How Do Biology Undergraduates "Explain" Photosynthesis? Investigating Student Responses to Different Constructed Response Question Stems

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Introduction

- Constructed response questions require students to create a written answer from their understanding of the question and the concepts involved in it (Kuechler & Simkin 2010)
- Experts and novices reason differently
- Photosynthesis question requires students to:
  - Trace matter and energy
  - Move across scales
- Answering this question requires naming a process
- To try and get more students to name the process that they describe, we changed the question stem to ask for the process that adds biomass to plants

Research Question

What is the impact on students' written explanations when they are explicitly asked to identify a process in their response?

Stem Version 1:
A mature maple tree can have a mass of 1 ton or more (dry biomass, after removing the water), yet it starts from a seed that weighs less than 1 gram.
Explain this huge increase in biomass.

Stem Version 2:
A mature maple tree can have a mass of 1 ton or more (dry biomass, after removing the water), yet it starts from a seed that weighs less than 1 gram.
Explain where this biomass comes from and by what process.

References

Keuchler, W.L., & Simkin, M.G. (2010). Why is performance on multiple-choice tests and constructed response tests not more closely related? Theory and and empirical test. Decision Sciences Journal of Innovative Education 8:55-73.

Methods

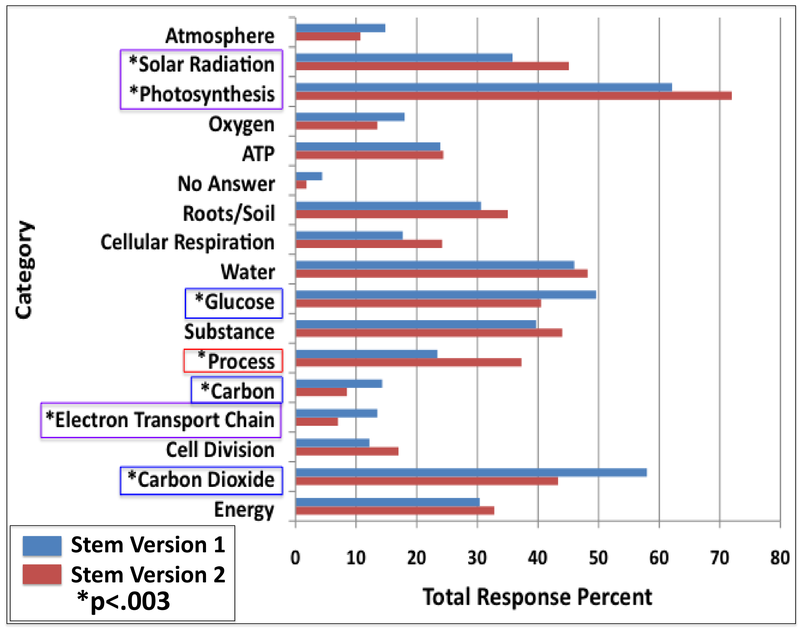
- Both versions of question stem given on exam in the introductory biology course Cells and Molecules

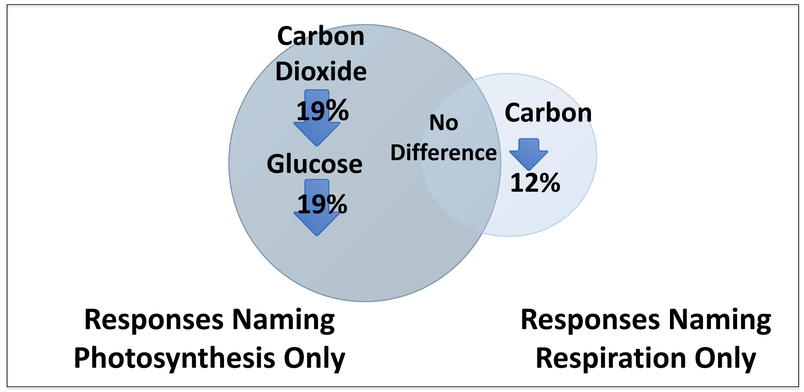
Stem Version 1:
Fall 2009: 385 students

Stem Version 2:
Fall 2010: 394 students
Fall 2011: 458 students

- Responses were categorized based on lexical content using IBM SPSS Text Analytics for Surveys software

Results





Discussion

Student Response to Stem Version 1
The increase is due to a large absorption of minerals and organic materials through the soil then joining their benefits with H2O, O2 and sunlight to help reach maximum production.

Student Response to Stem Version 2
Process responsible for increased biomass is photosynthesis. The biomass came from the incorporation of CO2 gas from the atmosphere that was delivered to molecules in the green leaves, sunlight helps create glucose and nutrients moved to roots.

Processes
Biomass Input or Output

- Even small changes in wording can influence how students respond.
- If the question is written so that it is clear to novices the amount of scientific detail they should provide in their answer, then they will provide more meaningful responses.

Future Work

- How did the quality of the responses change?
  - Analytic rubric scoring
- Why were inputs and outputs lost?
  - Split design –change order of "where biomass comes from" and "by what process"

More Information

A paper for this project can be found at the AACR website.
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