General Education Assessment Report

Scientific Knowledge and Understanding

Pete Benzi

Sharon Lynch

David Mullaney

Jianyu Zheng

Alexander J. Zozulin

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General Education Assessment Report

Semester and year: Spring semester 2016

Course name(s) and number(s): The assessed courses are given in Table 1.

Table 1. Courses Assessed for Scientific Knowledge and Understanding

Course Name	Course Number	No. of Sections
Principles of Astronomy	AST 101	2
Introduction to Astronomy	AST 111	1
Introduction to Biology	BIO 105	15
Principles of Human Body	BIO 110	4
Introduction to Nutrition	BIO 111	2
Human Biology & Lab	BIO 115	9
General Biology I	BIO 121	2
General Biology II	BIO 122	2
General Botany	BIO 155	1
Principles of Environmental Science	BIO 180	2
Environmental Science & Lab	BIO 181	1
Anatomy and Physiology I	BIO 211	9
Microbiology	BIO 235	5
Concepts of Chemistry	CHE 111	8
General Chemistry I	CHE 121	2
General Chemistry II	CHE 122	2
Introductory Physics	PHY 110	3
General Physics I	PHY 121	2
General Physics II	PHY 122	1

Prepared by:

Pete Benzi, Associate Professor

Sharon Lynch, Ph.D., Instructor

David Mullaney, Professor

Jianyu Zheng, Ph.D., Professor

Alexander J. Zozulin, Ph.D., Professor (Chair)

Date Submitted to General Education Committee: _____

Introduction

The three Board of Regents (BOR) learning outcomes selected for assessment are provided in Table 2. The courses assessed for the Scientific Knowledge and Understanding competency were required to submit an application to the General Education Assessment and Curriculum Design Committee (GEACC) for approval. The application provided the corresponding course outcomes that matched the BOR's learning outcomes. These were reviewed by GEACC and, if acceptable, approved. All approved courses were assessed during the spring 2016 semester.

A rubric was used to score the assessment (see Appendix A, page 25) and was based on the ConnSCU General Education Assessment Rubric for this competency area.

This is the first time these courses were assessed for this competency.

The assessment committee members are those listed above for the preparation of this report.

Table 2. Board of Regents Learning Outcomes Selected for Assessment

Description
1. Communicate using appropriate scientific terminology
2. Use representations and models to communicate scientific knowledge and solve scientific problems.
4. Articulate the reasons that scientific explanations and theories are refined or replaced.

Assessment Methodology

The development of the assessment began at the start of the fall semester 2015. Discussions in the Science Department meeting centered on the type of questions, free response and/or multiple choice. It was decided that the desired information could be obtained with multiple-choice questions. All instructors, both full and part-time, were asked via email to provide questions in multiple-choice format that would address the BOR's learning outcomes 1, 2, and 4. The instructors were provided with a statement of the BOR' learning outcomes and a copy of the scoring rubric. In addition, they were informed that the choices must be ones, which could be scored based on the scoring rubric (see Appendix A, page 25). The courses were divided amongst the assessment committee members and, once the information was received, each committee member reviewed and edited the documents. From this basis set of questions, three questions were selected for each BOR's learning outcome. The length of the assessment was a compromise between obtaining sufficient data without requiring large amounts of class time, which was a concern of many instructors. Near the end of the fall semester, a pilot test of the assessment was conducted to work out the mechanics of administering and grading the assessment. As a result, some of the assessment documents were revised. The assessment documents are provided in Appendix B (pages 26 – 87).

Prior to administering the assessment, all instructors received instructions via an email message and a memorandum included with the assessment. The instructions indicated the assessment was

a timed assignment (20 minutes) and no textbooks or notes were allowed. A Periodic Table was permitted for the chemistry courses. Scranton forms would be used but the students were not to provide their names or the instructor's name on the answer sheet. All assessment documents and completed answer sheets were collected by the instructor and returned to the assessment committee. The assessment was conducted during the last two weeks of the spring semester. All course sections participated in the assessment but the inability to retrieve the necessary data from two online courses prevented their inclusion in this study. The two online courses were one section of AST 101 and BIO 211.

Assessment Data

Since the assignment used multiple-choice questions, all enrolled students were given the assessment and all assignments were scored. Since all artifacts were scored, the scored artifacts were representative of the student demographics in each course. Once all the artifacts for a particular course were obtained, the artifacts were scored using an Apperson Educational Products' Periodic Assessment Scoring System, Benchmark 3000, which was connected to personal computer. DataLink Connect from Apperson Educational Products allowed an interface between the Benchmark 3000 and the computer as well as provided data manipulation. Answer key cards were marked according to the answers provided by the course instructor or team leader for a multi-section course. These answer keys were scanned by the Benchmark 3000 and the scoring was changed to rubric scoring using their DataLink Connect software. The rubric scoring for each choice was based on the answers provided by the course instructor or team leader for a multi-section course. The artifacts collected during the pilot test were used to test the scoring and the assessment committee members verified the answer key cards and the rubric scoring. The answer keys were saved, stored to a flash drive, and re-opened for scoring the assessments for spring 2016. The rubric scoring was again verified just before grading by the scorer. All scoring was performed by the chairperson. Table 3 provides the number of artifacts collected for each course. Appendix C (pages 88 – 196) provides the assessment data and Appendix D (pages 197 – 250) gives the statistical analysis results.

