Maximizing Student Performance in Lecture By Providing Clear Expectations

David Wren, PhD
Assistant Teaching Professor and Director of the Chemistry Center
Department of Chemistry

Workshop Learning Outcomes

- Be able to clearly articulate your expectations of your student and assumptions on which these expectations are based

- Learn strategies to communicate your expectations to your students

- Learn strategies to obtain information about student expectations and ways to maximize overlap with your own expectations

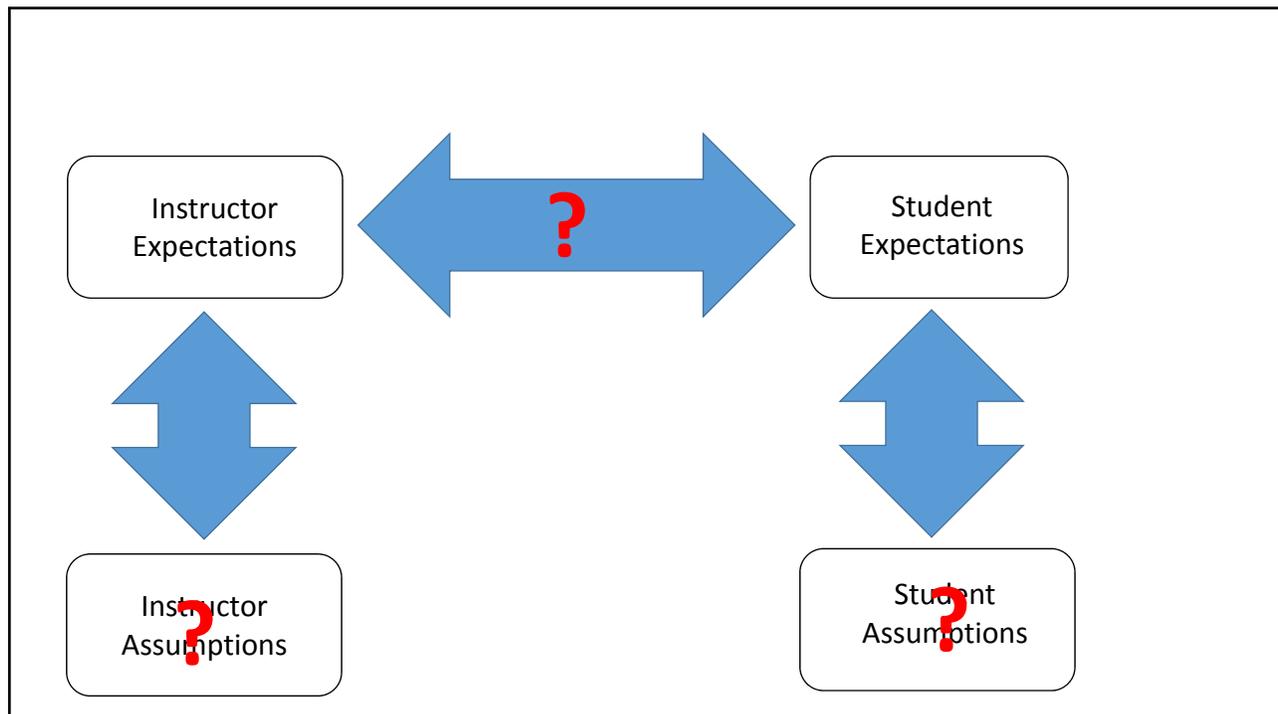- Obtain understanding of the importance of having student know expectations and rational for these expectations
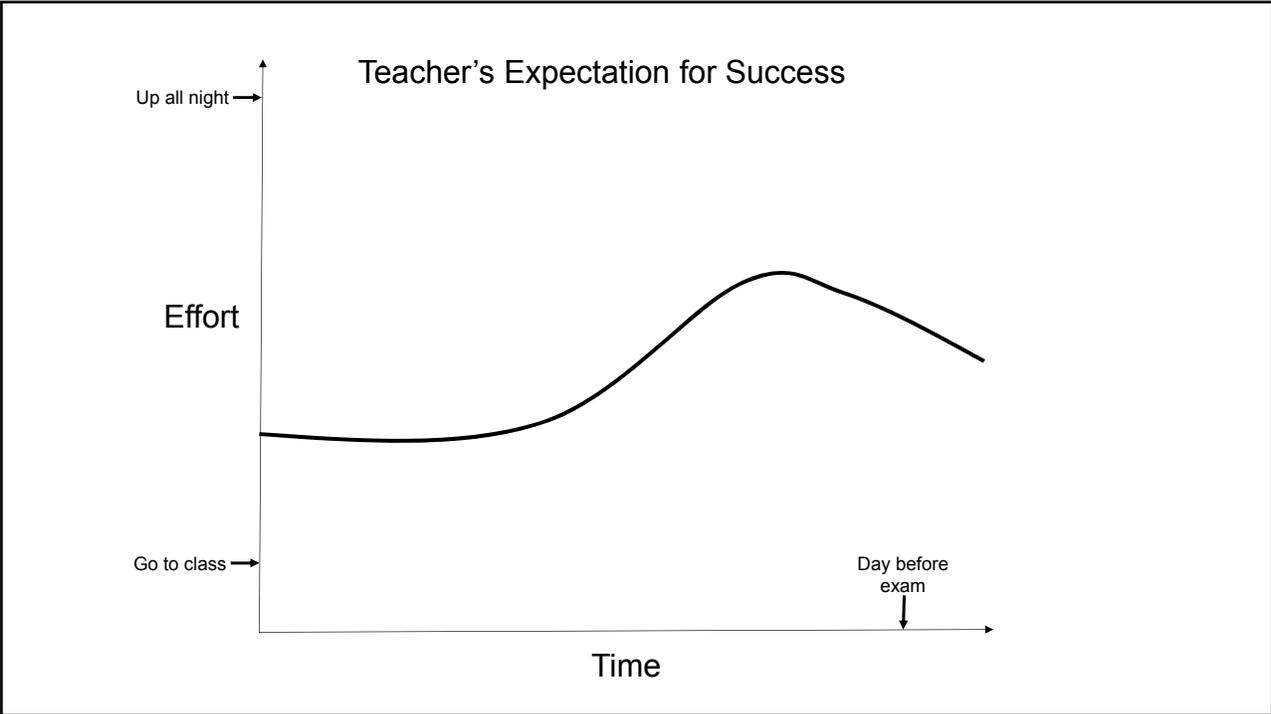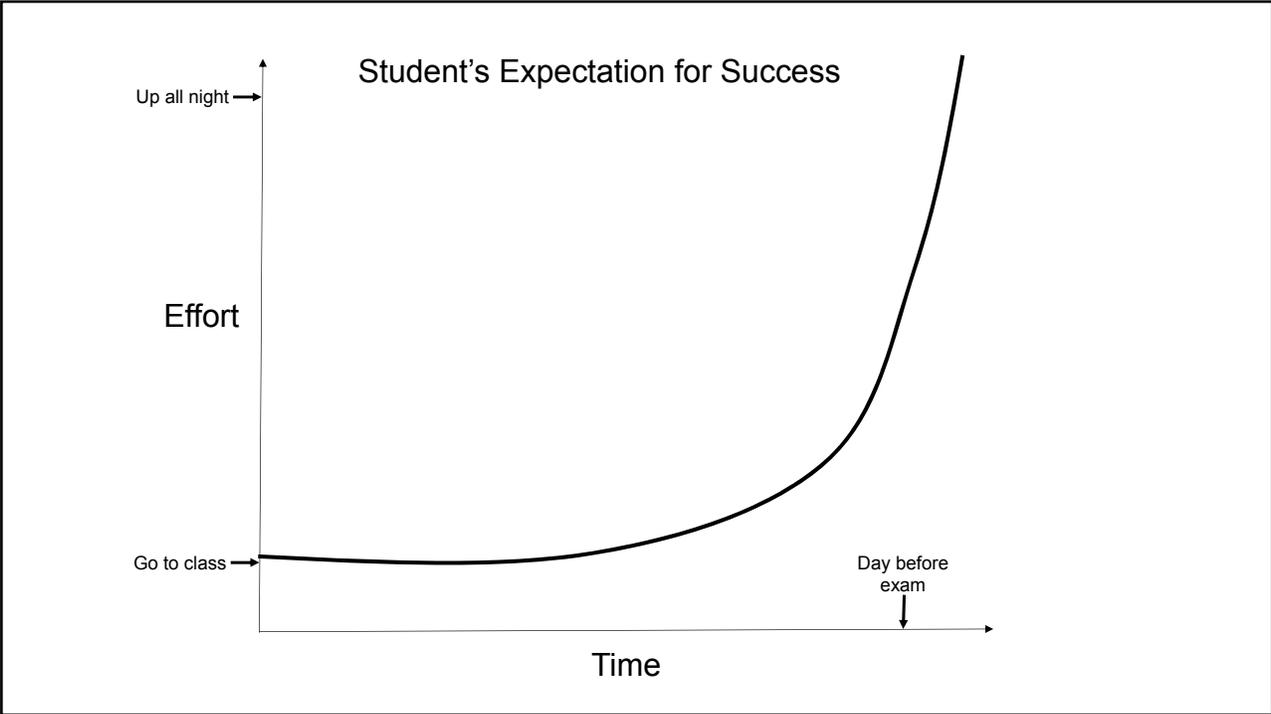
What Factors Affect PERFORMANCE?

