Wright College Academic Department/Program Assessment Project
Fall 2014

WHAT?
This project will assess the student learning of course outcomes for Chemistry 201 and Astronomy 201 that relate to the general education SLOs related to critical thinking for the Fall 2014 institutional assessment.

WHY?
The Physical Sciences and Engineering Department is participating in the Assessment Committee's ongoing assessment of Wright College's general education student learning outcomes. For Fall 2014, the Assessment Committee is starting with the first learning outcome of Critical Thinking, which the department has mapped as one of the outcomes they deliver. We are assessing the critical thinking in general chemistry and astronomy courses.

HOW?
Andrew Kruger is writing the assessment for Astronomy 201 with the help of Justin Lowry, and Maria Valentino is writing the assessment for Chemistry 201 with the help of Tracy Mitchell. There will be two long-answer form assessments for each course, one at the beginning (1^{st} -3^{rd} week) and toward the end (11^{th} -15^{th} week). The first will cover information the student is expected to understand when they come into the course, and the second assessment will cover information they have been taught in that course.

The students will be asked to use critical thinking to answer questions that are relevant to a course SLO that has been mapped to the departmental SLO: "Students will demonstrate an understanding of the basic principles in the physical sciences to evaluate and solve qualitative and quantitative problems using appropriate scientific models and/or mathematical manipulations."

The Astronomy 201 assessment will be focusing on the fifth course-level SLO: "Classify stars according to their luminosity and temperature."

The Chemistry 201 assessment will be focusing on the seventh course-level SLO: "Students should apply the principles of thermochemistry to study calorimetry, specific heat, standard enthalpies of formation and change in enthalpy for endothermic and exothermic reactions."

WHAT WE FOUND

Assessments were given to students in 3 course sections of Astronomy 201 and Chemistry 201. The results were graded by Andrew Kruger and Maria Valentino, respectively. Rubrics were created that categorizes student performance with regard to "Evidence" (ability to exclude irrelevant data), "Analysis" (ability to collect and organize data), "Evaluation" (ability to relate and interpret data), and "Synthesis" (ability to make logical conclusions). The rubrics with percentage of students who A) did not meet expectations, B) partially met expectations, or C) met expectations are given below.

Astronomy 201

The first assessment asked the students to compare people with differing weight and height in order to deduce which people were "bulkier" or "skinnier" based on criteria given. Five questions were given about four people that were positioned on a diagram showing their relative heights and weights. The second assessment, related to the course SLO discussed above, used a similar format with similar criteria, but instead asked students to compare stars with differing luminosity and temperature to deduce which stars were larger or smaller in size. Five questions were given about four stars that were positioned on a diagram showing their relative luminosities and temperatures. The students were evaluated based on their ability to answer the five questions.

The student performance was similar between assessments except in the "Evidence" objective, where they did significantly worse in the second assessment (nearly 20% increase in students who do not meet expectations). They only did slightly better in "Analysis" and

"Evaluation", and did slightly worse in "Synthesis". The use of irrelevant information lowered the percentage of students who were able to deduce the relationships between stars. Since the "Synthesis" objective was not significantly worse, this showed the students performed better in other parts of the assessment.

In the second assessment, students were more likely to try to answer the questions by using concepts they had learned in class. This showed they were trying to use memorized facts to reason through the problems rather than critical thinking. Along with the fact that students were less likely to exclude irrelevant information, this assessment indicates that more time is needed to teach the students to think critically about the relationships between stars rather than to try to memorize relationships. While in-class activities that have the students reason through these types of problems already, this indicates that more emphasis needs to be put on these conceptual problems, specifically in understanding when information is relevant and knowing when to exclude irrelevant information.

Chemistry 201

The first assessment asked the students to identify the type of material a plastic was made of based on whether if floated in different substances, requiring students to compare relative densities to deduce how the plastic would float or sink. The second assessment, related to the course SLO discussed above, required students to deduce the heat required to evaporate a given quantity of water. Each assessment required the students to deduce the one characteristic, and they were evaluated based on their ability to use the information provided to make conclusions.