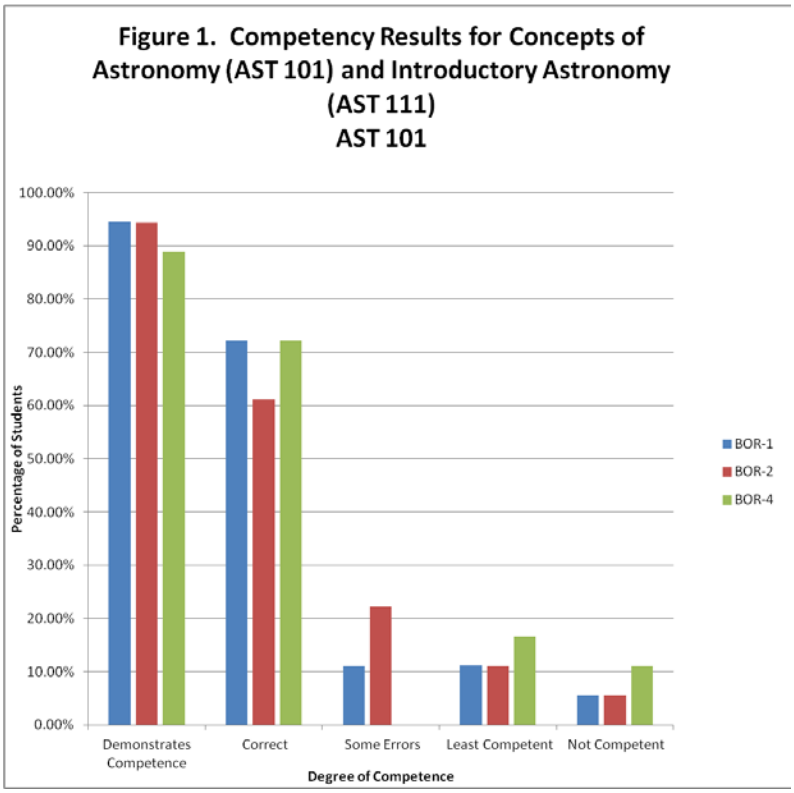
Table 3. Student Artifacts Collected per Course.

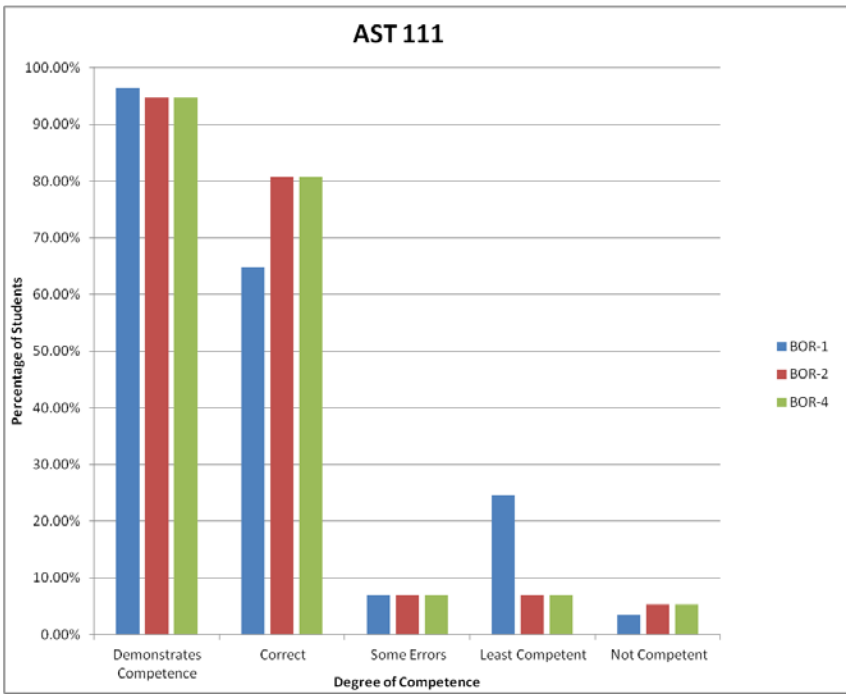
Course Name	Course Number	No. of Artifacts
Principles of Astronomy	AST 101	8
Introduction to Astronomy	AST 111	19
Introduction to Biology	BIO 105	228
Principles of Human Body	BIO 110	29
Introduction to Nutrition	BIO 111	40
Human Biology & Lab	BIO 115	141
General Biology I	BIO 121	29
General Biology II	BIO 122	20
General Botany	BIO 155	19
Principles of Environmental Science	BIO 180	20
Environmental Science & Lab	BIO 181	16
Anatomy and Physiology I	BIO 211	137
Microbiology	BIO 235	85
Concepts of Chemistry	CHE 111	110
General Chemistry I	CHE 121	31
General Chemistry II	CHE 122	21
Introductory Physics	PHY 110	52
General Physics I	PHY 121	25
General Physics II	PHY 122	20
	Total	1044

Findings

Astronomy

Overall, the total percentage of student's answers demonstrating some competency averaging to about 95% is encouraging. Further, these graphs show that the majority of students—approximately 70%—in both astronomy courses have the highest score in all three BOR competency areas. This leaves about 25% with some errors in their answers and only about 5% of answers demonstrating no competency.