Cognitive Factors
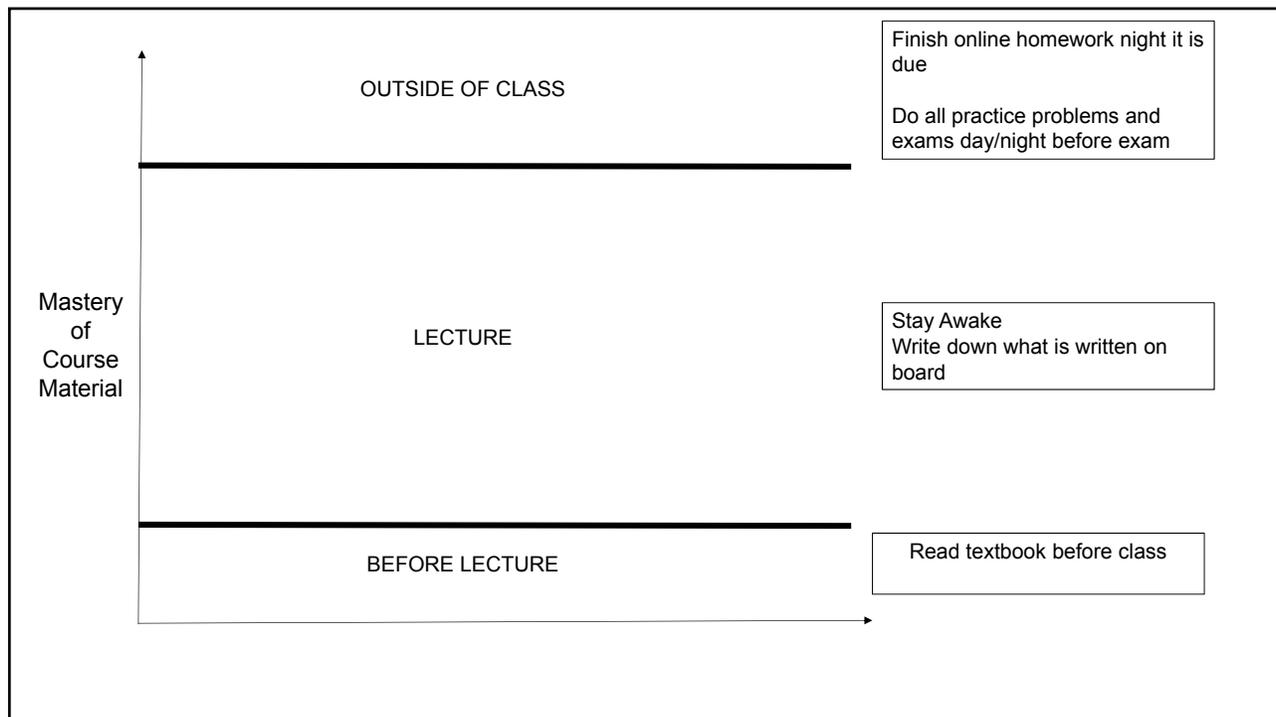> Content knowledge
> Ability to apply content knowledge

