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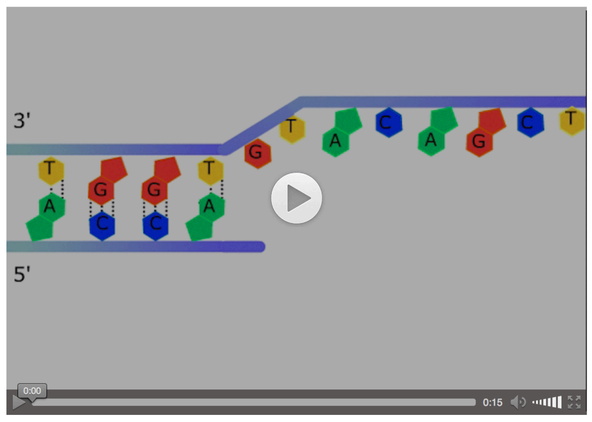
Pairing animations with practice and feedback improves student learning in an online DNA replication module

The OLI platform allows instructors to create customized text, static images, animations, and adaptable practice and feedback. We sought to understand the extent to which variation in the spatial arrangement of embedded animations and practice exercises would impact student learning

Project Design

- Course: introductory biology for majors and non majors (Modern Biology),169 participants
- Divide the class randomly into 4 groups (see table below)
- All students required to complete their assigned OLI module for course credit
- All students in all study conditions took the same pre-test and post-test

To the right:
Example animation demonstrating a key process. The cellular components that participate in the process are seen as cartoons in the animation



Synthesis of the Complementary Strand: The top strand is the template. Lower strand is the primer. DNA Polymerase is represented by the **yellow sphere**. It binds to DNA at the 3' end of the primer and builds a complementary sequence by adding bases to the 3' end of the growing DNA strand. The **blue ring** is a special protein called the sliding clamp, whose role is to interact with DNA polymerase III to keep it tightly bound to the DNA during synthesis.

Project Organization & Evaluation

Assessment: baseline quiz at beginning and final quiz upon completion of OLI module

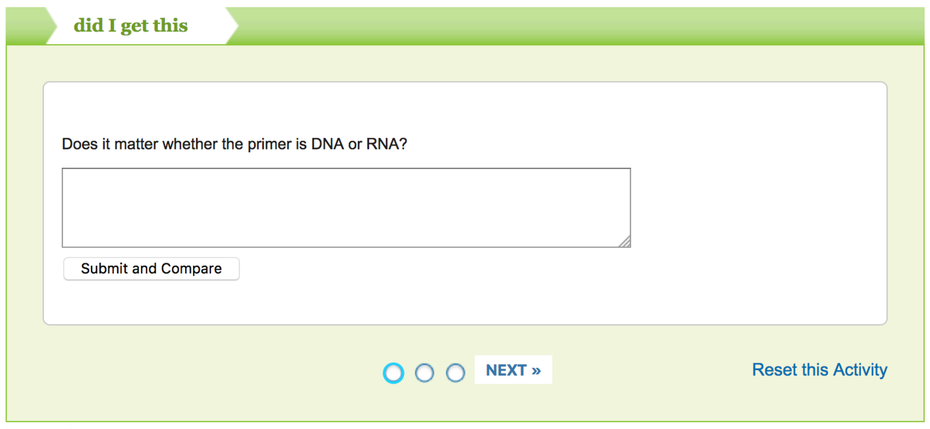
OLI Group	Practice & Feedback at end	Practice & Feedback embedded
Animations at end	"AllAtEnd": mimics paper textbook with online resources	"PFatEnd": mimics a paper textbook with embedded questions plus secondary animations
Animations embedded	"AnnimateAtEnd": mimics traditional online textbook with separate P&F	"NormalOLI": Embedded animations and P&F, takes full advantage of OLI

TABLE. Study group designations and descriptions.
All groups have text mixed with static figures. Practice & Feedback questions include a mixture of multiple choice and short essay.

Lessons Learned

- Students show the strongest immediate learning gains when practice & feedback are presented immediately after animations
- This effect is independent of whether the animations and the practice & feedback are paired with relevant static text and static images or whether the static text and images were presented several pages before the animations and/or practice/feedback questions
- Results suggest that OLI can improve learning by presenting practice questions simultaneously with animations, while traditional textbooks cannot

To the left:
Example practice & feedback question in which students have a chance to submit open-ended answers. After submission they compare to a provided answer and later get feedback from instructor.



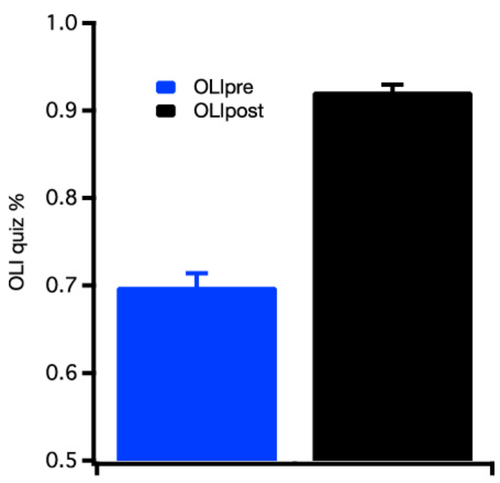


FIGURE 1. Score before and after OLI module. For all groups the post-OLI score was higher. We also found that pre-OLI score was significantly correlated with incoming SAT math scores (not shown).

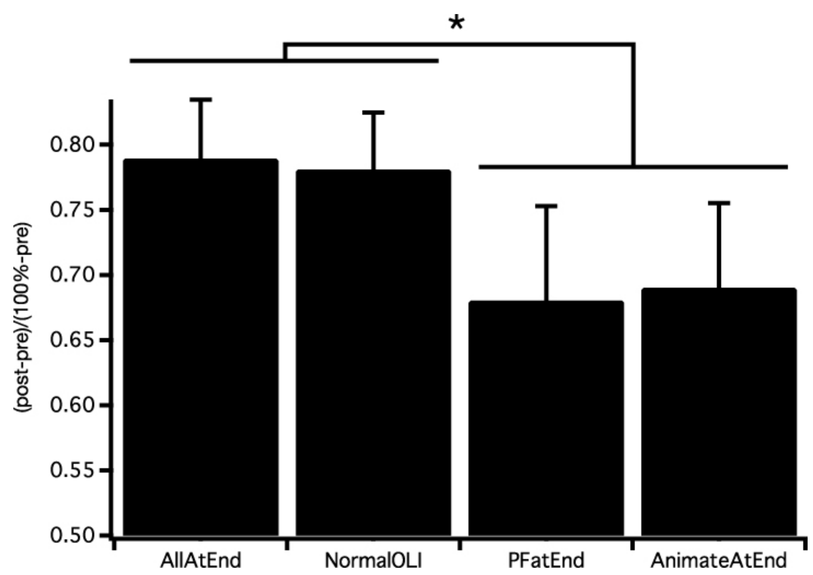


FIGURE 2. Change in OLI performance scaled by maximum possible increase. When these changes are corrected for the incoming difference in pre-test score as a function of SAT scores, the AllAtEnd and NormalOLI groups significantly outperform the PFatEnd and AnimateAtEnd groups (ANCOVA with incoming SAT score as a covariate, $p < 0.05$).