Utilizing a Concept Inventory to Facilitate Data-Driven Course Improvement

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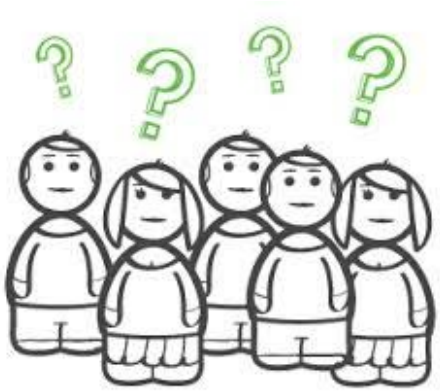
How do I know students are learning?

What is a concept inventory?

"Concept inventories are research-based instruments that measure students' conceptual understanding of topics for which students share common misconceptions and faulty reasoning."

D'Avanzo, C. (2008) Biology Concept Inventories: Overview, Status, and Next Steps. *Bioscience*, 58: 1079-1085.



What are the key features of a concept inventory?

* **Not just a test bank.**
* **Simple to administer and easy to grade.**
  * Often a multiple choice format or multiple true/false is used
* **Concepts measured are focused on key misconceptions.**
  * Faculty must agree on most important concepts
* **Careful analysis is done to ensure validity and reliability.**
* **Interviewing students helps to remove jargon.**

Adams, W.K. & Wieman, C. E. (2010) Development and validation of instruments to measure learning of expert-like thinking. *International Journal of Science Education*, 1-24.

History of Concept Inventories

* 1992- Force Concept Inventory is developed to measure physics concepts.
* To date over 25 concept inventories exist.
* They have been primarily developed in the scientific disciplines.

Steps for Concept Inventory Creation

Step One:

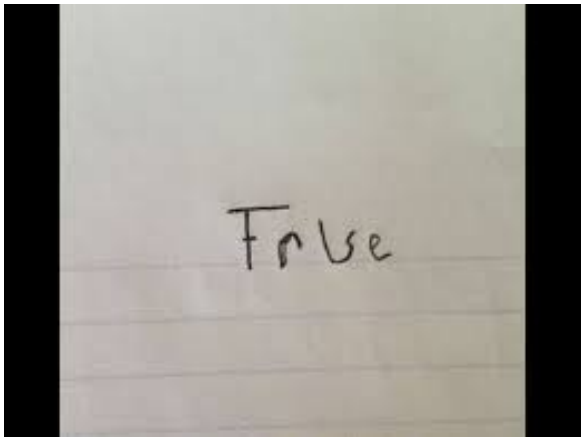
Establish topics that are important to faculty teaching the course.

Adams, W.K. & Wieman, C. E. (2010) Development and validation of instruments to measure learning of expert-like thinking. *International Journal of Science Education*, 1-24.

Step Two:

Identify student thinking about these topics and identify misconceptions.

Step Three:
Create questions to probe student thinking more broadly in test form.



Step Four:

Create a forced answer test that measures student thinking.

Step Five:

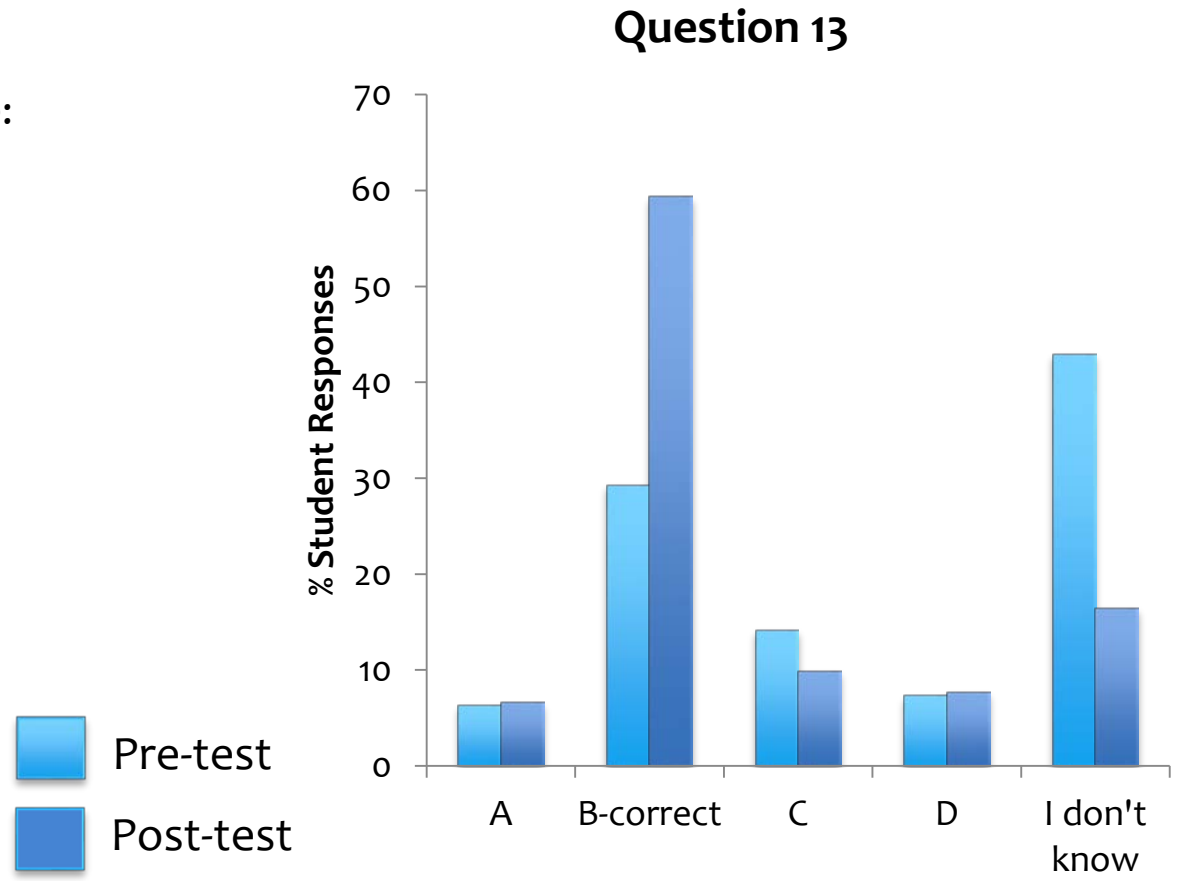
Carry out validation interviews with both novices and subject experts on the test questions.

- Use think out loud protocol with students.
- Subject experts don’t always agree!

_____13. If a single nucleotide is mutated in a bacterial gene, which one of the following statements would be the most likely outcome?

A) Nitrogenous bases would be added to the gene sequence.
B) The protein product of the gene might not function properly.
C) The mutation would cause unregulated growth of the cells.
D) The bacteria would automatically become drug resistant.
E) I don't know.

Please explain your answer choice:



_____13. If a single nucleotide is mutated in a bacterial gene, which one of the following statements would be the most likely outcome?

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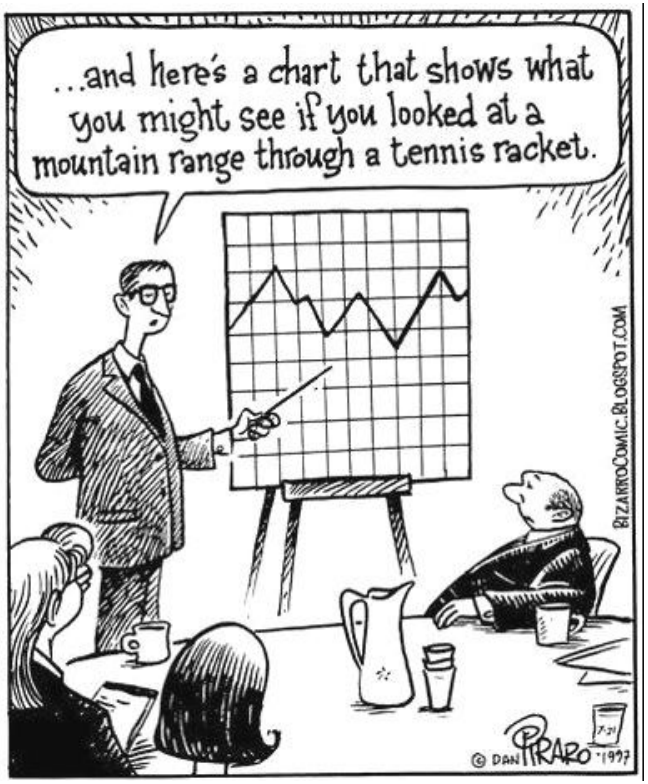
D) The bacteria would automatically become drug resistant.
E) I don't know.