Affective Factors
> Attitude
> Motivation
> Self-Concept

Student's Expectation for Success

Up all night →

Effort

Go to class →

Day before exam

Time

Teacher's Expectation for Success

Up all night →

Effort

Go to class →

Day before exam

Time

OUTSIDE OF CLASS

Finish online homework night it is due

Do all practice problems and exams day/night before exam

Mastery of Course Material

LECTURE

Stay Awake
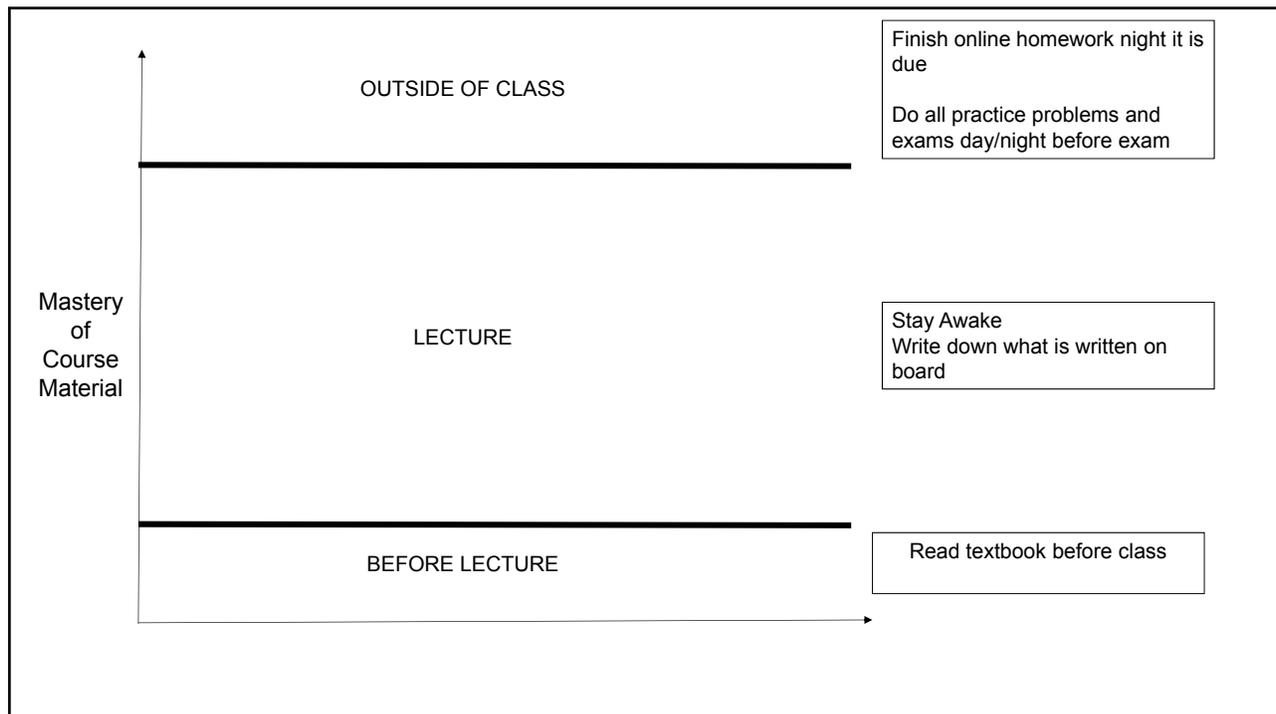Write down what is written on board
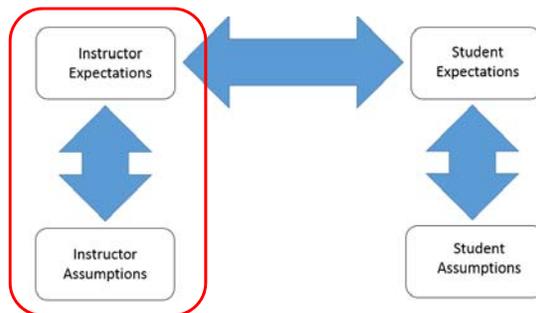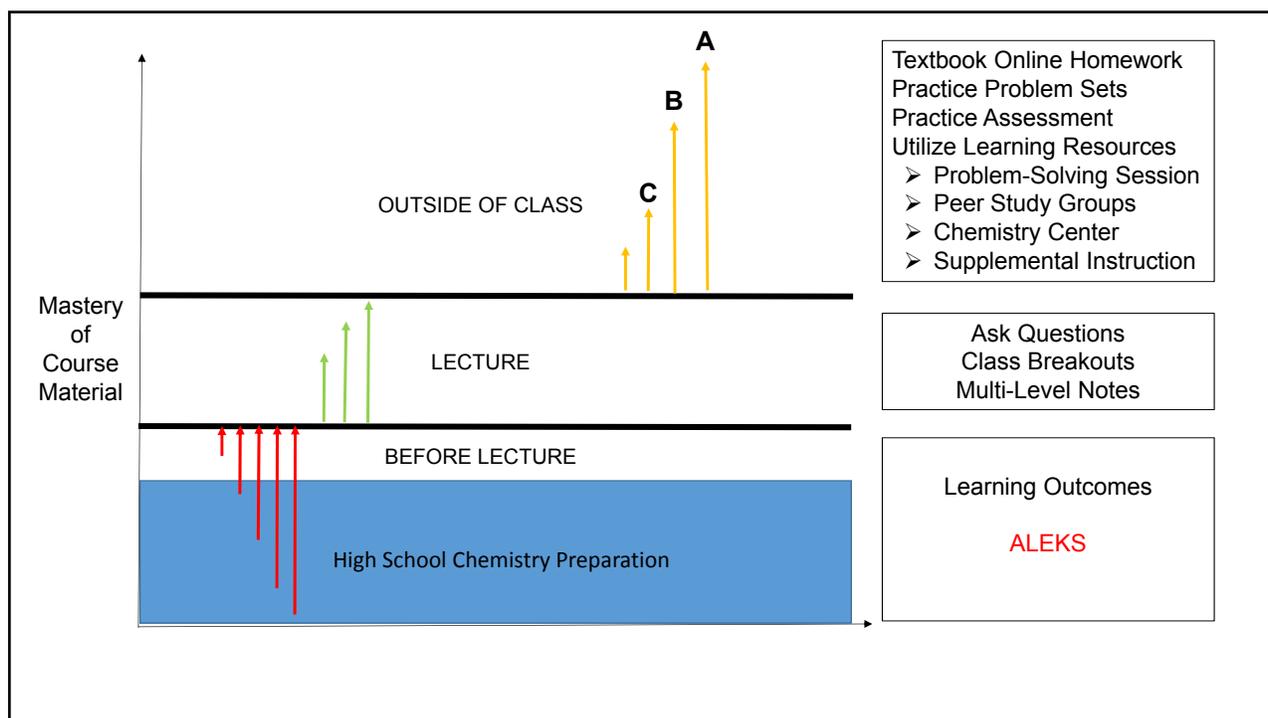
BEFORE LECTURE

Read textbook before class

➢ What are some expectations your **students** have at the beginning of your courses?

➢ On what assumptions are these expectations based?

Instructor Expectations

Student Expectations

Instructor Assumptions

Student Assumptions
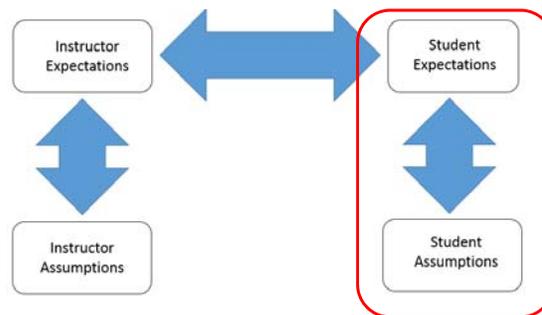
➤ What are some of YOUR expectations of your students at the beginning of your courses?

➤ On what assumptions are these expectations based?

