

Along the Continuum: A Discussion of Standards and Expectations

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Introduction:

Recognizing the importance of science knowledge in our society, federal education legislature now requires states to implement science testing at specific grade levels through the K-12 continuum. But the NAEP science assessment results of 2005 showed that more than 40 percent of 8th and 11th graders did not meet the basic level.

Are the science standards that have been set by the states and by NAEP realistic for the various grade levels? Do they emphasize the most important science ideas?

Do they place enough emphasis on critical response skills, on analytical or quantitative reasoning, on inquiry skills?

How well are the K-12 standards articulated with university-level studies in science? How can university faculty become more aware of the expectations now being placed on students in the middle and high school grades?

How can K-12 teachers prepare their students for success on state and national assessments and at the same time ensure that they will meet with success in college?

Focus Questions for the Session:

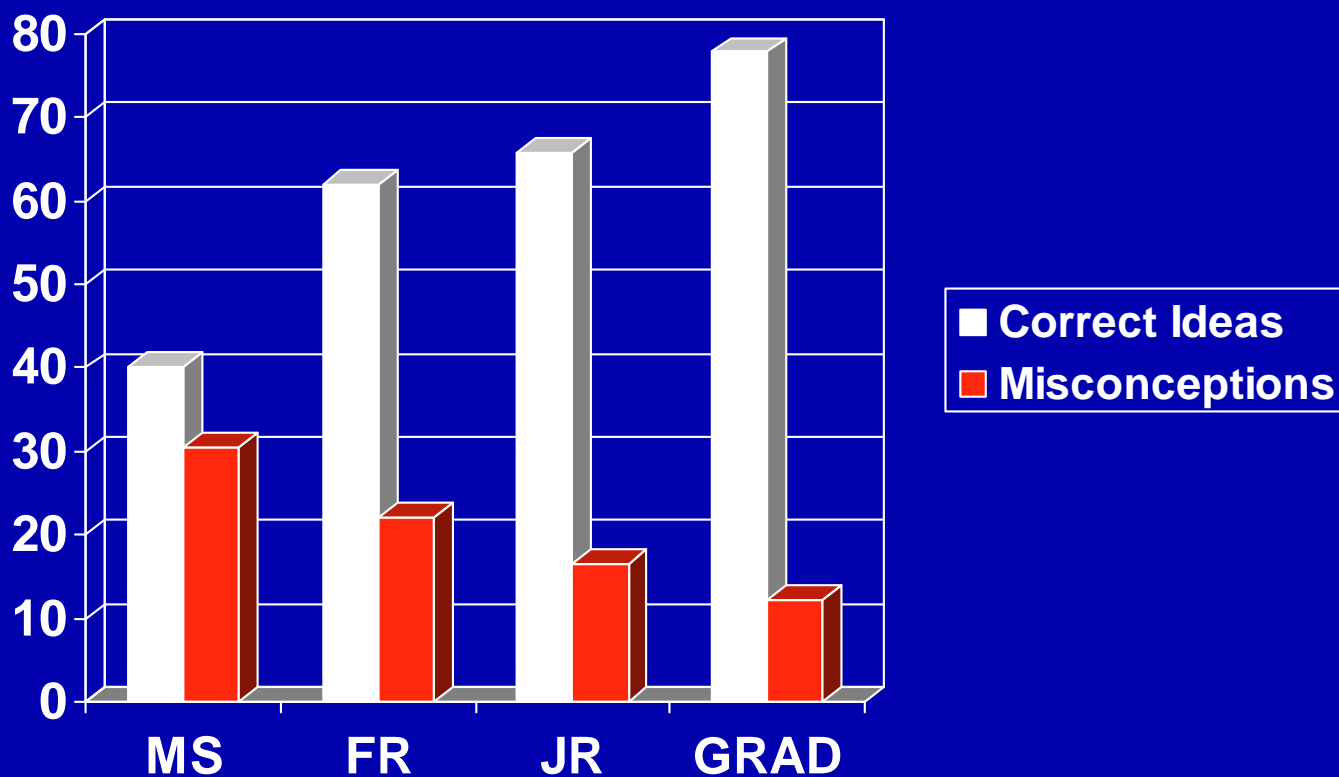
- What do middle school students know about key science ideas in chemistry and the application of those ideas to living systems?
- What do entering college students know about key science ideas in chemistry and the application of those ideas to living systems?
- How much do college and university faculty know about the middle school and high curriculum, what students are actually learning, and what misconceptions they still have when they get to college?
- What do college faculty think are some of the most important ideas students should be learning in middle and high school to prepare them for college.
- How can college and university faculty become more aware of the expectations now being placed on middle and high school students?

Some things middle school students are expected to know (statements are from *Benchmarks for Science Literacy*, AAAS, 1993)