Please explain your answer choice:

Student responses
The mutation of a nucleotide would cause the gene to not function properly.
The protein might lose its function because the base pairing was disrupted.
Because more genes would be bad for the bacteria
Yes, because it can code for an entirely different codon, then an entirely different amino acid, and a different protein.
Depending on the nucleotide, the mutation may or may not be harmful.
A single nucleotide being mutated could potentially alter the genes making the protein not function properly.

Step Six:

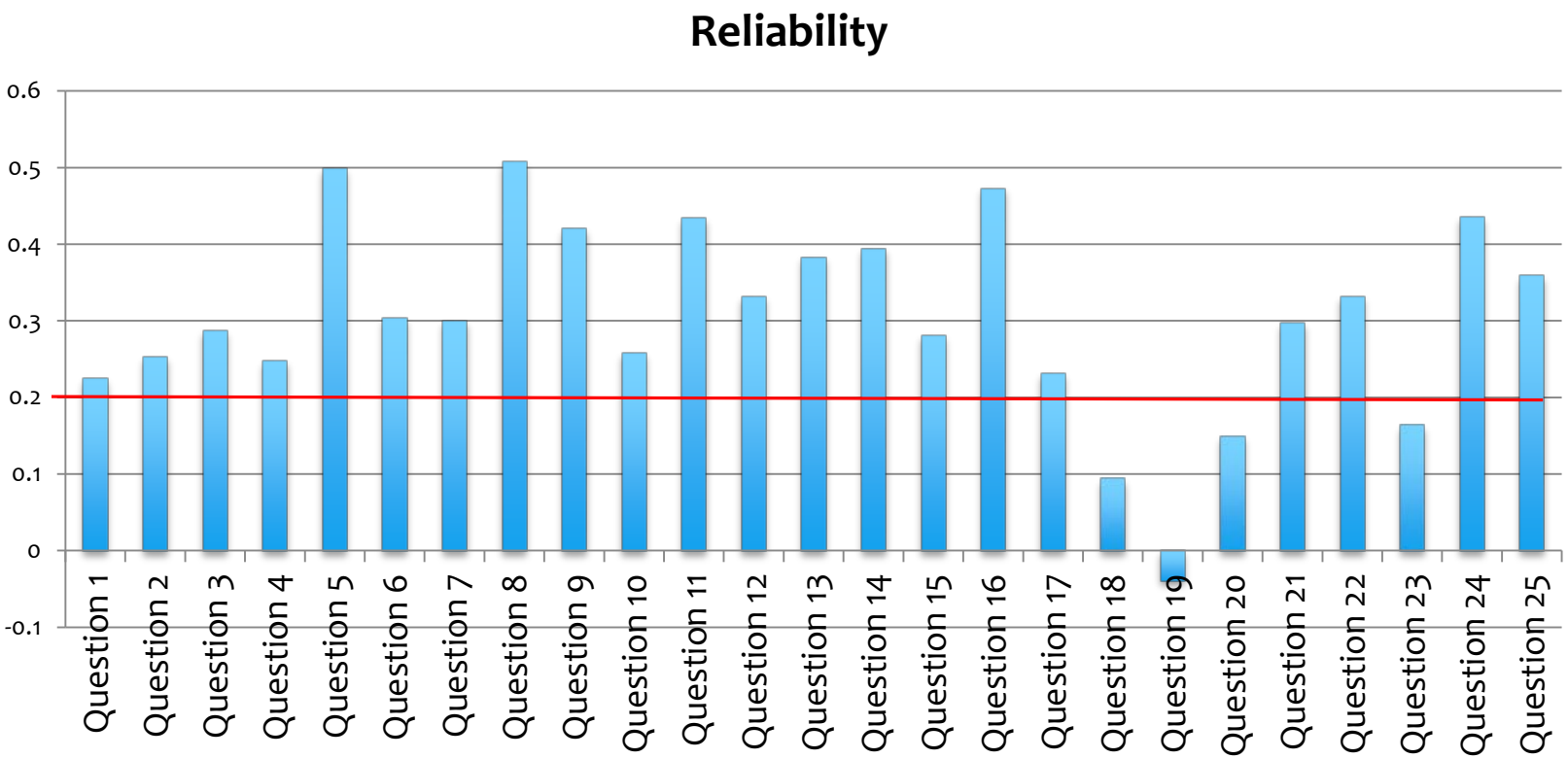
Administer to classes and run statistical tests on the results.