The student performance was similar in the "Analysis" objective, but somewhat worse in the "Evidence" objective (9% increase in student who do not meet expectations, respectively). However, the students did significantly better in the "Synthesis" and "Evaluation" objectives (13% and 18% decrease in students who do not meet expectations, respectively), showing they have improved their ability to formulate logical conclusions based on the data given.

This assessment suggests that more emphasis can be made in teaching students to exclude relevant information when analyzing questions. This may be done by including irrelevant information in questions or

activities given to students in order to teach them to exclude this information in their analysis.

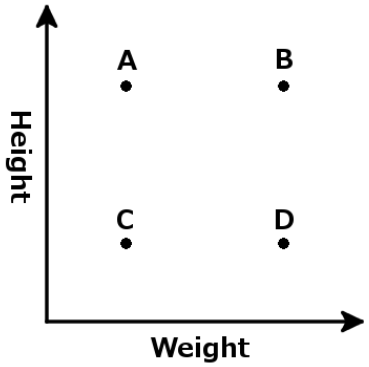
The findings from these assessments will be shared with the instructors in the corresponding courses.

Astronomy 201 Assessment of Student Learning #1 (Critical Thinking)
Department of Physical Sciences and Engineering
Wright College
Fall 2014

Weight vs. Height Problem

People are often considered "skinny" or "bulky" based on a combination of height and weight. Keep in mind these relationships:

A) If two people have the same height, the person that weighs more is "bulkier".
B) If two people are the same weight, the taller person is "skinnier".
C) On average, males weigh more and are taller than females.



The diagram shown on the right can be used to characterize people based on height and weight. The farther a person is positioned to the right, the more they weigh. The farther a person is positioned upward, the taller they are. Use the positions of the people in the diagram to answer the following questions. If any of the questions cannot be answered based on the information provided, state this and explain why.

1. Between person C and person D, which one is "skinnier"? Explain your reasoning.

2. Between person A and person D, which one is "skinnier"? Explain your reasoning.

3. Between person B and person C, which one is "skinnier"? Explain your reasoning.

4. If person A is male and person B is female, which one is taller? Explain your reasoning.

5. Which person is the "bulkiest"? Explain your reasoning.

Astronomy 201 Assessment of Student Learning #1 (Critical Thinking)
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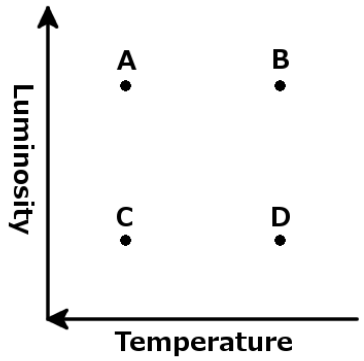
Luminosity vs. Temperature Problem

The size of stars can be found by comparing their luminosity and temperature. Keep in mind these relationships:

A) If two stars have the same luminosity, the hotter star is smaller.
B) If two stars are the same temperature, the more luminous star is larger.
C) On average, a blue star is hotter and more luminous than a red star.



The diagram shown on the right can be used to characterize stars based on luminosity and temperature. The farther a star is positioned to the right, the cooler they are. The farther a star is positioned upward, the more luminous they are. Use the positions of the stars in the diagram to answer the following questions. If any of the questions cannot be answered based on the information provided, state this and explain why.