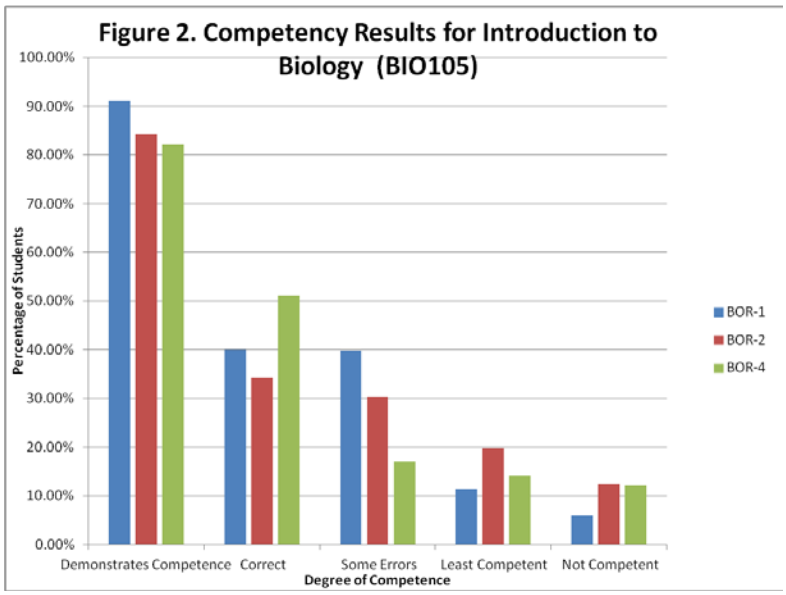


There is a trend in this data of consistent decrease in more and more incorrect answers. This is a good general trend as it suggests students are learning and thinking about the material rather than just guessing at it. There is a notable exception for BOR 1 questions in AST 111; a spike in the lowest competence answers. This suggests a kind of bifurcation with one group having a good understanding and one group having a poor understanding with little middle ground. Unfortunately, we only have one section so far for this data and I cannot be sure this was not just a bit of random error or a misconception within a subset of the astronomy class.

The practices employed in the astronomy class have been tested at many other large universities with multiple sections and show significant improvement over standard lecture based teaching methods. It is very likely then if we had a few more sections this outlying data would be smoothed out.

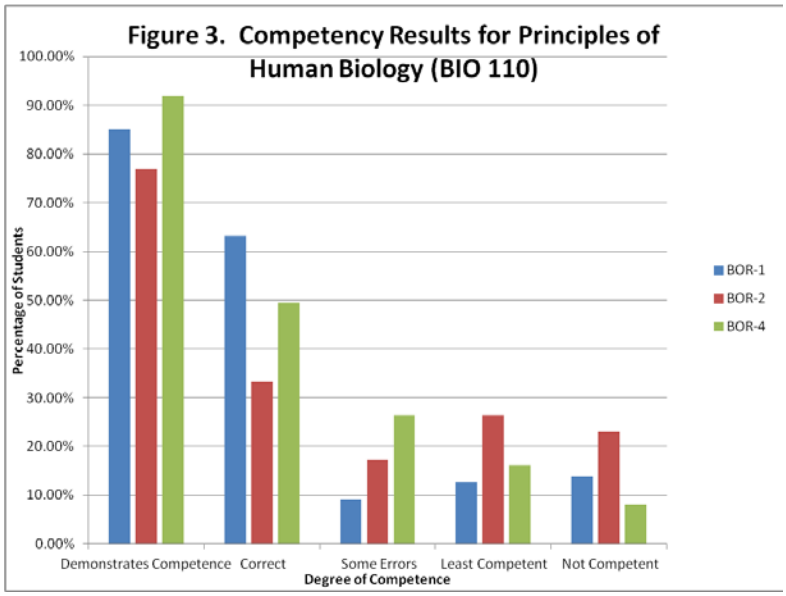
Biology

Introduction to Biology



The mean overall score of competency in Biology 105 was 86%. The first set of Bars is the average of all the scores showing all levels of competency other than none. Students were slightly stronger in BOR student learning outcome (SLO) 1 (91%) than in BOR SLO 2 (84%) and BOR SLO 4 (82%). Similar trend was seen among the students who were not competent: they were weaker in BOR SLO #2 (12%) and BOR SLO #4 (12%) than in BOR SLO 1 (5%). These results indicate that most students have built a solid foundation on the use of scientific terminology (SLO 1), the use of models (SLO 2) and the understanding of scientific theories (SLO 4) throughout the course. More students (7%) are not competent on the use of models and understanding of the scientific theories than those on the use of scientific terminology are. Based on these findings, improvements in student competency may be achieved through continued integration and reinforcement of scientific terminology and scientific theory in the course as well as improving the use of models inside and outside classroom. For non-competent students, a separate tutoring group may be established to reach a better outcome for BOR SLO 2 and BOR SLO 4.

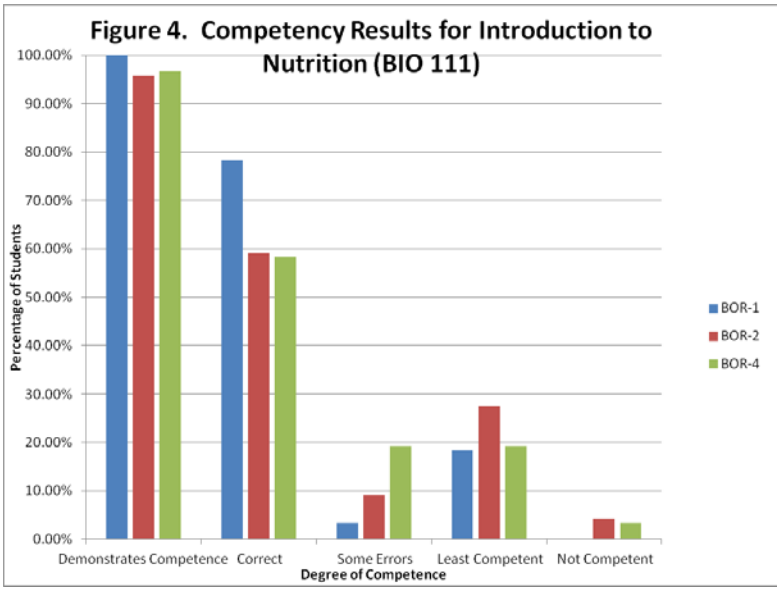
Principles of Human Biology



The mean overall score of competency in Biology 110 was 84.7%. The first set of Bars (labeled Demonstrates Competence) is the average of all the scores showing all levels of competency other than none. Students were stronger in BOR learning outcome 1 (85.1%) and BOR learning outcome 4 (92%). BOR learning outcomes 1 and 4 showed more students received full credit on those questions than on BOR learning outcome 2. The lower student performance on BOR learning outcome 2 may mean that the use of models is not heavily reinforced in this course. The solid student performances on the use of scientific terminology (BOR 1) and understanding of scientific theories (BOR 4) are indicative of the infusion of the concepts throughout the course. Overall, the results from this assessment tool suggest the students have achieved competency in all three BOR outcomes.