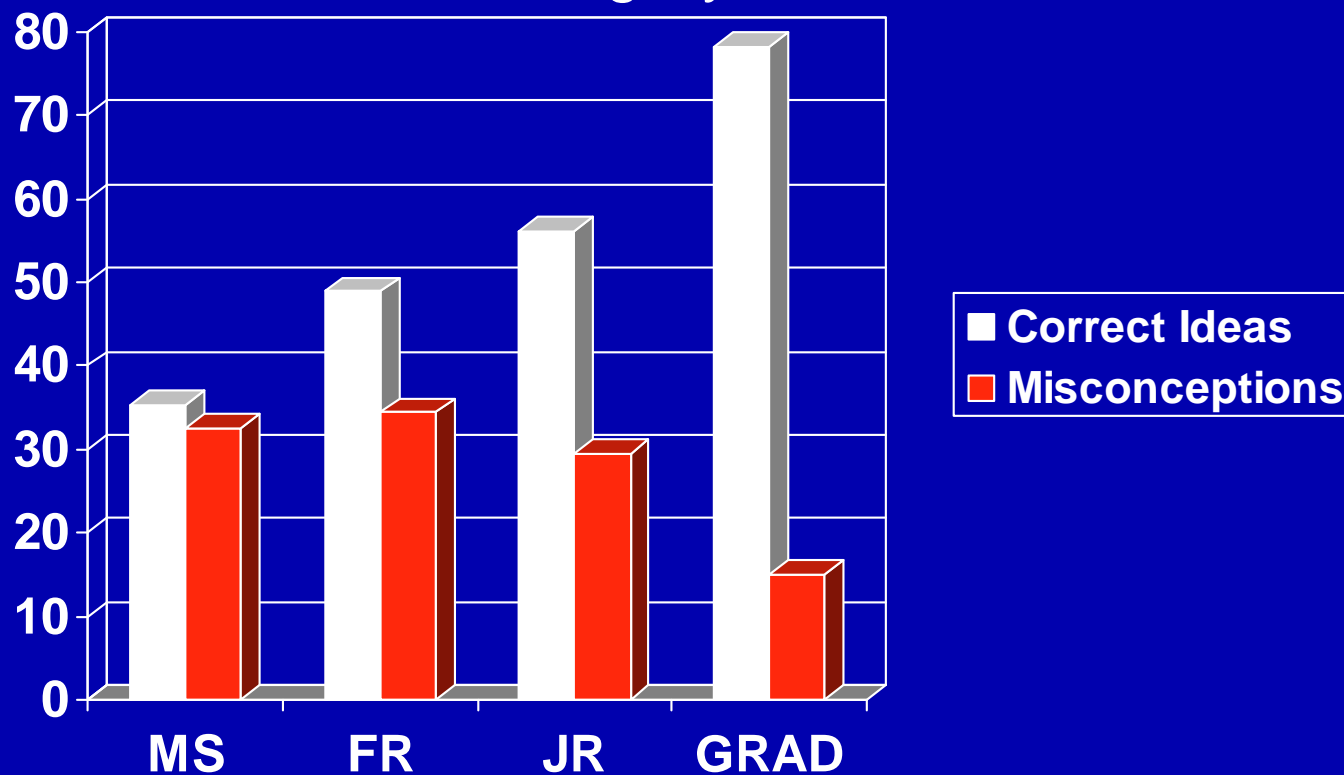
- No matter how substances within a closed system interact with one another, or how they combine or break apart, the total mass of the system remains the same.
- The idea of atoms explains the conservation of matter: If the number of atoms stays the same now matter how the atoms are rearranged, then their total mass stays the same.
- The idea of atoms explains chemical reactions: When substances interact to form new substances, the atoms that make up the molecules of the original substances combine in new ways.
- Food provides molecules that serve as fuel and building material for all organisms.
- Plants use the energy from light to make [food in the form of] sugars from carbon dioxide and water.

- When do students actually learn these ideas?

Progression of Understanding and Common Misconceptions for the Topic of Chemical Reactions



Progression of Understanding and Common Misconceptions for the Topic of Matter and Energy in Living Systems



Middle School Sample

N=3337 (Students of randomly selected volunteer teachers from the NSTA Building a Presence Database)

Male 49.0%; Female 51.0%

English is Primary Language 89.6%

6th Grade 25.1%; 7th Grade 42.9%; 8th Grade 32.0%

Race and Ethnicity:

White 53.1%

Hispanic or Latino 14.2%

Black 11.1%

Asian 4.2%

American Indian or Alaskan Native < 1.0%

Other 17.4%

Entering College Students

N=474 (Students enrolled in one section of Introduction to Chemistry and one section of Pre-Chem)

Male 42.0%; Female 58.0%

SATV 474.2; SATM 502.7

Year in School

First Year	83.5%
Sophomore	8.9%
Junior	5.1%
Senior	1.3%
Graduate	<1.0%

Race and Ethnicity

Native American	<1.0%
African American	19.4%
Asian	19.8%
Hispanic	4.2%
Caucasian	44.7%
Other	8.6%
No Response	2.7%

Upper Level College Students

N=84 (Students Enrolled in Junior level Chemistry Course: Quantitative Analysis)