1. Between star C and star D, which one is larger? Explain your reasoning.

2. Between star B and star C, which one is larger? Explain your reasoning.

3. Between star A and star D, which one is larger? Explain your reasoning.

4. If star A is a blue star and star B is a red star, which one is more luminous? Explain your reasoning.

5. Which star is the smallest? Explain your reasoning.

Astronomy 201 Assessment of Student Learning Question #1
Department of Physical Sciences and Engineering
Wright College
Fall 2014

Results
# of students = 103, 3 out of 8 sections of Astronomy 201, Fall 2014
Weight vs. Height Problem

Objective/Criteria	Does not meet expectations	Partially meets expectations	Meets expectations
Evidence – Can the student identify relevant/irrelevant data? Gender included as irrelevant data.	Includes irrelevant data in analysis. 63.1%	Excludes irrelevant data from analysis 36.9%	Excludes irrelevant data, and the exclusion is noted and justified. 0.0%
Analysis – Can the student collect and organize data? Use of both weight and height to justify relationships.	Minimal or no information is presented to justify conclusions. 27.2%	Information is presented to justify conclusions. 58.2%	Comprehensive information is presented to fully justify conclusions. 14.6%
Evaluation – Can the student interpret data? Numerical values not given to height and weight.	Judgment on the value of the information is only superficial. 82.5%	Some judgment on the value of the information is attempted. 6.8%	Thorough judgment on the value of the information is attempted. 10.7%
Synthesis – Can the student make conclusions about the data? Deduced relationship between individuals.	Conclusions are not logically derived from evidence. 70.9%	Conclusions logically derived from evidence. 19.4%	Conclusions logically derived from evidence and are clearly explained and justified. 9.7%

Astronomy 201 Assessment of Student Learning Question #2
Department of Physical Sciences and Engineering
Wright College
Fall 2014

Results
# of students = 69, 3 out of 8 sections of Astronomy 201, Fall 2014
Luminosity vs. Temperature Problem

Objective/Criteria	Does not meet expectations	Partially meets expectations	Meets expectations
Evidence – Can the student identify relevant/irrelevant data? Star color included as irrelevant data.	Includes irrelevant data in analysis. 82.6%	Excludes irrelevant data from analysis 15.9%	Excludes irrelevant data, and the exclusion is noted and justified. 1.4%
Analysis – Can the student collect and organize data? Use of both luminosity and temp. to justify relationships.	Minimal or no information is presented to justify conclusions. 21.7%	Information is presented to justify conclusions. 59.4%	Comprehensive information is presented to fully justify conclusions. 18.8%
Evaluation – Can the student interpret data? Numerical values not given to luminosity and temperature.	Judgment on the value of the information is only superficial. 76.8%	Some judgment on the value of the information is attempted. 13.0%	Thorough judgment on the value of the information is attempted. 10.1%
Synthesis – Can the student make conclusions about the data? Deduced relationship between stars.	Conclusions are not logically derived from evidence. 73.9%	Conclusions logically derived from evidence. 18.8%	Conclusions logically derived from evidence and are clearly explained and justified. 7.2%

CHEM 201 Assessment of Student Learning Question #1
Department of Physical Science and Engineering
Wright College
Fall, 2014

Density Problem

David found an unmarked piece of plastic that he wanted to identify and potentially recycle. David took the plastic to the laboratory for analysis. He recorded the temperature of the laboratory as 23.7°C and the mass of the plastic piece as 7.8 grams. Continuing with his analysis, David put the piece of plastic in a beaker containing 400 mL of ethanol, and he observed that the plastic sank to the bottom of the beaker. Next, he put the piece of plastic in a beaker containing 400 mL of olive oil, and again, he observed that the plastic sank to the bottom of the beaker. David then put the piece of plastic in 400 mL of water, and he observed that the plastic floated on the surface of the water. Finally, David put the piece of plastic in a beaker containing a mixture of 50% ethanol in H_2O, and he observed that the piece of plastic hovered in the solution but eventually sank to the bottom of the beaker.

David concluded that the piece of plastic was high density polyethylene. Is David's conclusion correct? Using David's recorded data and observations, support your conclusions clearly and completely (providing details) on the attached paper using calculations, illustrations, and sentences as appropriate.