In order to further student competency the course should continue to integrate and reinforce the scientific terminology and theories in the course and improve the use of models to ensure stronger performance in BOR learning outcome 2.

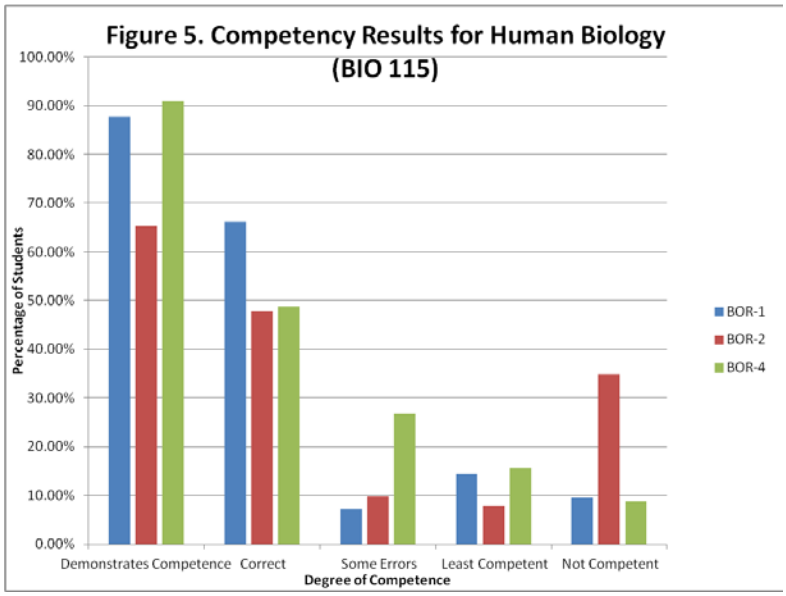
Introduction to Nutrition



The mean overall score of competency for Introduction to Nutrition was 97.5%. The first set of Bars (labeled Demonstrates Competence) is the average of all the scores showing all levels of competency other than none. All students showed some level of competency in BOR learning outcome 1 (100%) and scored very well in both BOR learning outcome 2 (95.8%) and BOR learning outcome 4 (96.7%) as well. This very strong student performance demonstrates that these three learning outcomes are strongly incorporated in the course material throughout the semester. Overall, the results from this assessment tool suggest the students have achieved competency in all three BOR outcomes.

In order to further student competency the course should continue to integrate and reinforce the scientific terminology, the use of models, and scientific theories in the course.

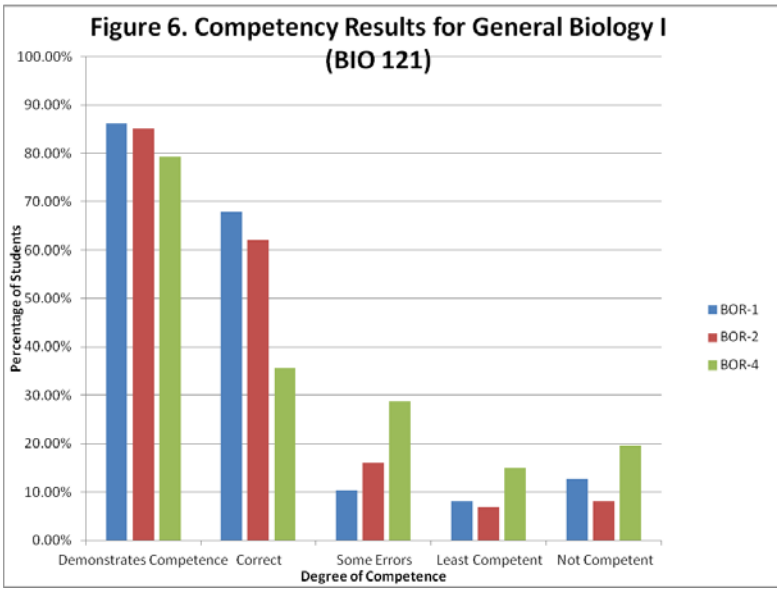
Human Biology



The mean overall score of competency in Biology 115 was 81%. The first set of Bars is the average of all the scores showing all levels of competency other than none. Students were stronger in BOR SLO 1 (88%) and BOR SLO 4 (91%) than in BOR SLO 2 (65%). The marked high performance on BOR SLO 1 and SLO 4 suggest that most students have a solid understanding of the scientific terminology and scientific theories. The relatively low student performance on BOR SLO 2 may reflect how ineffectively the models have been used in the classroom. Among the non-competent students, 35% are not competent with BOR SLO 2, which is significantly higher than those students, who are not competent with BOR SLO 1 (9%) and BOR SLO 4 (9%). This suggests about a third of the students lack the ability of using the models. These data indicate that the majority of the students have a solid understanding of scientific terminology (SLO 1) and scientific theories (SLO 4) throughout the course.

Based on the assessment data, improvements in the course include better integration and reinforcement of the scientific terminology and theories in the course. Enhancing the use of models inside and outside classroom should ensure stronger performance in SLO 2. Finally, for non-competent students, a separate tutoring group may be established to improve the use of models (BOR SLO 2).

General Biology I



For the BOR learning outcome 1, the data for questions one, two, and three reveal competency in the area of being able to communicate using appropriate scientific terminology. The mean statistic for question one is 2.7. There is unimodal distribution with the best answer being chosen 18 times out of 29 responses. The second best choice for this question was chosen two times. The incorrect answer was chosen six times. The mean statistic for question two is 2.8. There is unimodal distribution with the correct answer being chosen 23 times out of 29 responses. The second best choice for this question was chosen three times. The mean statistic for question three is 2.6. There is unimodal distribution with the correct answer being chosen 18 times out of 29 responses. The second best choice for this question was chosen four times.