Instructor Expectations	⬌	Student Expectations	
⬍		⬍	
Instructor Assumptions		Student Assumptions	

Mastery of Course Material	OUTSIDE OF CLASS	Finish online homework night it is due Do all practice problems and exams day/night before exam
	LECTURE	Stay Awake Write down what is written on board
	BEFORE LECTURE	Read textbook before class
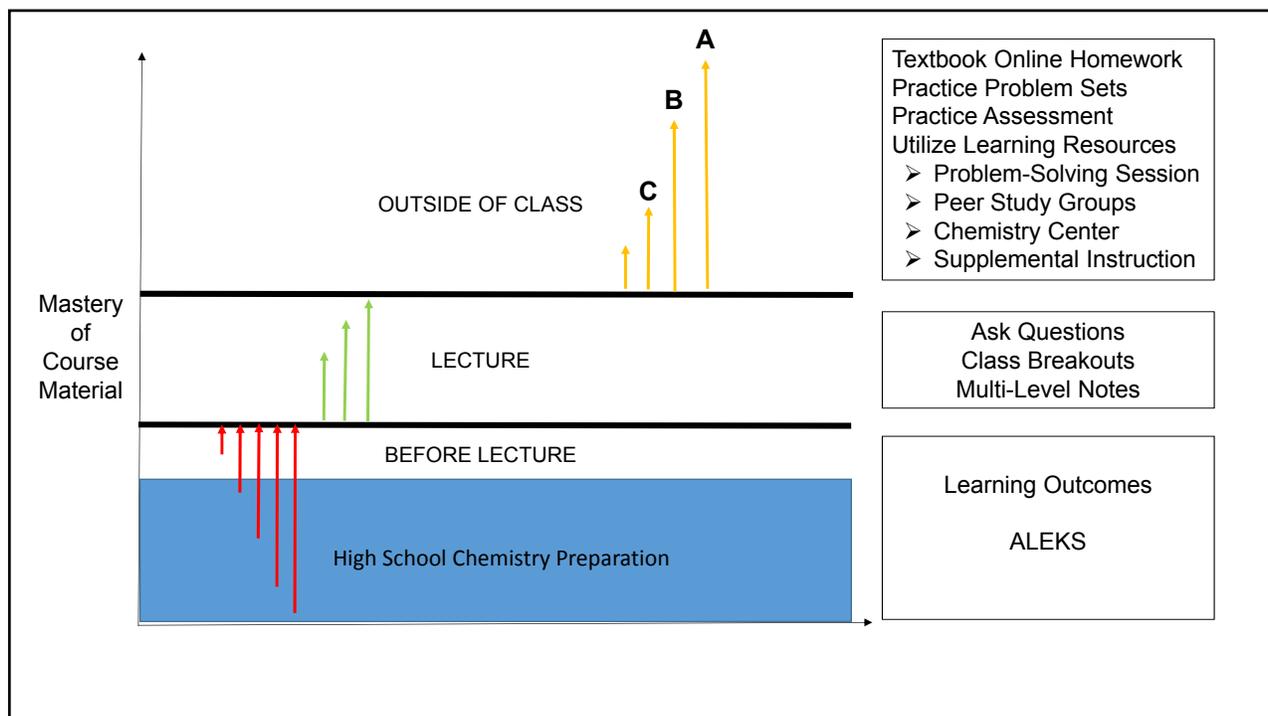
Student Grading Rubric

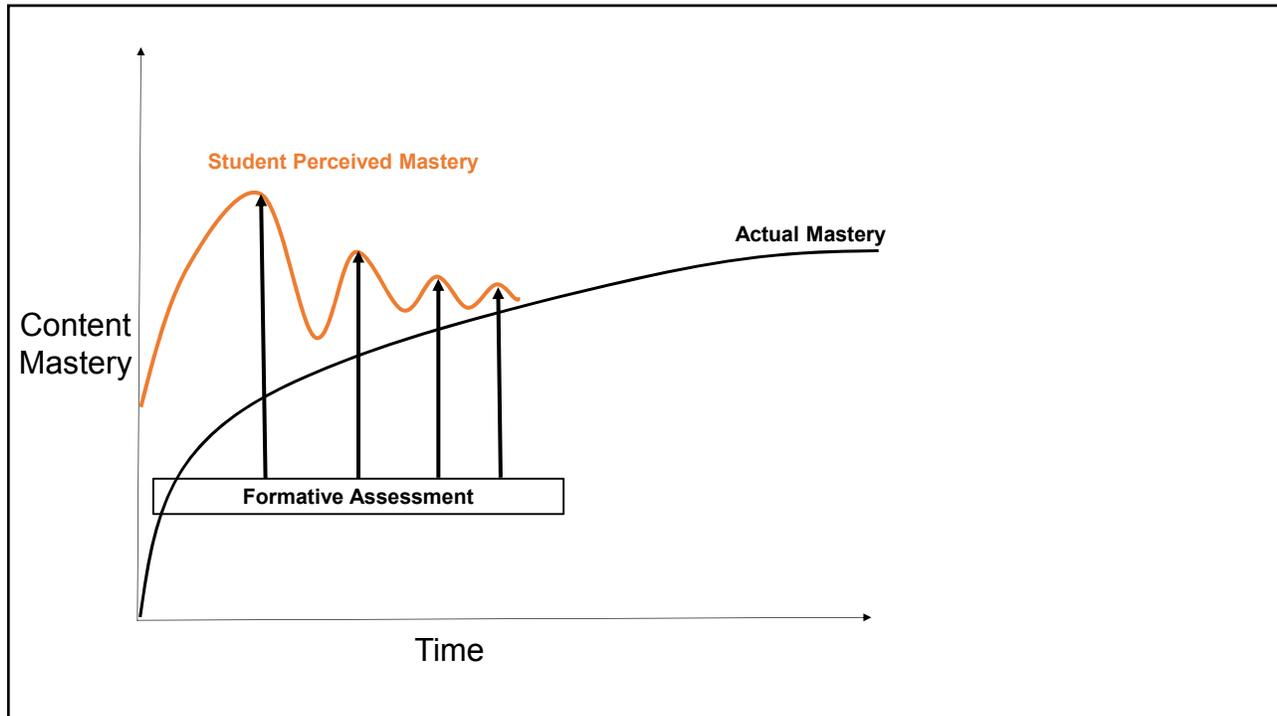| Grade	Measures
"A" Student	**Engagement** • Attends each class, on time ready to learn • Actively avoids digital distractions • Prepares for lecture by complete ALEKS assignments BEFORE content is covered in lecture • Actively participates in class discussion; asks questions when confused • Takes notes in meaningful way, adding to what is written on board • Engages with course material outside of class (peer study groups, Chemistry Center, tutor, etc.) • Attends office hours, problem-solving sessions, seeks out help from instructor when challenged by course material • Completes practice problems and Connect homework AFTER content is covered in lecture **Focus of Learning** • Operational definitions of key terms highlighted in each Chapter • Algorithmic knowledge need for calculations • Conceptual understanding of difficult and abstract concepts • Focuses on concepts related to learning outcomes for each course unit **Performance** • Ability to translate information provided in word problem and use effective strategy to approach and solve chemistry problems • Diligently uses correct units and significant figures • Deep conceptual understanding that integrates multiple concepts from multiple topics • Ability to apply conceptual knowledge to novel situations