Liquid	density (g/mL) at 25°C	Plastic	density (g/mL) at 25°C
ethanol	0.789	polyethylene terephthalate (PETE)	1.37
50% ethanol in H_2O	0.94	polystyrene (PS)	0.85
water	1.00	high density polyethylene (HDPE)	0.95
olive oil	0.92	nylon 6/12	1.07
10% NaCl in H_2O	1.08	polytherimide	1.27
toluene	0.867	polycarbonate	1.20

CHEM 201 Assessment of Student Learning Question #2
Department of Physical Science and Engineering
Wright College
Fall, 2014

Heat of Vaporization Problem

David knows that wet clothes dry on warm summer days. David found that a wet shirt contained
24 grams of water. On that day, the atmospheric temperature was 22^{o}C and the atmospheric pressure was 29.15 inches of mercury. David hung his shirt outside, and it dried.

David calculated that 0.054 kJ of heat was necessary to dry his shirt and he concluded this was an endothermic process. Are David's calculation and conclusion correct? Support your answer clearly and completely (providing details) on the attached paper using calculations, illustrations, and sentences as appropriate.

Physical properties for H_2O	
Molar mass	18.016 g/mol
Normal boiling point	100.00 ^{o}C
Melting point	0.00 ^{o}C
Heat of fusion, ΔH_{fus}	6.01 J/mol
Heat of vaporization, ΔH_{vap}	40.7 J/mol
Density at 22^{o}C	0.998 g/mL

CHEM 201 assessment of student learning #1 (Critical Thinking)
Department of Physical Science and Engineering
Wright College
Fall, 2014

Results
# of students = 82, 3 out of 11 sections of CHEM 201, Fall 2014
Density Problem

Objective/Criteria	Does not meet expectations **0 points**	Partially meets expectations **1 point**	Meets expectations **2 points**
Evidence – Can the student identify relevant/irrelevant data? Mass and temperature, D=M/V are excluded.	Includes irrelevant data in analysis. 54%	Excludes irrelevant data from analysis. 46%	Excludes irrelevant data, and the exclusion is noted and justified. 0.0%
Analysis – Can the student collect and organize data? Plastic sank/floated in liquid.	Data collection is not attempted. 34%	Some data collection is attempted. 37%	Data collection is comprehensive and thorough. 29%
Evaluation – Can the student interpret data? Density of plastic is >/< liquid.	Judgment on the value of the information is only superficial. 60%	Some judgment on the value of the information is attempted. 20%	Thorough judgment on the value of the information is attempted. 20%
Synthesis – Can the student make conclusions about the data? Agrees/disagrees with David, plastic is identified as HDPE.	No conclusions or outcomes are given. 49%	Conclusions and/or outcomes are partially explained. 27%	Conclusions and/or outcomes are clearly explained. 24%

CHEM 201 assessment of student learning #1 (Critical Thinking)
Department of Physical Science and Engineering
Wright College
Fall, 2014

Results
# of students = 67, 3 out of 11 sections of CHEM 201, Fall 2014
Heat of Vaporization Problem

Objective/Criteria	Does not meet expectations **0 points**	Partially meets expectations **1 point**	Meets expectations **2 points**
Evidence – Can the student identify relevant/irrelevant data? BP, MP, ΔHfus, density, pressure, temp. are excluded.	Includes irrelevant data in analysis. 63%	Excludes irrelevant data from analysis. 37%	Excludes irrelevant data, and the exclusion is noted and justified. 0.0%
Analysis – Can the student collect and organize data? Mass / Mm * ΔHvap	Data collection is not attempted. 37%	Some data collection is attempted. 37%	Data collection is comprehensive and thorough. 25%
Evaluation – Can the student interpret data? Heat absorbed, 54 kJ.	Judgment on the value of the information is only superficial. 42%	Some judgment on the value of the information is attempted. 40%	Thorough judgment on the value of the information is attempted. 18%
Synthesis – Can the student make conclusions about the data? Agrees/disagrees with David, endothermic process.	No conclusions or outcomes are given. 36%	Conclusions and/or outcomes are partially explained. 39%	Conclusions and/or outcomes are clearly explained. 25%