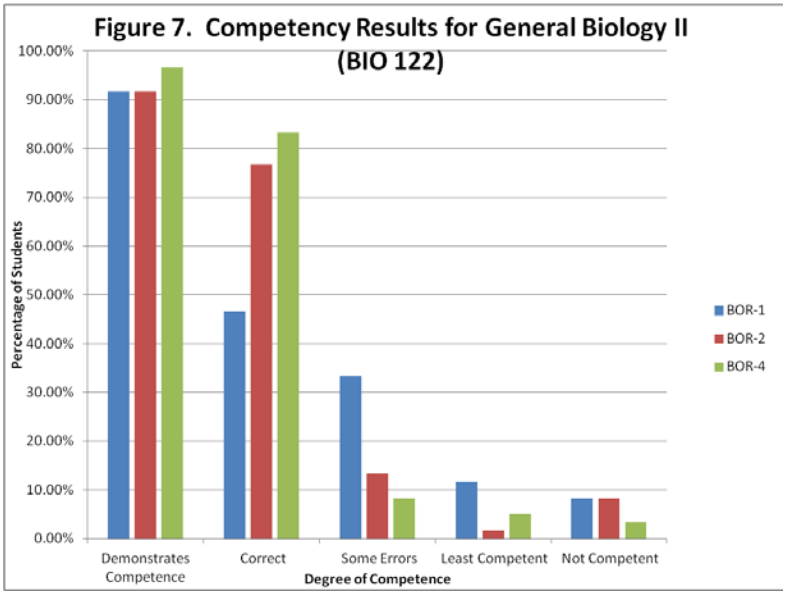
For the BOR learning outcome 2, the data for questions five and six reveal competency in the area of being able to use representations and models to communicate scientific knowledge and solve scientific problems. The mean statistic for question four is 2.8. There is unimodal distribution with the best answer being chosen 24 times out of 29 responses. The second best choice for this question was chosen four times. The mean statistic for question five is 2.7. There is unimodal distribution with the correct answer being chosen 21 times out of 29 responses. The second best choice for this question was chosen two times. The mean statistic for question six is 2.4. There is multimodal distribution with the correct answer being chosen 9 times out of 29 responses. The second best choice for this question was chosen eight times.

Examination of question six should focus on the relatively high choice (17.2%) of the incorrect answers to determine whether the question could be better written or if student bias is due to inadequate preparation for this question. Interestingly, 17.2% selected choice E, which was essentially a non-choice since the available choices were A through D.

Overall, the data suggest the students have achieved competency in the BOR outcomes 1 and 2.

For the BOR learning outcome 4, the data for questions seven and eight reveal competency in the area of being able to articulate the reasons that scientific explanations and theories are refined or replaced. The mean statistic for question seven is 2.3. There is bimodal distribution (41.4% and 37.9%) with the best answer being chosen 12 times out of 29 responses. The second best choice for this question was chosen 11 times. The mean statistic for question eight is 2.4. There is unimodal distribution with the correct answer being chosen 15 times out of 29 responses. The second best choice for this question was chosen five times. The mean statistic for question nine is 2.0. There is bimodal distribution (31.8% and 37.9%) with the correct answer being chosen 4 times out of 29 responses. The second best choice for this question was chosen nine times. The incorrect answer was chosen 11 times. Examination of question nine should focus on the relatively high choice (37.9%) of the incorrect answer to determine whether the question could be better written or if student bias is due to inadequate preparation for this question. Overall, the data suggest competency for this outcome.

General Biology II



For the BOR learning outcome 1, the data for questions one, two, and three reveal competency in the area of being able to communicate using appropriate scientific terminology. The mean statistic for question one is 2.0. There is unimodal distribution with the best answer being chosen 3 times out of 20 responses. The second best choice for this question was chosen 14 times. The mean statistic for question two is 2.8. There is unimodal distribution with the correct answer being chosen 15 times out of 20 responses. The second best choice for this question was chosen one time. The mean statistic for question three is 2.4. There is bimodal distribution with the correct answer being chosen 10 times out of 20 responses. The second best choice for this question was chosen five times.

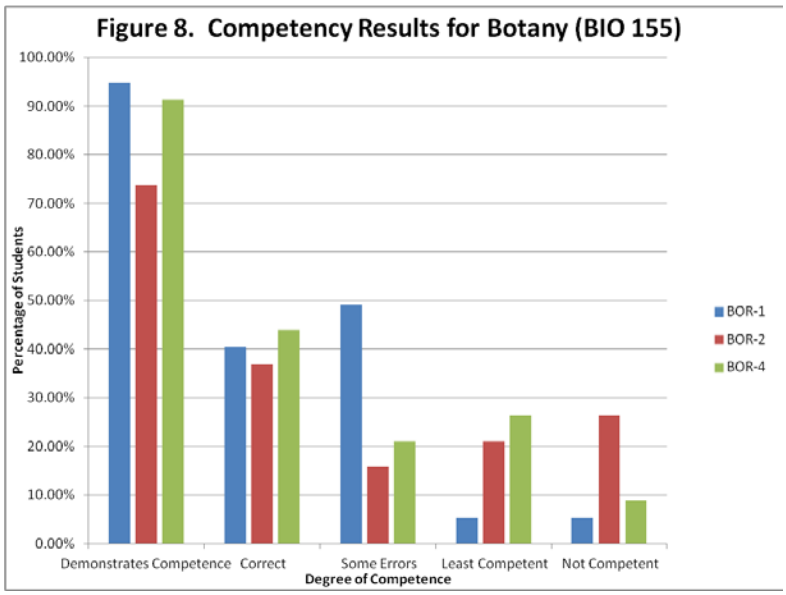
Examination of question one should focus on the relatively high choice (70%) of the second best answer to determine whether the question could be better written or if student bias is due to inadequate preparation for this question.