Male 45.20%; Female 54.8.0%

SATV 508.8; SATM 565.0

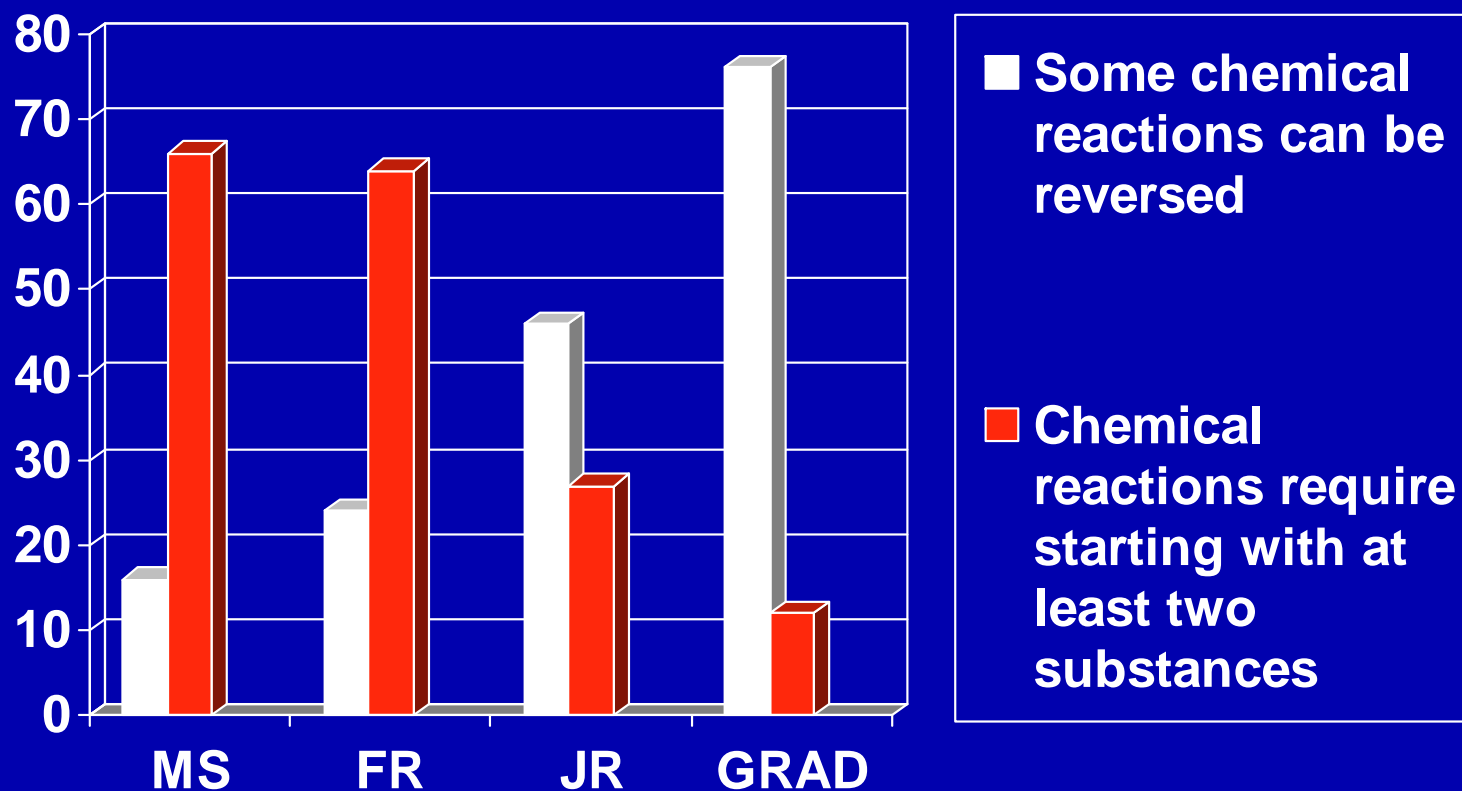
Year in School

First Year	1.2%
Sophomore	13.1%
Junior	59.5%
Senior	25.0%
Graduate	1.2%

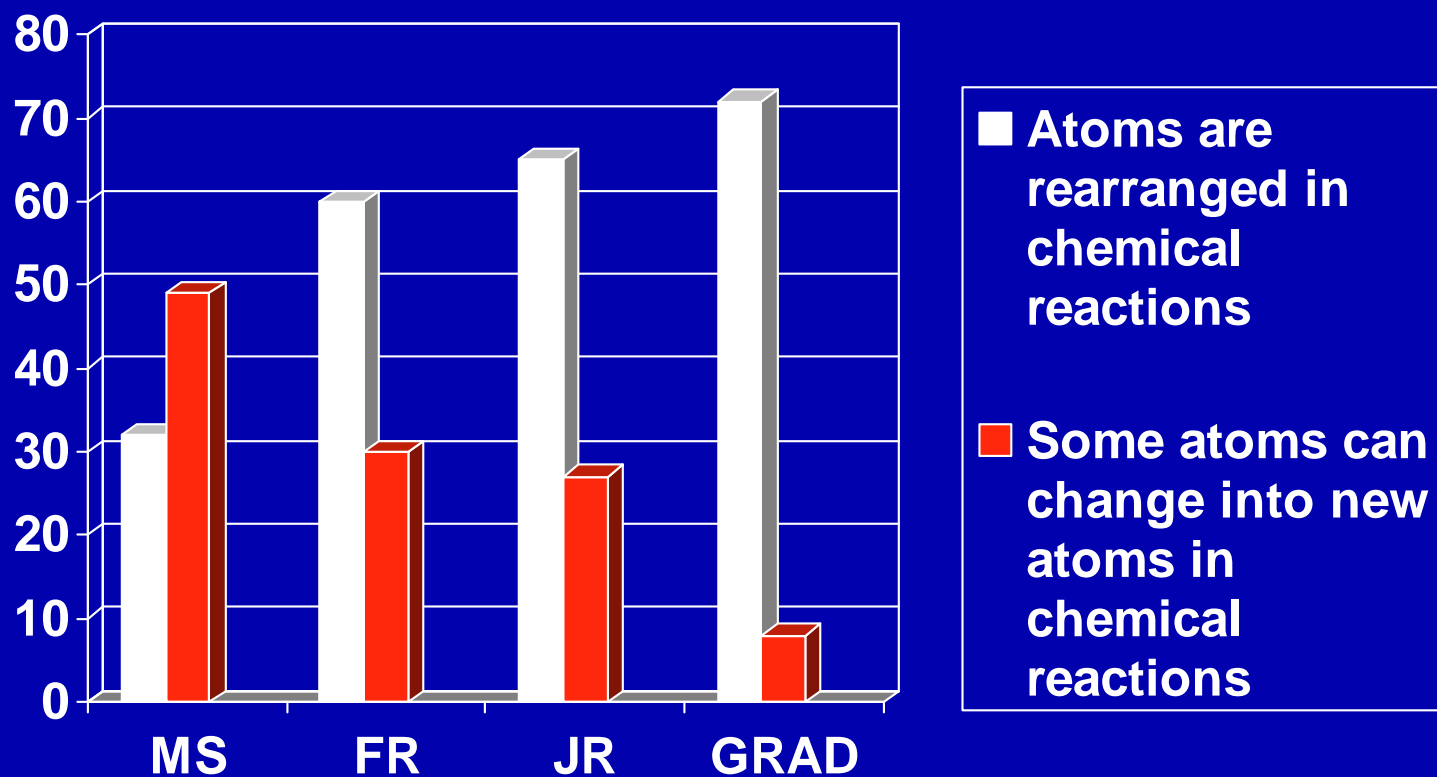
Race and Ethnicity

Native American	<1.0%
African American	15.5%
Asian	36.9%
Hispanic	2.4%
Caucasian	34.5%
Other	4.8%
No Response	2.7%