---
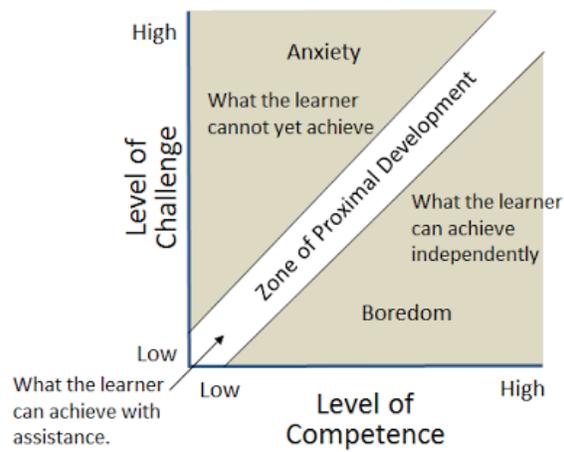
Example of Learning Outcomes for General Chemistry

Chapter 1

Students will:

1.1 Meaningfully memorize operational definitions of key terms in Chapter (those highlighted on side of text pages)

1.2 Have functional relationship between key terms and operational definitions

1.3 Have an understanding of different forms of energy and matter in the context of chemical and physical processes
   a. Know the difference between a physical and chemical process

1.4 Have an understanding of scales used in Chemistry (e.g., Temperature scales)
   a. Know the difference between F, C and K scales, both quantitatively and qualitatively

1.5 Be able to describe the unique information that empirical, chemical, structural, VSEPR structural formulas can provide

1.6 Have a proficiency in determining uncertainty in calculations and reporting accurate number of significant figures
   a. Know the rules for counting significant figures, and how to apply these rules
   b. Know how to account for significant figures for specific mathematical operations (add/subtracting, multiplication/division)

1.7 Consistently know how to determine the correct units to report for answers to calculations

1.8 Be comfortable reporting numbers in scientific notation

1.9 Know the difference between precision and accuracy

Vygotsky's Zone of Proximal Development

Example of In-Class Breakout

CHM 111_Wren_F14   Breakout #4

NAME_____   Section Time: 10 AM or 1 PM

Using each of the following ions *only once*, come up with **two** unique double-displacement reactions (e.g., choose the reactants and then complete the reaction). Indicate the state of each reactant and product. If a ppt forms, write the net ionic equation.

Ions: Pb^{2+}, I^-, NO_3^-, Ba^{2+}, Ag^+, Fe^{2+}, OH^-, Cl^-

Reaction 1

Reaction 2

CHM 111 Population: Perks and Problems

- Freshman student come in very motivated and with little expectations

- Two populations of students

  ➤ **AP Chemistry** (Junior or Senior year of High School)

  ➤ **General or Honors Chemistry** (Sophomore year of High School)

- Large amount of material to cover during semester

- Non-traditional 1:2:1 (Gen Chem 1 → Orgo 1 → Orgo 2 → Gen Chem 2)

Desired outcome for my CHM 111 course: **Success in future Chemistry course**

Initial Teaching Approach

- No student left behind—clearly go over basic material for under-prepared students
  - ➢ Go slow through "Exam 1" material, go fast through "Exam 4" material

  Pros: All students have equal opportunity to succeed

  Cons: "AP students" are bored; unable to cover all course material

Initial Teaching Approach

- No student left behind—clearly go over basic material for under-prepared students
  - ➢ Go slow through "Exam 1" material, go fast through "Exam 4" material

Fall 2015 Teaching Approach

• Use new ALEKS program to help under-prepared students through Exam 1 material: Go fast through "Exam 1" material, slow through "Exam 4" material

   ➢ Summer Review Assignment (Avg = 20 hours by end of first week of class)

