Promoting higher order thinking skills in biology: evaluation of a newly developed course using Bloom’s taxonomy.

Coral L. Murrant, Nicolette S. Bradley, Genevieve S. Newton, Kerry L. Ritchie, Justine M. Tishinsky, William J. Bettger

The Challenge…

To build a “better” first year biology course.

By “better” we mean:
1. Increase engagement
2. Develop skills (oral communication and independent learning)
3. Emphasize inquiry
4. Encourage a deeper level of learning

The Challenge…

Replace 2 courses with 3 that will span different biological scales.

- molecules
- cells
- tissue
- systems
- individual
- populations

The Challenge…

Replace 2 courses with 3 that will span different biological scales.

- molecules
- cells
- tissue
- systems
- individual
- populations

BIOL 1080
Biological Concepts of Health
But was it better?

To build a “better” first year biology course.

By “better” we mean:

1. Increase engagement
2. Develop skills (oral communication and independent learning)
3. Emphasize inquiry
4. Encourage a deeper level of learning

Blooms Taxonomy: Hierarchy of Ways of Knowing


Reference:
(remembering) – what does the student remember, tested using language very similar to that in class.

(understanding) – what does the student understand, tested using different language and examples from that given in class.

(applying) – students must apply what they know using principles and information not given.

(analyzing) – student must be able to deconstruct examples and see the individual parts, see relationships.
Blooming Biology

- (creating) – student must be able to put elements or parts together to create something that was not there before.
- (analyzing) – student must be able to deconstruct examples and see the individual parts, see relationships.
- (applying) – students must apply what they know using principles and information not given.
- (understanding) – what does the student understand, tested using different language and examples from that given in class.
- (remembering) – what does the student remember, tested using language very similar to that in class.

- (evaluating) – students must be able to have opinions, make judgments, or appraise ideas, solutions, methods, etc.
- (creating) – student must be able to put elements or parts together to create something that was not there before.
- (analyzing) – student must be able to deconstruct examples and see the individual parts, see relationships.
- (applying) – students must apply what they know using principles and information not given.
- (understanding) – what does the student understand, tested using different language and examples from that given in class.
- (remembering) – what does the student remember, tested using language very similar to that in class.

- assigned a bloom level to each test question and task of each component of the course that will be graded.
Blooming Biology


Blooming process

Gathered team of bloomers
- we used team of 6
- must have an inherent and deep interest in teaching
- had different levels of familiarity with the courses to be bloomed.

Blooming process

Team needs a leader
- to lead the training - gather resources for help in understanding levels especially as they applied to science-type courses.
- moderate group discussions
- collate data

Blooming training

The grey cell and the white cell are two different cell types that reside in the same tissue. The grey cell is releasing 4 different signaling molecules.

When one cell produces a signaling molecule that stimulates a neighboring cell, the type of communication is called:

- a) Paracrine
- b) Autocrine
- c) Endocrine
- d) Neurocrine
The grey cell and the white cell are two different cell types that reside in the same tissue. The grey cell is releasing 4 different signaling molecules.

**Autocrine communication would be the result of:**

a) C binding to its membrane receptor
b) B binding to its membrane receptor
c) A binding to its membrane receptor
d) D binding to its membrane receptor

**Which signaling molecule is lipid soluble?**

**What is the assumption about the biochemical nature of signaling molecule A?**

**Design an experiment to test whether the white cell has a membrane receptor population for molecule B.**
The grey cell and the white cell are two different cell types that reside in the same tissue. The grey cell is releasing 4 different signaling molecules.

Autocrine is an effective communication method. Explain why you agree or disagree with this statement.

Evaluation

54. Which of the following statements is FALSE?
   a. Protein synthesis is increased following dynamic exercise
   b. Protein synthesis is decreased during exercise
   c. Protein breakdown is increased following dynamic exercise
   d. Untrained individuals show a greater increase in protein synthesis following exercise than trained individuals

10. You come across the following figure and the y-axis is unlabeled. Which of the following variables is most likely to be the missing y-axis variable?
   A. Cardiac Output
   B. Stroke Volume
   C. (a-v) O₂ difference
   D. Heart Rate

41) The best interpretation of this graph is:
   a) Lifestyle intervention is positively associated with an increased incidence of diabetes.
   b) Lifestyle, metformin and placebo interventions all caused diabetes.
   c) Lifestyle intervention blunted the incidence of diabetes over time compared to placebo.
   d) The incidence of diabetes increased over time in the placebo group only.
Bloomer agreement

Must have rules for assigning each question/component a bloom level:

**AGREEMENT** = at least 4 out of 6 choose the same level

- When 4 to 6 raters agree – choose common answer
- When only 3 raters agree and ratings differ by 1 (1,1,1,2,2,2) – average and alternate rounding up and down
- When only 3 raters agree and ratings differ by 2 (2,2,2,4,4,4) – take average
- When 2 raters agree and ratings are sequential (1,1,2,2,3,3) – choose intermediate value

Wanted inter-rater agreement of 80%
Blooming Results

**BIOL 1030**
1.93±0.1

**BIOL 1040**
2.95±0.2

**BIOL 1080**
3.28±0.2

IR agreement 86.0%

**BIOL 1030**
1.93±0.1
IR agreement 79.4%

**BIOL 1040**
2.95±0.2
IR agreement 86.4%

**Blooming benefits**

- can be used to compare to published data.
- can be used to compare to replaced courses.
- helps inform about the structure of course.
- have a baseline for growth of course.
- can build subsequent courses in curriculum with deeper learning.

*Great Start!!!*
Blooming benefits

- great discussions on teaching and learning.
- enhanced test writing.
- increase awareness of status quo and motivational in need for change.
- provided a common language.
- difference between “hard” and higher order learning.

Blooming issues

1. Knowledge
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation
ICE taxonomy

3 levels of growth of learning when progressing from novice to mastery.

1. Ideas
2. Connections
3. Extensions


ICE taxonomy

1. Ideas — building blocks of learning, information including facts, definitions, vocabulary, steps in processes, elemental concepts, details, etc.

2. Connections — establish and articulate relationships among ideas, combine ideas, relate to what they already know.

ICE taxonomy

1. Ideas — building blocks of learning, information including facts, definitions, vocabulary, steps in processes, elemental concepts, details, etc.
ICE taxonomy

1. Ideas – building blocks of learning, information including facts, definitions, vocabulary, steps in processes, elemental concepts, details, etc.

2. Connections – establish and articulate relationships among ideas, combine ideas, relate to what they already know.

3. Extensions – use learning in novel ways, extrapolate, articulate implications, anticipate outcomes.

Blooms 1. Knowledge and 2. Comprehension

ICE taxonomy

1. Ideas – building blocks of learning, information including facts, definitions, vocabulary, steps in processes, elemental concepts, details, etc.

2. Connections – establish and articulate relationships among ideas, combine ideas, relate to what they already know.

3. Extensions – use learning in novel ways, extrapolate, articulate implications, anticipate outcomes.

Blooms 1. Knowledge and 2. Comprehension

ICE taxonomy

1. Ideas – building blocks of learning, information including facts, definitions, vocabulary, steps in processes, elemental concepts, details, etc.

2. Connections – establish and articulate relationships among ideas, combine ideas, relate to what they already know.

3. Extensions – use learning in novel ways, extrapolate, articulate implications, anticipate outcomes.

Blooms 1. Knowledge and 2. Comprehension

Blooms 3. Application and 4. Analysis

ICE taxonomy

1. Ideas – building blocks of learning, information including facts, definitions, vocabulary, steps in processes, elemental concepts, details, etc.

2. Connections – establish and articulate relationships among ideas, combine ideas, relate to what they already know.

3. Extensions – use learning in novel ways, extrapolate, articulate implications, anticipate outcomes.

Blooms 1. Knowledge and 2. Comprehension

Blooms 3. Application and 4. Analysis

1. Knowledge → 1
2. Comprehension
3. Application → 2
4. Analysis
5. Synthesis → 3
6. Evaluation

BIOL 1030
1.17±0.05
BIOL 1080
1.81±0.1

BIOL 1040
1.64±0.1

Same conclusions!

BIOL 1030
1.17±0.05
BIOL 1080
1.81±0.1

BIOL 1040
1.64±0.1

Same conclusions!

BIOL 1030 - IR agreement 79.4% to 92.1%
BIOL 1040 - IR agreement 86.4% to 96.8%
BIOL 1080 - IR agreement 86.0% to 97.2%
**Blooming vs ICEing**

- **Condensed blooming**
  - faster, easier, less information

- **Blooming**
  - slower, harder, more information

- **ICEing**
  - can’t ICE without Blooming first

**Conclusions...**

Yes, we built a “better” first year biology course.

1. Increase engagement
2. Develop skills (oral communication and independent learning)
3. Emphasize inquiry
4. Encourage a deeper level of learning

**Conclusions...**

For course developers:
More guidance with less assumption.

For Students:
More 3, 4, 5, and 6 with less 1 and 2.

**Thank you!**

QUESTIONS?