Psychometric Analysis: Item analysis

* **Difficulty Index (P)**- How hard was the question?
* **Discrimination Index (D)**- Measures discriminatory power of each question. Students that do well on the entire test should answer the question correctly compared with students who do poorly.
* **Reliability (Point biserial coefficient)** Measures consistency of a single question with the whole test. Did students who answered this question correctly do better on the whole test?

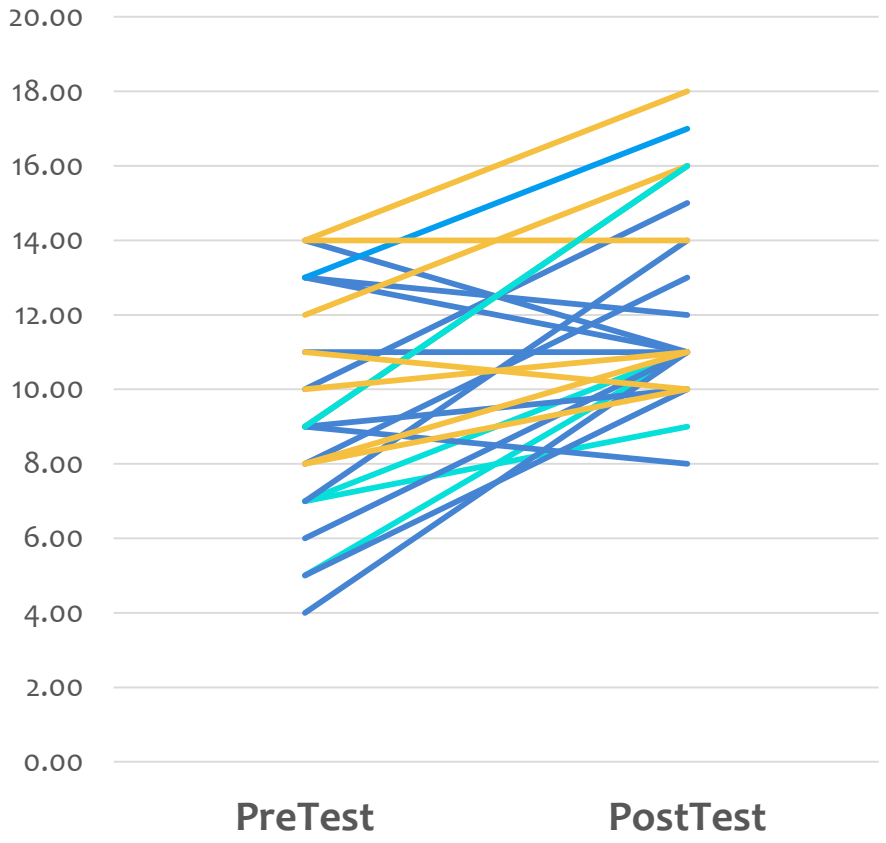
How to find a troublesome question?