   ➢ Learning objectives due before content taught in lecture

   ➢ Use Breakouts in class as way cover "review" material

Pros: Gained 4 lectures by Exam 1 that were used to cover Exam 4 material in greater depth without compromising student learning

Cons: Student's required to do an average of 60 hours more work outside of class over course of semester

---

Fall 2015 Teaching Approach

• Use new ALEKS program to help under-prepared students through Exam 1 material: Go fast through "Exam 1" material, slow through "Exam 4" material

   ➢ Summer Review Assignment (Avg = 20 hours by end of first week of class)

   ➢ Learning objectives due before content taught in lecture

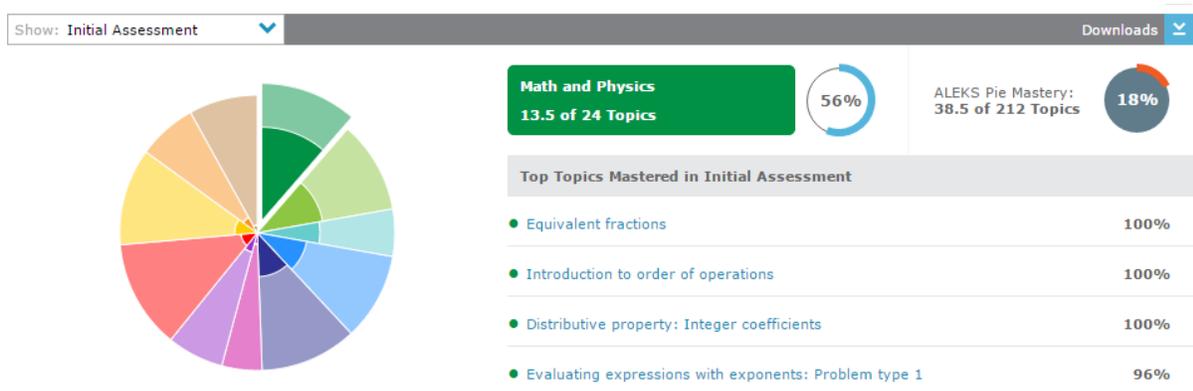   ➢ Use Breakouts in class as way cover "review" material

ALEKS
Lecture
Assigned Problems

How ALEKS Works

- **ALEKS** = **A**ssessment and **LE**arning in **K**nowledge **S**paces

- Online learning program associated with textbook

- Artificially intelligent assessment and learning system utilizing adaptive questioning to accurately and quickly determine student's current "knowledge state"

- ALEKS guides students to work on topics they are ready to learn

- Students work through topics: goal to Master topic and maintain mastery throughout semester

---

How ALEKS Works

Show: Initial Assessment   Downloads

| **Math and Physics** 13.5 of 24 Topics | 56% | ALEKS Pie Mastery: 38.5 of 212 Topics | 18% |

Top Topics Mastered in Initial Assessment

● Equivalent fractions	100%
● Introduction to order of operations	100%
● Distributive property: Integer coefficients	100%
● Evaluating expressions with exponents: Problem type 1	96%

How ALEKS Works: Initial Assessment

Course Progress
(87 of 212 topics)

Advanced Material (0 of 17)
Gases (1 of 15)
Chemical Bonding (5 of 24)
Electronic Structure (3 of 27)
Thermochemistry (1 of 14)
Simple Reactions (3 of 10)
Math and Physics (20 of 24)
Measurement (17 of 23)
Matter (7 of 12)
Atoms, Ions and Molecules (16 of 22)
Stoichiometry (14 of 24)

← High Preforming Student

Course Progress
(25 of 212 topics)

Advanced Material (0 of 17)
Gases (0 of 15)
Chemical Bonding (1 of 24)
Electronic Structure (0 of 27)
Thermochemistry (0 of 14)
Simple Reactions (0 of 10)
Math and Physics (15 of 24)
Measurement (4 of 23)
Matter (2 of 12)
Atoms, Ions and Molecules (2 of 22)
Stoichiometry (1 of 24)

← Low Preforming Student

ALEKS Feedback To Instructor

- Student content mastery BEFORE material covered in lecture

- Student progress and effort on material

- When students are working in ALEKS and for how long

- Identify at-risk students before first exam

ALEKS Feedback To Student

- Short and long-term mastery of concepts

- Progress of material mastered in course

- Individualized direction of what material they are ready to learn

Results: Quantitative

- Number of D and F grades reduced; Number of A grades unchanged

- Highest class average and median score on nationally-normed standardized final exam (3 years of scores)

  ➤ Small standard deviation, very few low final scores

- Covered 4 additional lectures of material not covered in past semesters

  ➤ Better prepare students for organic chemistry next semester

- Same end-of-semester faculty evaluation scores

Results: Qualitative

- Qualtric Survey sent to all enrolled student in CHM 111

  ➢ $N_{completed}$=166 (~40%)