For the BOR learning outcome 2, the data for questions four, five, and six reveal competency in the area of being able to use representations and models to communicate scientific knowledge and solve scientific problems. The mean statistic for question four is 3.0. There is unimodal distribution with the best answer being chosen 20 times out of 20 responses. The mean statistic for question five is 2.5. There is multimodal distribution with the correct answer being chosen 9 times out of 20 responses. The second best choice for this question was chosen six times. The incorrect answer was chosen four times. The mean statistic for question six is 2.9. There is unimodal distribution with the correct answer being chosen 17 times out of 20 responses. The second best choice for this question was chosen two times.

For the BOR learning outcome 4, the data for questions seven, eight and nine reveal competency in the area of being able to articulate the reasons that scientific explanations and theories are refined or replaced. The mean statistic for question seven is 2.6. There is unimodal distribution with the best answer being chosen 13 times out of 20 responses. The second best choice for this question was chosen 15 times. The mean statistic for question eight is 2.8. There is unimodal distribution with the correct answer being chosen 17 times out of 20 responses. The second best choice for this question was chosen two times. The mean statistic for question nine is 3.0. There is unimodal distribution with the correct answer being chosen 20 times out of 20 responses.

In conclusion, the data suggest the students have achieved competency in all three BOR outcomes.

General Botany



For the BOR learning outcome 1, the data for questions one, two, and three reveal competency in the area of being able to communicate using appropriate scientific terminology. The mean statistic for question one is 2.3. There is bimodal distribution with the best answer being chosen 6 times out of 19 responses. The second best choice for this question was chosen 12 times. The mean statistic for question two is 2.4. There is bimodal distribution with the correct answer being chosen 9 times out of 19 responses. The second best choice for this question was chosen

eight times. The mean statistic for question three is 2.5. There is bimodal distribution with the correct answer being chosen 8 times out of 19 responses. The second best choice for this question was chosen eight times.

Examination of questions one, two, and three should focus on the relatively high choices (63.2%, 42.1%, and 42.1 % respectively) of the second best answer to determine whether the questions could be better written or if student bias is due to inadequate preparation for these questions.

For the BOR learning outcome 2, the data for questions four and six reveal competency in the area of being able to use representations and models to communicate scientific knowledge and solve scientific problems. The mean statistic for question four is 2.1. There is multimodal distribution with the best answer being chosen 7 times out of 19 responses. The second best choice for this question was chosen six times. The third best answer was chosen five times. The mean statistic for question five is 2.3. There is multimodal distribution with the correct answer being chosen 5 times out of 19 responses. The second best choice for this question was chosen 0 times. The incorrect answer was chosen 11 times. The mean statistic for question six is 2.3. There is unimodal distribution with the correct answer being chosen 9 times out of 19 responses. The second best choice for this question was chosen three times.

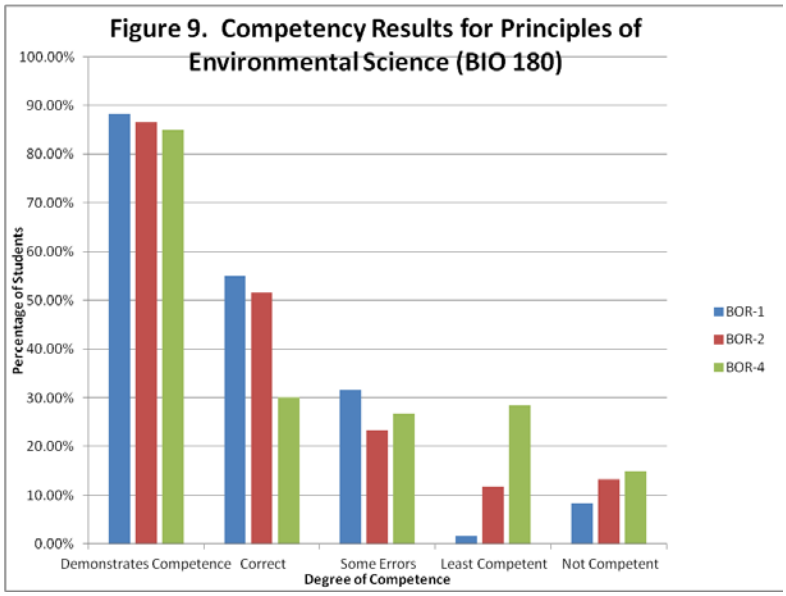
Examination of question five should focus on the relatively high choice (57%) of the incorrect answer to determine whether the question could be better written or if student bias is due to inadequate preparation for this question.

For the BOR learning outcome 4, the data for questions seven and eight reveal competency in the area of being able to articulate the reasons that scientific explanations and theories are refined or replaced. The mean statistic for question seven is 1.9. There is multimodal distribution with the best answer being chosen 5 times out of 19 responses. The second best choice for this question was chosen five times. The third best choice for this question was chosen six times. The mean statistic for question eight is 2.2. There is multimodal distribution with the correct answer being chosen8 times out of 19 responses. The second best choice for this question was chosen five times. The third best choice for this question was chosen five times. The mean statistic for question nine is 2.4. There is unimodal distribution with the correct answer being chosen 12 times out of 19 responses. The second best choice for this question was chosen two times.

Examination of questions seven should focus on the relatively low choice (26.3%) of the best answer to determine whether the question could be better written or if student bias is due to inadequate preparation for this question.

Overall, the data suggest the students have attained competency in the three BOR outcomes assessed.

