Does Access to Supplementary Online Tools Help Non-Major’s Biology Students Learn the Central Dogma of Biology?

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Does interaction with online tools that provide instruction, practice, and instant-feedback help students to better develop their conceptual understanding of biology’s central dogma?

Three non-major’s introductory biology courses, each at different college campuses, participated in this project during Spring 2017. Each class comprised laboratory and lecture components, and each received instruction on DNA replication prior to instruction on the Central Dogma.

Participation in online tools was optional and students self-reported their time spent on each tool. Online tools were developed at H5P.org.

Online Tools
Designed to supplement a full lecture, the online presentation moves at the student’s pace. The presentation defined and described the details of the transcription and translation processes. Presentation slides included embedded animated explanations with self-assessment questions with instant-feedback, text descriptions, and non-biological analogies, intended to help students develop conceptual understandings. Content questions such as those below prompted students to select responses or type responses in blank spaces. Feedback addressed misconceptions.

Results and Discussion
Students self-selected into groups that opted in or out of online tool use. Separation into tool-use groups was highly skewed, and most students at the Madison Colleges opted in.

Pre- and post-quiz questions were adopted from the Central Dogma Concept Inventory.2 Students who engaged with online tools filled out a survey estimating how much time they spent on the presentation and other activities; students rated the activities by perceived helpfulness.

Student scores on the post-quiz differed significantly by institution and ranked as follows:

- **Madison College-Truax (MCT)** (p-value < 0.005; ANOVA with Tukey post-hoc test)
- **Madison College-Downtown (MCD)**
- **University of Wisconsin-Whitewater (UWW)**

For pre- to post-quiz, students’ improvement was greatest and most consistent in the category of translation for all institutions. In the transcription category, improvements were inconsistent among institutions. Students’ final understanding within the four categories were inconsistent across institutions and were not predicted by online tool use.

Post-quiz scores revealed misconceptions and confusions held by students, including:

- **DNA and RNA**: Students incorrectly believe that DNA and RNA are the same molecule.
- **Transcription**: Students believe that DNA replication produces an entire copy of the genome.
- **Translation**: Students believe that DNA replication produces a new mRNA molecule.

Reflection
Randomizing students into access groups prior offering online tools may have provided more balanced experimental groups.

There was no correlation between time spent using online tools, and there was no consensus on the perceived helpfulness of these tools.

Madison College-Truax students scored the highest on the post-quiz. It is likely that the in-class instruction method and classroom attributes contributed to this performance. Follow-up projects might integrate these or other materials into class time in a peer-partnered active learning activity.

It may be helpful to test instructional methods that focus on teaching concepts with a lower level of detail prior to introducing molecular jargon.

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Literature Cited