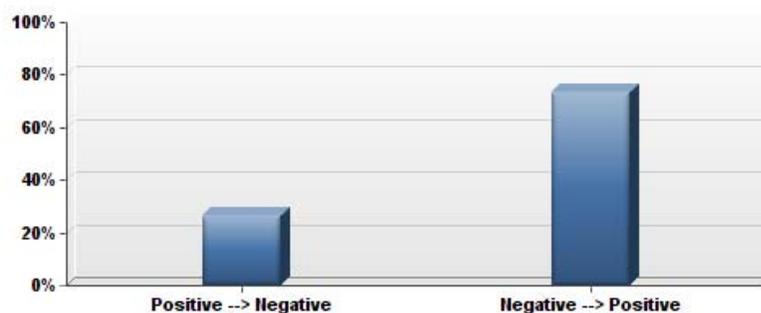- 32/44 students (72%) of my section completed survey

When did you last complete a course in Chemistry, prior to this Semester?
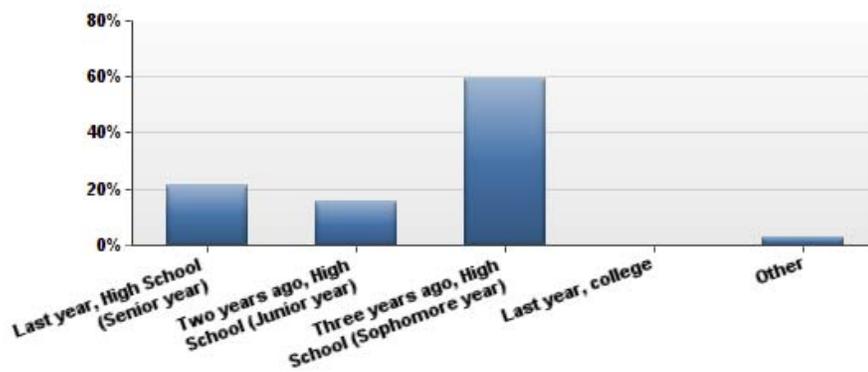
Overall, do you feel that ALEKS is a useful learning tool that you would want to use again for another Chemistry Course?
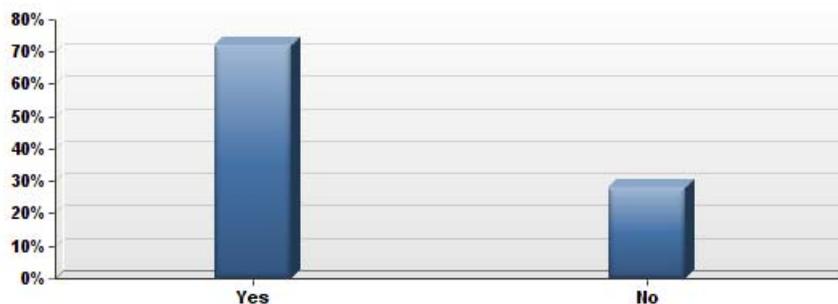
How did your opinion of ALEKS change?

60% of students opinion of ALEKS changed

Reason for Positive Opinion

"ALEKS gave me **immediate feedback** for a wide variety of problems in addition to the answers to these problems. . . ALEKS also gave me a **different lens** to view chemistry compared to that of lecture. It **helped reinforce what I had learned**, or it was a nice **preview to the material I had not yet learned**."

"**It was repetitive** which helped me remember things we went over throughout the entire semester."

"It **forced me to remember** past lessons and if I didn't it would give me exercises to review, which were very useful."

Reason for Negative Opinion

"It doesn't really teach you anything and its **not very helpful if I haven't learned the material in class yet because I don't really know what to do for the topics**. And then it takes a really long time to get a topic right and sometimes the course says your wrong when you are actually right."

"ALEKS caused me more stress than necessary. It also was long and grueling every time I had to do it. It also took me much longer since we hadn't covered the material in lecture yet. **I learn better with auditory/ talking** so having to sit and read a book then read problems without talking to someone was very challenging. Additionally, I ran into numerous technical problems, which caused further stress. Overall, I felt like ALEKS didn't even benefit me. I DID benefit from the connect assignments because I treated them like practice tests and could go back and check to see what I did wrong and redo them**. I could also forsee how many problems I had to do** with Connect. **With ALEKS I may be able to see the number of topics, but they had the possibility of taking me 5 minutes or 45 minutes per topic**."

Student Metacognition and ALEKS

- Students both liked and disliked ALEKS for similar reasons

    Repetition
    Challenge of reviewing material before lecture

- No correlation between "AP Students" and liking/disliking ALEKS

- Many students opinion of ALEKS changed from negative to positive over course of semester

    Increased metacognition?

"You'll die a little inside, but you'll learn a lot"

"I have never loved and hated a professor so much at the same time. He's a really nice person but expects an unreasonably large amount of work. His tests are extremely hard and require a lot of prep.

Despite this, he's really helpful and recognizes when a student is putting in a ton of work. . . . All material was new to me and it was really hard for me to keep up with the class. I failed my first test. I got Bs and As on the rest of the tests after selling my soul to doing nothing but studying for the class 24/7. You're GPA will take a hit, but you'll be smarter than other gen chem kids so pick your poison."

-Anonymous wakerating (Jan. 2016)

Ways to Communicate Expectations

Workshop Learning Outcomes

- Be able to clearly articulate your expectations of your student and assumptions on which these expectations are based

- Learn strategies to communicate your expectations to your students

- Learn strategies to obtain information about student expectations and ways to maximize overlap with your own expectations

- Obtain understanding of the importance of having student know expectations and rational for these expectations

Thoughts?