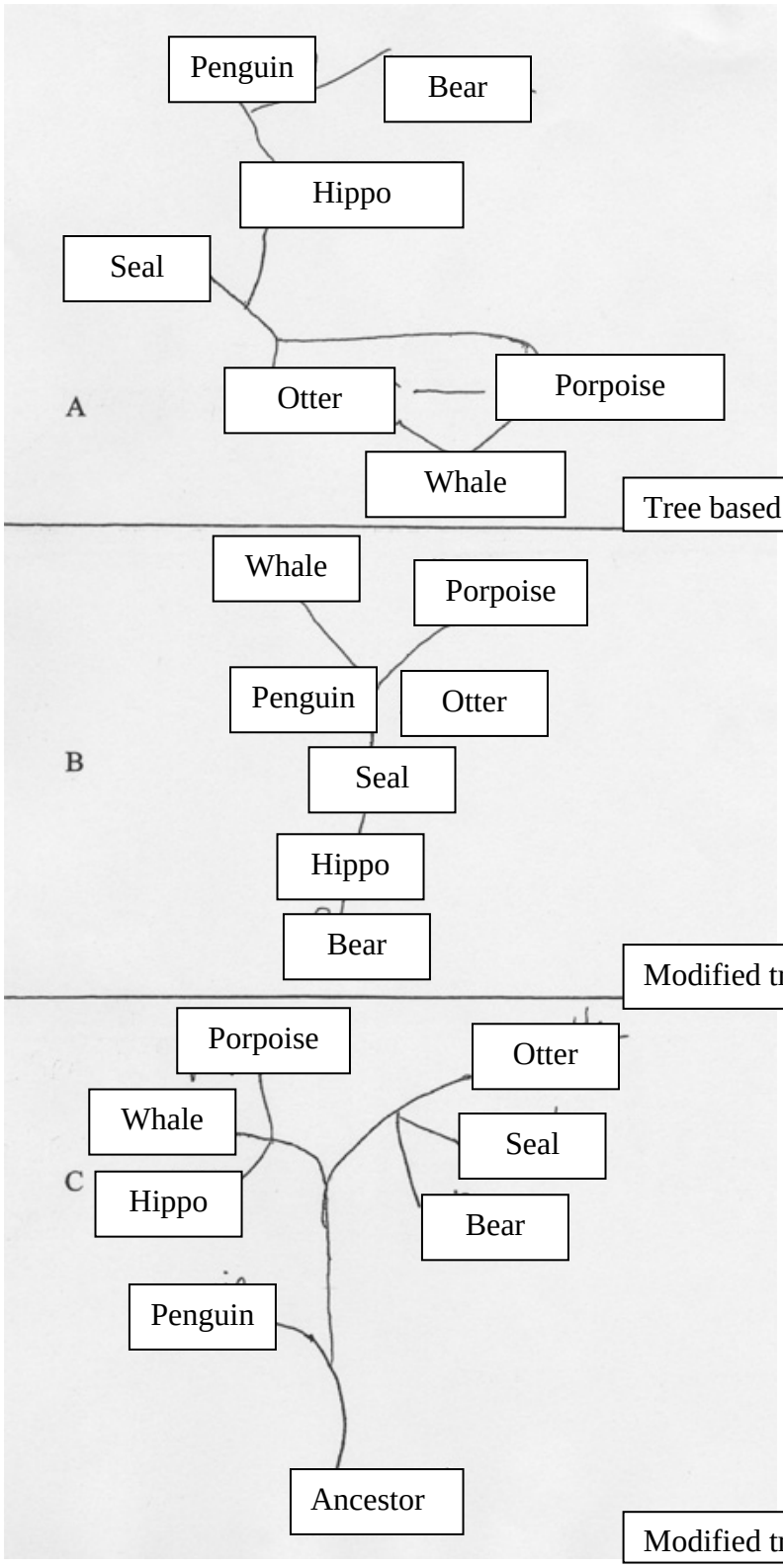

Figure 1. Sample formative assessment responses from a group of students during Evolution Module. Text has been modified to improve readability.