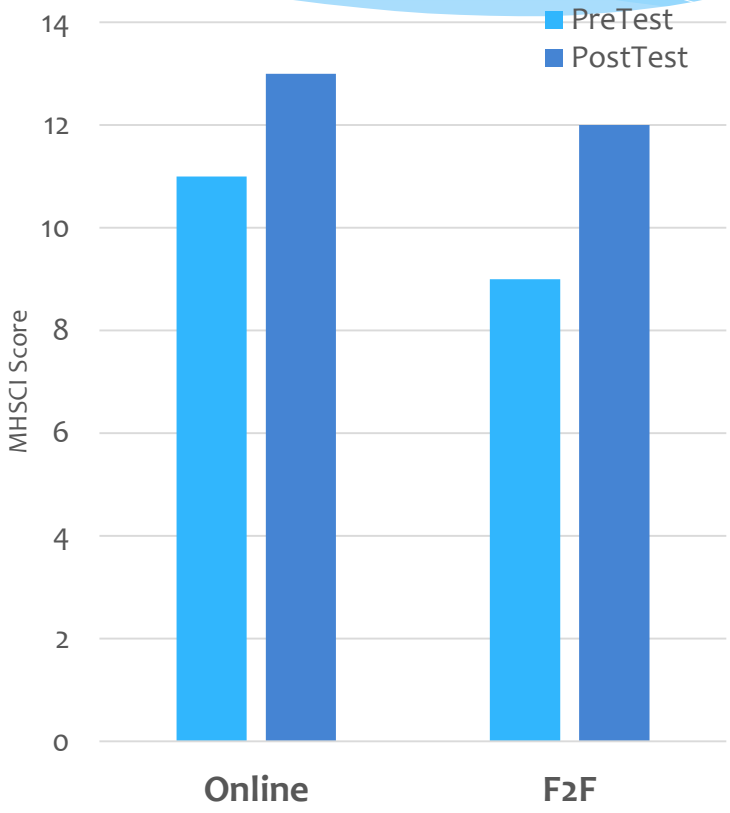


Course Level Assessment

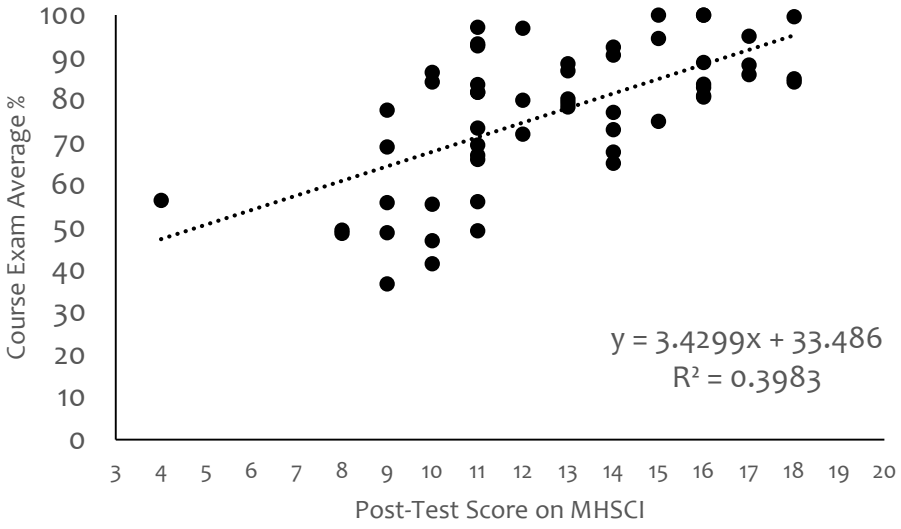
* Images are powerful.
* Prepare for class or modify classroom strategy.
* Metacognition.
* Individualized study plan.

