# The Effects of Online Learning on Student Understanding of RNA Folding

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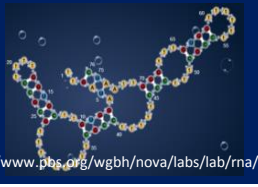

http://www.pbs.org/wgbh/nova/labs/lab/rna/)

## Abstract

Student understanding of RNA folding increased significantly after completing an online RNA learning activity. Students in this study included five freshman, eight sophomores, and 12 Juniors. Analysis of Variance comparisons of pretest and posttest scores for each group showed no difference for control questions but significant difference for RNA related questions.

## Introduction

Previous studies with students using project based lessions[2], molecular manipulatives[1], or virtual models and games[3] showed that such active learning projects increased student understanding of scientific process more than just using textbooks. The EteRNA project (http://eterna.cmu.edu) engages students in designing RNAs. I hypothesized that students that completed the related NOVA tutorial and puzzles would have a better understanding of RNA structure and function.

## Methods

- 25 Upward bound students took a pretest that contained 10 RNA related questions and 5 general biology control questions.
- The students did an online RNA lab activity (http://www.pbs.org/wgbh/nova/labs/lab/rna/).
- Students did a posttest that contained rearranged questions and answers of the pretest.
- Data from both tests were analyzed by ANOVA (Bonferroni) and paired t-tests.

## Results

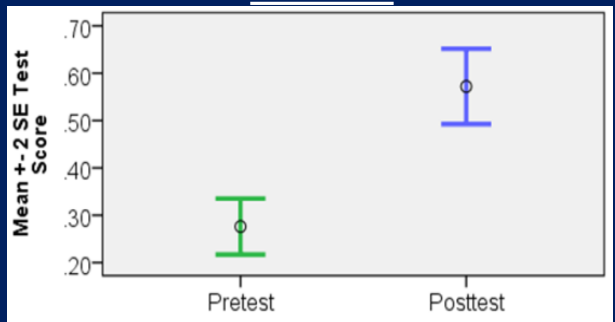


Figure 1: Average Scores on RNA-Related Questions for Pretest and Posttest (t= -3.994*** )

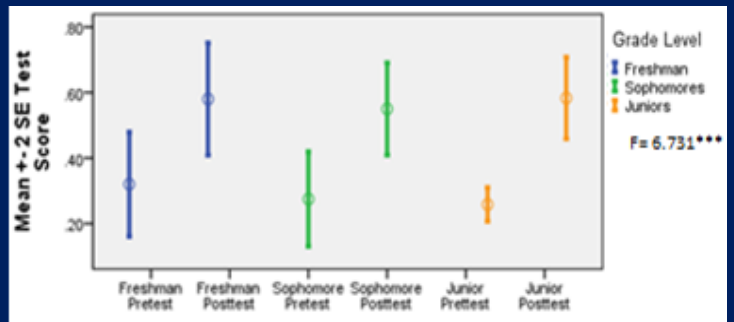


Figure 3: RNA Related Questions for Grade Level Pretest and Posttest

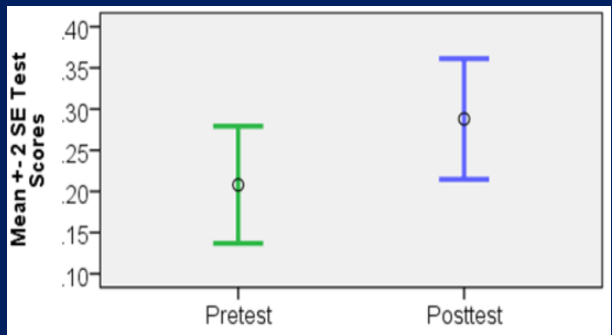


Figure 2: Average Scores on Biology Control Questions for Pretest and Posttest ( t= -0.990ns)

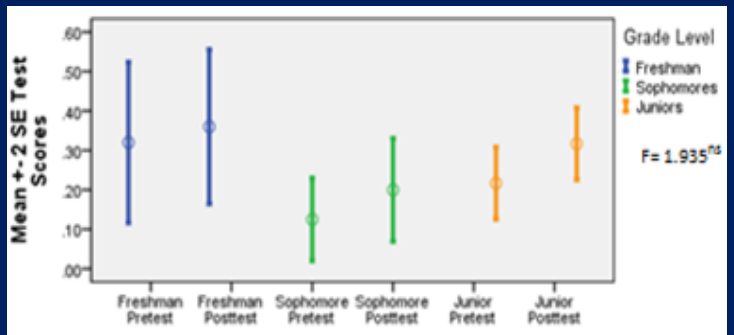


Figure 4: Biology Control Questions for Grade Level Pretest and Posttest

**Table 1: RNA-Related Questions Mean Difference (Bonferroni) Among Groups**

| Mean Difference (Bonferroni) | Freshman Pretest | Freshman Posttest | Sophomore Pretest | Sophomore Posttest | Junior Pretest | Junior Posttest |
|---|---|---|---|---|---|---|
| Freshman Pretest | | | | | | |
| Freshman Posttest | 0.26 | | | | | |
| Sophomore Pretest | -0.05 | -0.31 | | | | |
| Sophomore Posttest | 0.23 | -0.03 | 0.28 | | | |
| Junior Pretest | -0.06 | -0.32* | -0.02 | -0.29* | | |
| Junior Posttest | 0.26 | 0.003 | 0.31* | 0.03 | 0.33* | |

## Conclusion

-The data supported my hypothesis that students that completed the online RNA lab activity had an better understanding of RNA structures (Fig. 1 and Fig. 3).
- Juniors had the most significant difference between the pretest and posttest (Table 1 and Fig. 3).

## References

1. Ben-Nun M, Yarden A. Learning molecular genetics in teacher-led outreach laboratories. Journal of Biological Education (Society of Biology) 2009 Winter2009;44(1):19-25.
2. Pešakovic D and et al. Development and evaluation of a competence-based teaching process for science and technology education. Journal of Baltic Science Education 2014 09;13(5):740-55.
3. Schönborn KJ, Bivall P, Tibell LAE. Exploring relationships between students' interaction and learning with a haptic virtual biomolecular model. Comput Educ 2011 11;57(3):2095-105.