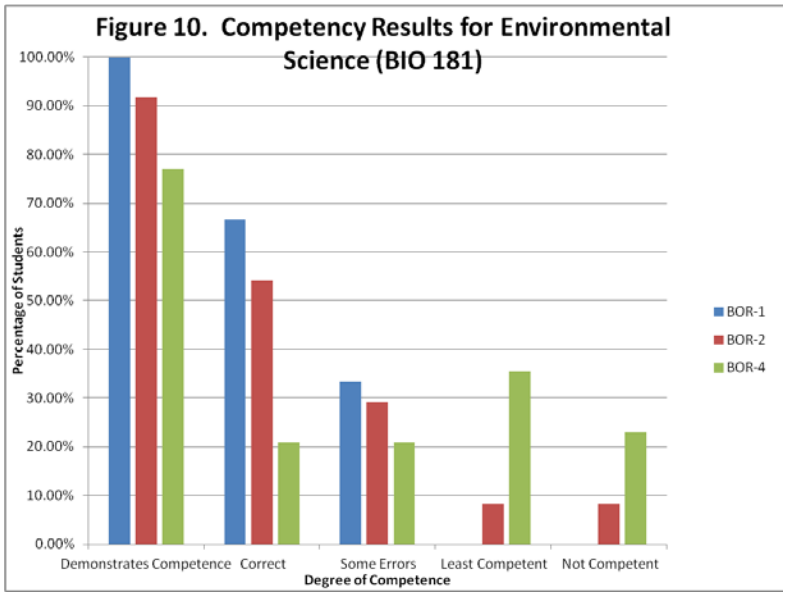
Principles of Environmental Science



The mean overall score of competency of Biology 180 was 86.7%. The first set of Bars (labeled Demonstrates Competence) is the average of all the scores showing all levels of competency other than none. Students demonstrated strong competency in all three areas. BOR learning outcome 1 (88.3%) scored slightly higher than BOR learning outcome 2 (86.7%) and BOR learning outcome 4 (85%). This solid student performance is indicative of the infusion of theses learning outcomes throughout the course. Overall, the results from this assessment tool suggest the students have achieved competency in all three BOR outcomes.

In order to further student competency the course should continue to integrate and reinforce the scientific terminology, the use of models and scientific theories in the course.

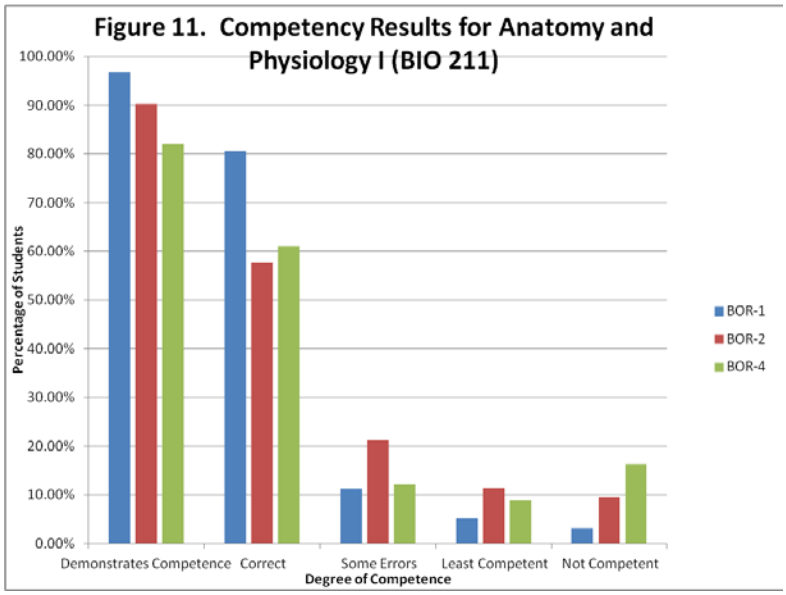
Environmental Science



The mean overall score of competency of Environmental Science was 89.6%. The first set of Bars (labeled Demonstrates Competence) is the average of all the scores showing all levels of competency other than none. All students showed some level of competency in BOR learning outcome 1 (100%) and were markedly stronger in BOR learning outcome 2 (91.7%) than in BOR learning outcome 4 (77.1%). The lower student performance on BOR learning outcome 4 may reflect how often scientific theories are discussed throughout this course. Since the assessment test was not given until the very end the semester, it may not be an accurate measurement, seeing how well the students performed on the other learning outcomes. The solid student performances on the use of scientific terminology (BOR 1) and the use of models (BOR 2) are indicative of the infusion of the concepts throughout the course. Overall, the results from this assessment tool suggest the students have achieved competency in all three BOR outcomes.

In order to further student competency the course should continue to integrate and reinforce the scientific terminology, the use of models and improve the discussion of scientific theories throughout the semester to ensure stronger performance in learning outcome 4.

Anatomy and Physiology I



For the BOR learning outcome 1, the data for questions one, two, and three reveal competency in the area of being able to communicate using appropriate scientific terminology. The mean statistic for question one is 2.6. There is unimodal distribution with the best answer being chosen 90 times out of 137 responses. The second best choice for this question was chosen 25 times. The mean statistic for question two is 2.9. There is unimodal distribution with the correct answer being chosen 123 times out of 137 responses. The second best choice for this question was chosen 11 times. The mean statistic for question three is 2.8. There is unimodal distribution with the correct answer being chosen 118 times out of 137 responses. The second best choice for this question was chosen 10 times.

For the BOR learning outcome 2, the data for questions four, five, and six reveal competency in the area of being able to use representations and models to communicate scientific knowledge and solve scientific problems. The mean statistic for question four is 2.1. There is multimodal distribution (26.3%, 36.5%, and 21.2%) with the best answer being chosen 36 times out of 137 responses. The second best choice for this question was chosen 50 times. The third best answer was chosen 29 times. The mean statistic for question five is 2.7. There is unimodal distribution with the correct answer being chosen 104 times out of 137 responses. The second best choice for this question was chosen 20 times. The mean statistic for question six is 2.7. There is unimodal distribution with the correct answer being chosen 96 times out of 137 responses. The second best choice for this question was chosen 17 times.