Course Level Assessment

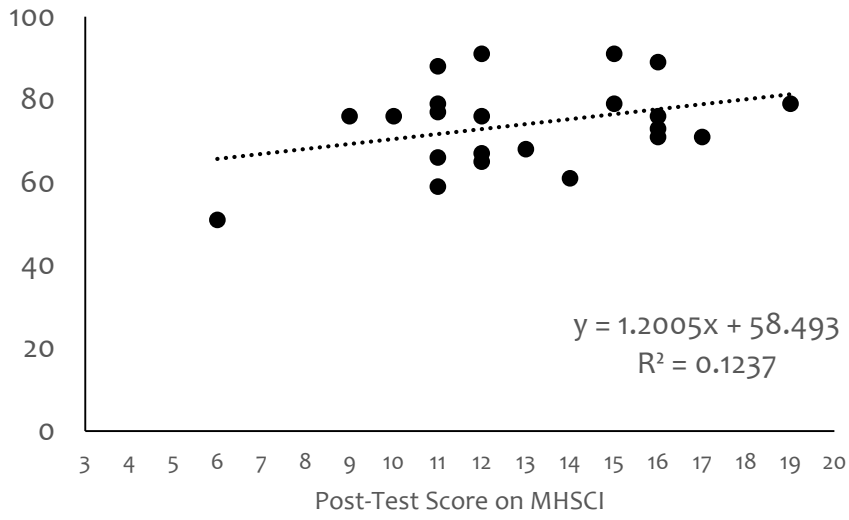




Faculty Learning Community



Instructor #1



Instructor #2

1. Are students making significant progress in a course?

Compare pre and post scores

Course	Pre	Post	Sig.
General Microbiology - BSCI223/Fall 2006 (N=109, 16 questions)	31.1±15.6	48.1±16.9	<.001***
General Microbiology - BSCI223/Spring 2007 (N=127, 16 questions)	31.9±15	44.2±19.4	<.001***
General Microbiology - BSCI223/Fall 2008 (N=90, 18 questions)	26.1±15.6	47.1±16.2	<.001***
General Microbiology - BSCI223/Spring 2009 (N=107, 17 questions)	30.1±14.8	49.1±14.1	<.001***