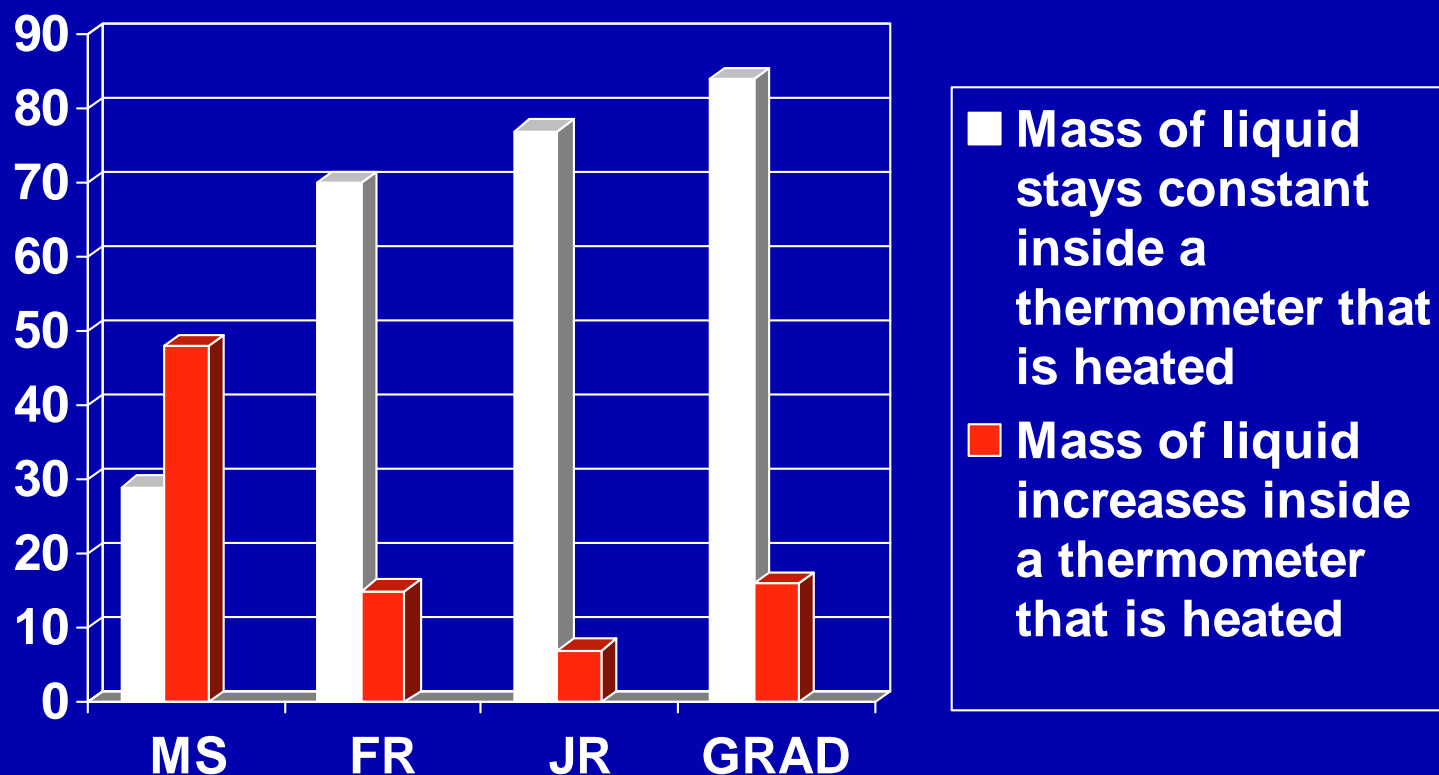
The Nature of Chemical Reactions



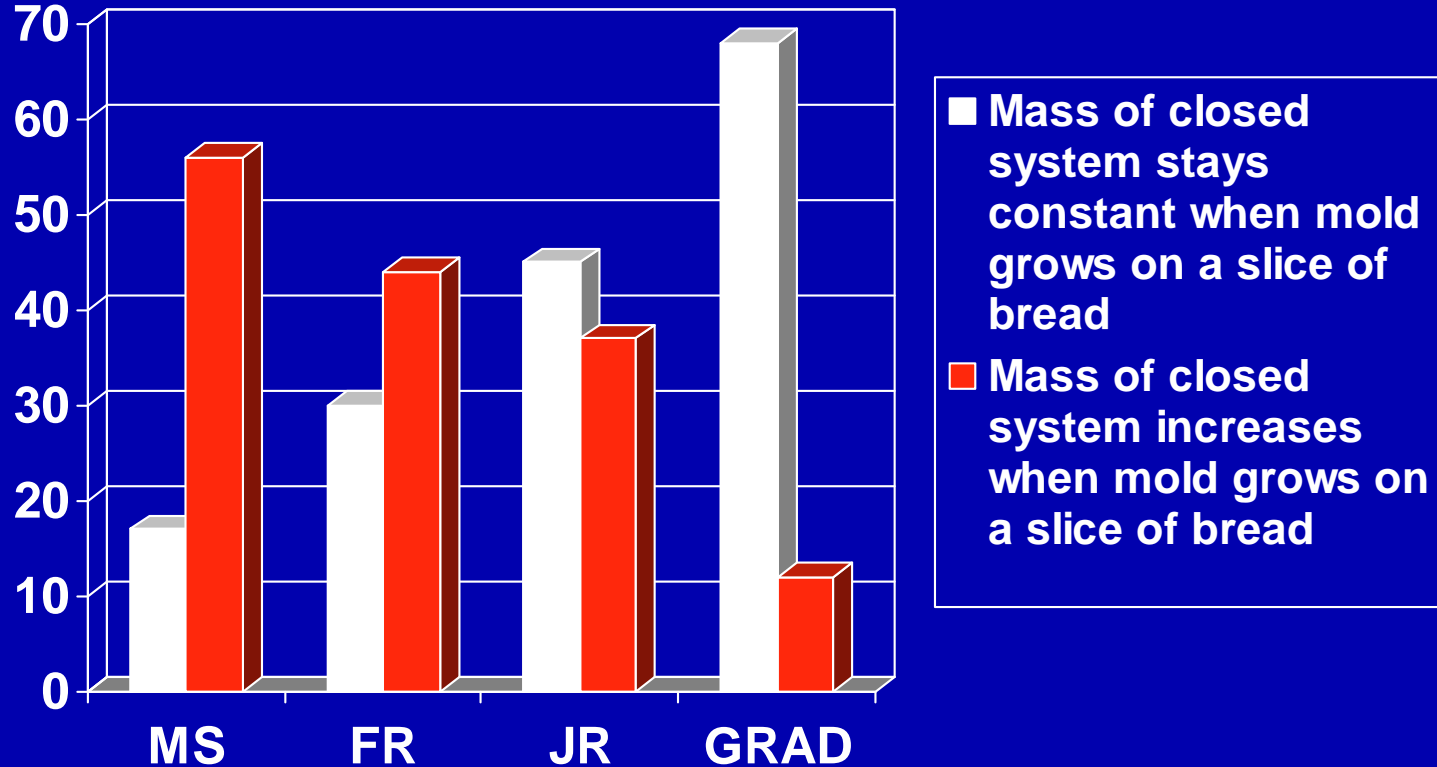
The Nature of Chemical Reactions



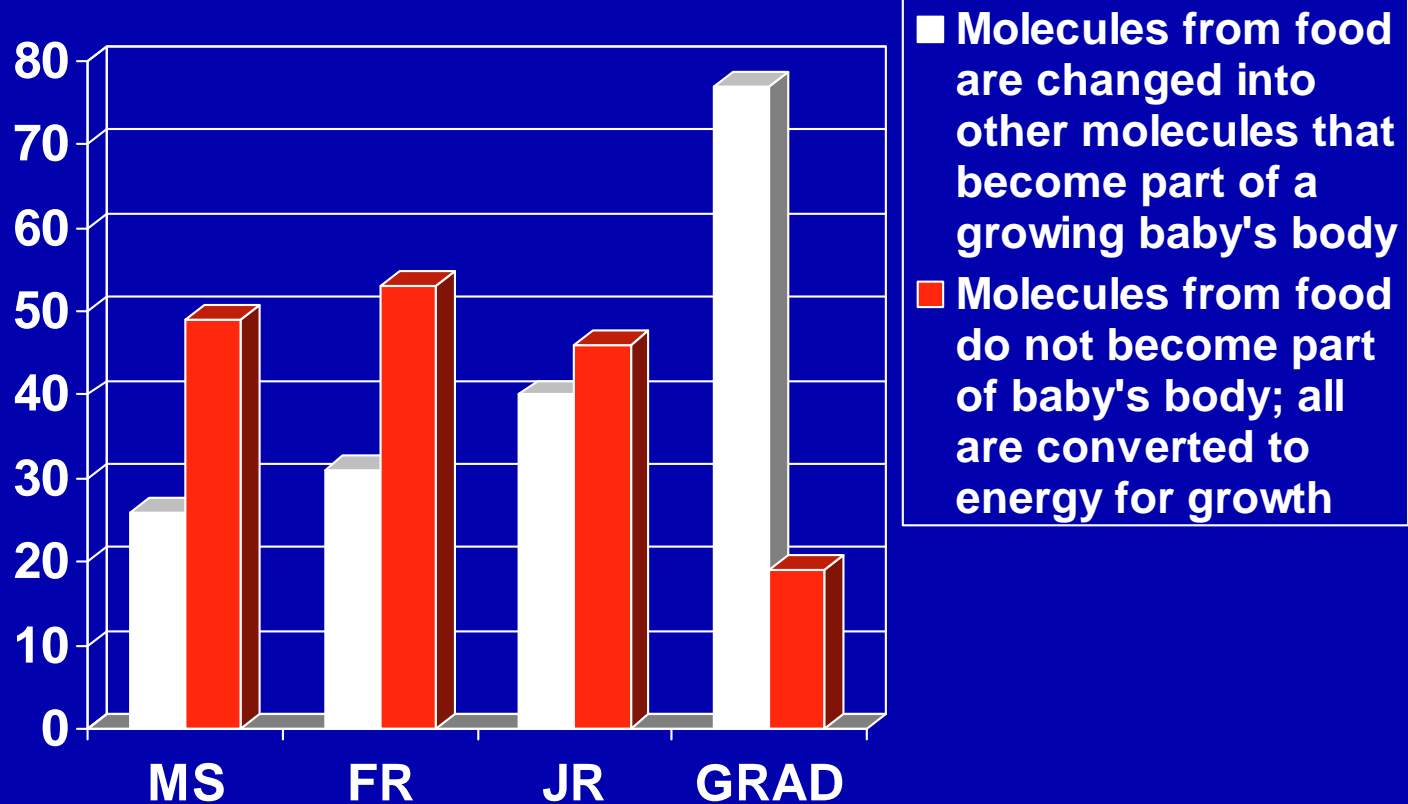
Conservation of Matter: Substance Level



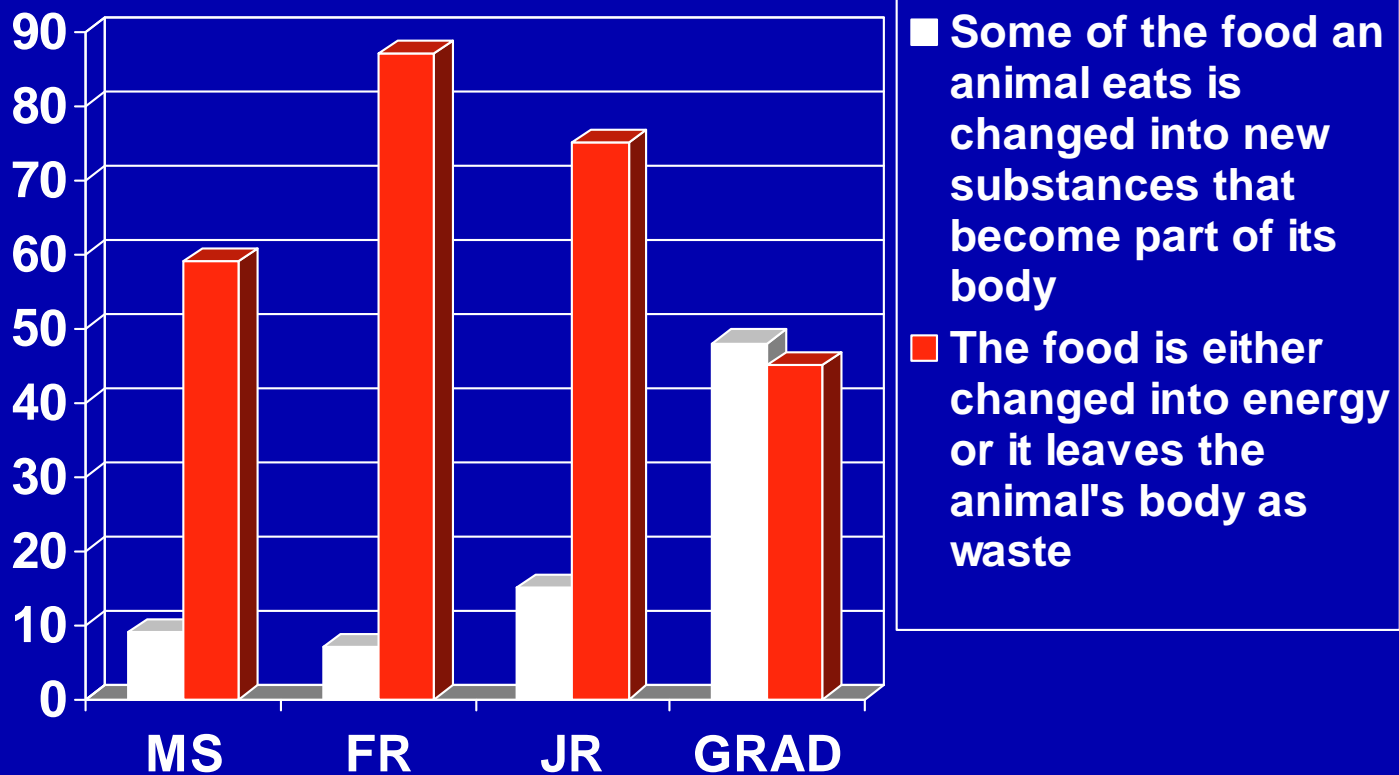
Conservation of Matter: Substance Level



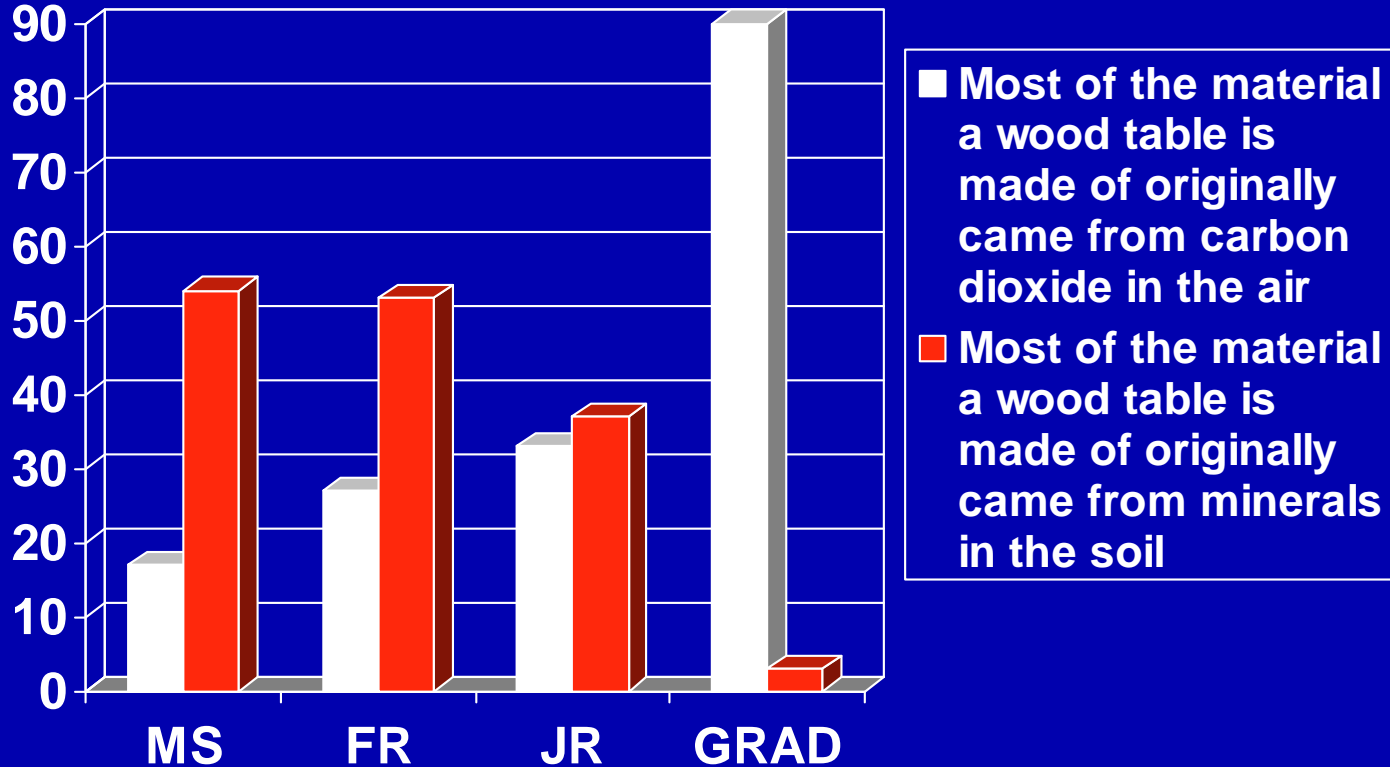
Molecules From Food Used for Growth



Food Used for Growth of Body Structures



Wood Comes from Carbon Dioxide in the Air



How do University and Community College faculty view the academic credentials of their freshmen?

Who are the faculty?

Teaching Expertise	Temple University Participants	Community College of Philadelphia Participants
Chemistry	7	11
Biology	6	8
Physics	4	0
Earth Science	0	1
Biochemistry	1	1
Engineering	0	1
Science Education	1	0
Mathematics	0	4

How do the faculty view the student's preparation for college?



	Science Content		Reading Skills		Quantitative Skills	
	Temple	CCP	Temple	CCP	Temple	CCP
Excellent	0	1	0	0	0	1
Very Good	1	1	0	3	0	1
Acceptable	9	10	11	7	6	6
Fair	3	10	6	13	9	6
Poor	6	4	2	3	4	12

Average faculty performance by subject area for selected PSSA test items

Content Area	Number of Items	Percent Correct
Astronomy	4	61
Biology	8	75
Physics	5	56
Methodology	2	71
Physical Science	3	89
Chemistry	3	81

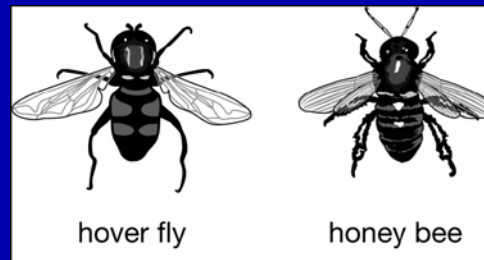
Content Covered & Mastery Level

Question #	Correct Answer		Question #	Correct Answer	
	Content	Level		Content	Level
1	Astronomy	11 th grade	14	Biology	11 th grade
2	Astronomy	11 th grade	15	Biology	8 th grade
3	Astronomy	11 th grade	16	Physics	8 th grade
4	Astronomy	4 th grade	17	Physics	8 th grade
5	Biology	4 th grade	18	Physics	8 th grade
6	Physics	4 th grade	19	Physical Science	8 th grade
7	Biology	4 th grade	20	Physical Science	11 th grade
8	Biology	4 th grade	21	Chemistry	11 th grade
9	Scientific Method	8 th grade	22	Chemistry	11 th grade
10	Physical Science	4 th grade	23	Chemistry	11 th grade
11	Scientific Method	8 th grade	24	Biology	11 th grade
12	Biology	8 th grade	25	Physics	11 th grade
13	Biology	11 th grade			

Sample Question

A hover fly looks like a honey bee. Which statement best explains how this adaptation helps the hover fly survive? (see below)

- A Looking like a honey bee keeps other animals away from the hover fly's food.
- B Looking like a honey bee allows the hover fly to collect more pollen.
- C Looking like a honey bee allows the hover fly to blend with its environment.
- D Looking like a honey bee keeps some predators from trying to eat the hover fly.**
- E I do not know.