3. Are students retaining concept knowledge?
Compare post score to pre score

Course	Pre	Post	Sig.
General Microbiology - BSCI223/Fall 2006 (N=109, 16 questions)	31.1±15.6	48.1±16.9	<.001***
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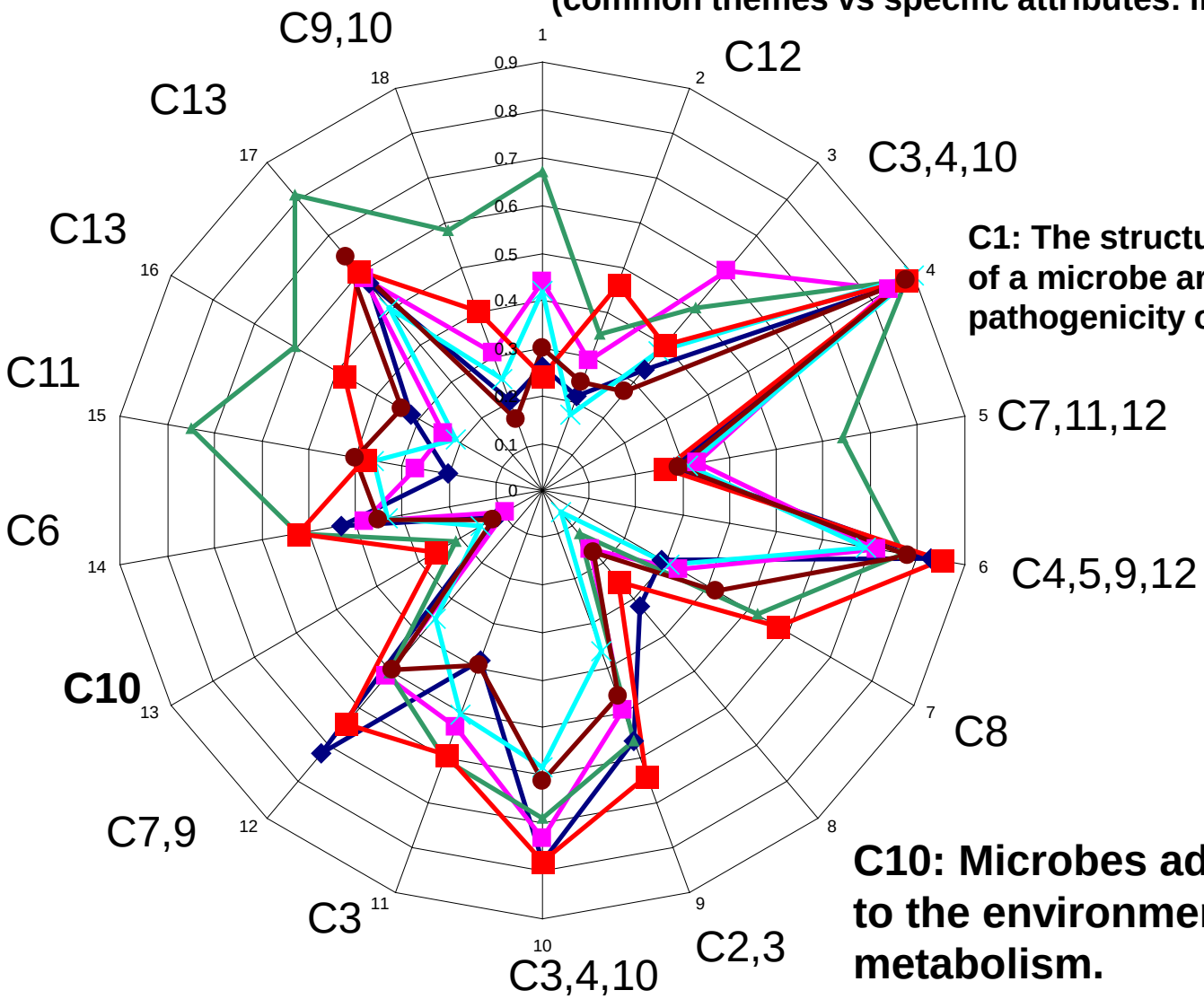
Immunology Lecture - BSCI422/Spring 2007 (N=48, 16 questions)	59.9±19.4	64.3±21.9	<.05*
Immunology Lecture - BSCI422/Spring 2008 (N=53, 18 questions)	53.7±16.9	56.6±17.8	.132
Immunology Lecture - BSCI422/Spring 2009 (N=31 , 17 questions)	58.8±15.7	61.6±16.4	.572

4. Are students making progress in all concepts?

C2: Diverse microbes use common themes to interact with the environment (host)

C12: Immune response recognizes general properties (common themes vs specific attributes: innate vs adaptive



C1: The structural characteristics of a microbe are important in the pathogenicity of that microbe

C10: Microbes adapt/respond to the environment by altering metabolism.

Look at distractor choices to gain insights for curriculum reform

Spring 2010	223		412		422		425		437		MC	
Number of Students	Pre 207	Post 242	Pre 28	Post 9	Pre 64	Post 56	Pre 45	Post 36	Pre 45	Post 44	Pre	Post 53
Which is _*NOT*_ true about the evolution of antibiotic resistance in bacterial populations? It can be mediated by												
selective growth of bacteria capable of degrading antibiotics	24.6	21.9	28.6	33.3	28.1	25	26.7	27.8	40.0	25.6	21.2	27.5
alterations of a bacterium's genetic material through mutation	6.3	7	3.6	0	9.4	8.9	8.9	8.3	13.3	4.7	8.2	9.8
changes in gene expression that occur in the presence of antibiotics.	**20.8**	**49.2**	**57.1**	**55.6**	**46.9**	**55.4**	**28.9**	**50**	**31.1**	**44.2**	**16.5**	**33.3**
modification of a bacterium's genome through uptake of new genetic information	12.1	11.2	3.6	0	6.3	8.9	22.2	11.1	8.9	11.6	16.5	21.6
I do not know the answer to this question.	35.7	10.7	7.1	11.1	9.4	1.8	11.1	2.8	6.7	14	31.8	7.8

Thank You!

AMERICAN SOCIETY FOR MICROBIOLOGY

Microbiology for Health Sciences Concept Inventory

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Microbiology Concept Inventory

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