This question represents material that should be mastered at what grade level?

- F 4th Grade**
- G 8th Grade
- H 11th Grade
- I University Level

Distribution of Scores on the Content Section

Number Correct	# of Faculty with this Score	% of Faculty with this Score or Less
12	2	4.4
13	3	11.1
14	1	13.3
15	4	22.2
16	1	24.4
17	4	33.3
18	2	37.8
19	10	60.0
20	3	66.7
21	6	80.0
22	2	84.4
23	4	93.3
24	3	100
25	0	-
Mean = 17.84		

Distribution of Scores on the Levels Section

Number Correct	# of Faculty with this Score	% of Faculty with this Score or Less	Number Correct	# of Faculty with this Score	% of Faculty with this Score or Less
> 5	2	4.4	12	0	-
5	1	6.5	13	8	84.8
6	2	10.9	14	4	95.7
7	3	17.4	15	0	-
8	5	28.3	16	1	95.7
9	4	37.0	17	1	97.8
10	6	50.0	18	0	-
11	8	67.4	19	1	100
Mean = 10.41					

Do faculty understand state standards?

	Option Chosen					Level Chosen			
	A	B	C	D	E	4 th	8 th	11 th	Univ.
Q1.	7	1	20*	0	17	4	9	14*	18
Q2.	0	3	6	18*	18	0	7	17*	21
Q3.	4	25*	1	5	10	4	13	19*	9
Q4.	37*	3	5	0	0	29*	14	1	0
Q5.	1	1	1	41*	1	10*	22	13	0
Q6.	2	39*	3	0	1	1*	22	22	0
Q7.	0	44*	0	0	1	27*	14	4	0
Q8.	2	40*	1	3	0	19*	25	1	0
Q9	37*	0	0	5	3	9	23*	11	2
Q10	2	0	40*	1	2	19*	18	7	1
Q11.	1	7	9	27*	1	16	22*	6	1
Q12.	1	8	3	31*	2	2	20*	20	3
Q13.	1	28*	4	3	9	0	12	26*	7

Do faculty understand state standards?

	Option Chosen					Level Chosen			
	A	B	C	D	E	4 th	8 th	11 th	Univ.
Q14.	2	1	5	24*	13	1	9	19*	14
Q15.	1	35*	0	0	9	3	16*	17	8
Q16.	1	30*	4	1	10	0	4*	28	13
Q17.	1	1	25*	5	14	1	6*	22	15
Q18.	2	4	38*	0	1	2	15*	25	3
Q19.	0	44*	0	1	0	4	25*	14	1
Q20.	1	1	36*	5	2	0	22	19*	4
Q21.	40*	0	1	1	3	0	9	27*	9
Q22.	0	0	14	31*	0	0	17	24*	4
Q23.	1	39*	2	0	3	2	9	21*	12
Q24.	31*	0	12	0	2	0	11	25*	8
Q25.	0	0	41*	2	2	2	14	25*	4

Relationship between content and level

	Level Chosen by Those with Correct Answer				Level Chosen by Those with Incorrect Answer or I don't know			
	4 th	8 th	11 th	Univ.	4 th	8 th	11 th	Univ.
Q1.	2	4	7	6	2	5	7	12
Q2.	0	3	10	5	0	4	7	16
Q3.	1	7	11	5	3	6	8	4
Q4.	25	9	1	1	4	5	0	0
Q5.	10	20	10	0	0	2	3	0
Q6.	1	17	20	0	0	5	2	0
Q7.	26	13	4	0	1	1	0	0
Q8.	17	22	0	0	2	3	1	0
Q9.	8	18	9	1	1	5	2	1
Q10.	18	15	5	1	1	3	2	0
Q11.	9	16	2	0	7	6	4	1
Q12.	2	14	13	1	0	6	7	2
Q13.	0	8	18	1	0	4	8	6

Relationship between content and level

	Level Chosen by Those with Correct Answer				Level Chosen by Those with Incorrect Answer or I don't know			
	4 th	8 th	11 th	Univ.	4 th	8 th	11 th	Univ.
Q14.	1	7	7	9	0	2	12	5
Q15.	2	13	17	2	1	3	0	6
Q16.	0	3	20	6	0	1	8	7
Q17.	0	4	13	6	1	2	9	9
Q18.	2	14	18	3	0	1	7	0
Q19.	4	25	12	1	0	0	2	0
Q20.	0	19	14	2	0	3	5	2
Q21.	0	8	24	7	0	1	3	2
Q22.	0	10	17	3	0	7	7	1
Q23.	2	8	17	11	0	1	4	1
Q24.	0	9	19	2	0	2	6	6
Q25.	1	14	23	2	1	0	2	1

Return to the Focus Questions:

- What do middle school students know about key science ideas in chemistry and the application of those ideas to living systems?
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