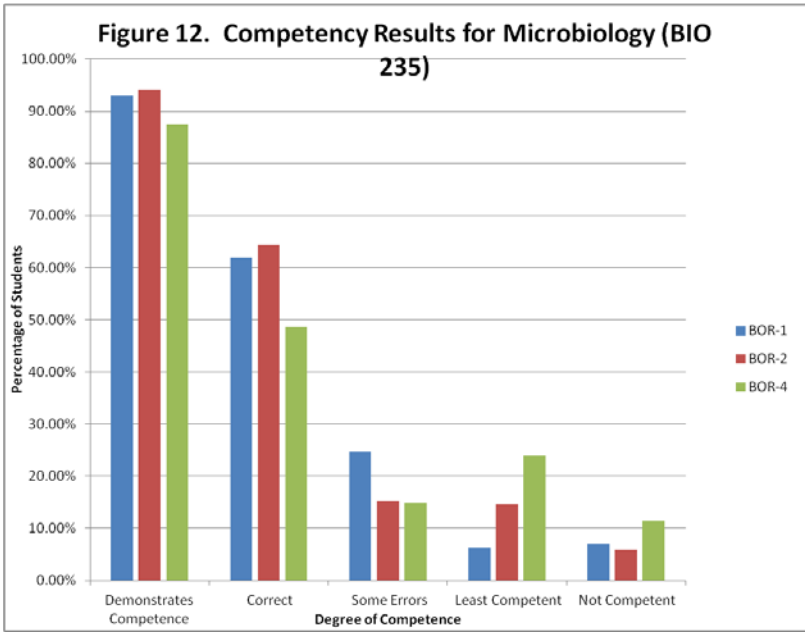
For the BOR learning outcome 3, the data for questions seven, eight, and nine reveal competency in the area of being able to articulate the reasons that scientific explanations and theories are refined or replaced. The mean statistic for question seven is 2.5. There is unimodal distribution with the best answer being chosen 70 times out of 137 responses. The second best choice for this question was chosen 22 times. The mean statistic for question eight is 2.6. There is unimodal distribution with the correct answer being chosen 98 times out of 137 responses. The second best choice for this question was chosen 20 times. The mean statistic for question nine is

2.8. There is unimodal distribution with the correct answer being chosen 83 times out of 137 responses. The second best choice for this question was chosen eight times. The incorrect answer was chosen 38 times.

Examination of question nine should focus on the relatively high choice (27.7%) of the incorrect answer to determine whether the question could be better written or if student bias is due to inadequate preparation for this question.

In conclusion, the data suggest students have achieved competency in the three BOR outcomes assessed.

Microbiology

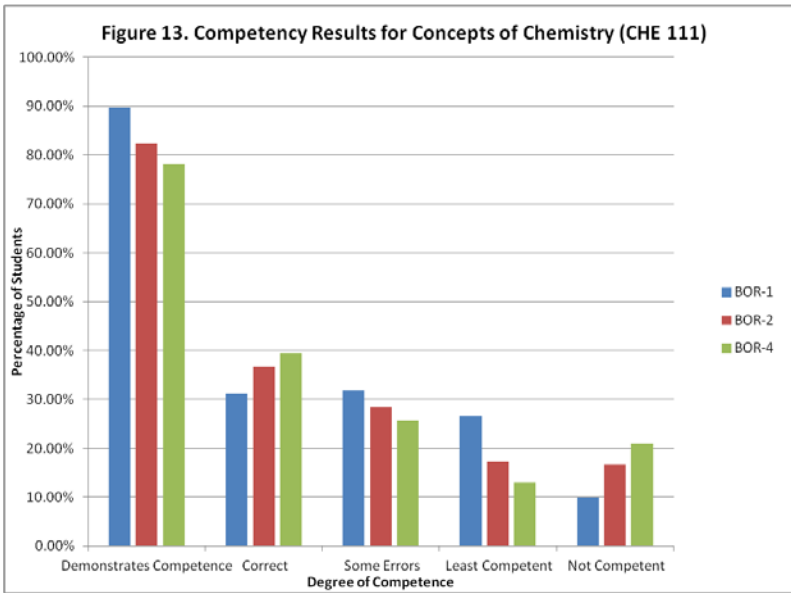


The mean overall score of competency of Microbiology was 91.5%. The first set of Bars (labeled Demonstrates Competence) is the average of all the scores showing all levels of competency other than none. Students demonstrated strong competency in all three areas. BOR learning outcome 2 (94.1%) scored slightly higher than BOR learning outcome 1 (92.9) and BOR learning outcome 4 (87.5%). This solid student performance is indicative of the infusion of theses learning outcomes throughout the course. Students appeared to have more difficulty with the understanding of scientific theories (35.3% of students had little or no competence in this area). The lower student performance on BOR learning outcome 4 may reflect how often scientific theories are discussed throughout this course. Since the assessment test was not given until the very end the semester, it may not be an accurate measurement, seeing how well the students performed on the other SLOs. Overall, the results from this assessment tool suggest the students have achieved competency in all three BOR outcomes.

In order to further student competency the course should continue to integrate and reinforce the scientific terminology, the use of models and improve the discussion of scientific theories throughout the semester to ensure stronger performance in learning outcome 4.

Chemistry

Figures 13, 14, and 15 show the competency results for Concepts of Chemistry (CHE 111), General Chemistry I (CHE 121), and General Chemistry II (CHE 122), respectively. Students in the three chemistry courses performed well for the BOR outcome 1 with approximately 91% of the students tested meeting this competency. On average 35% of the students in CHE 111 and CHE 121 scored a perfect grade for this outcome while 78% of the CHE 122 students had perfect scores. It should be noted that the CHE 122 assessment questions for the BOR outcome 1 were questions from a national standardized examination developed by the American Chemical Society's (ACS) Exam Institute. Overall, the students have developed good usage of scientific terminology.

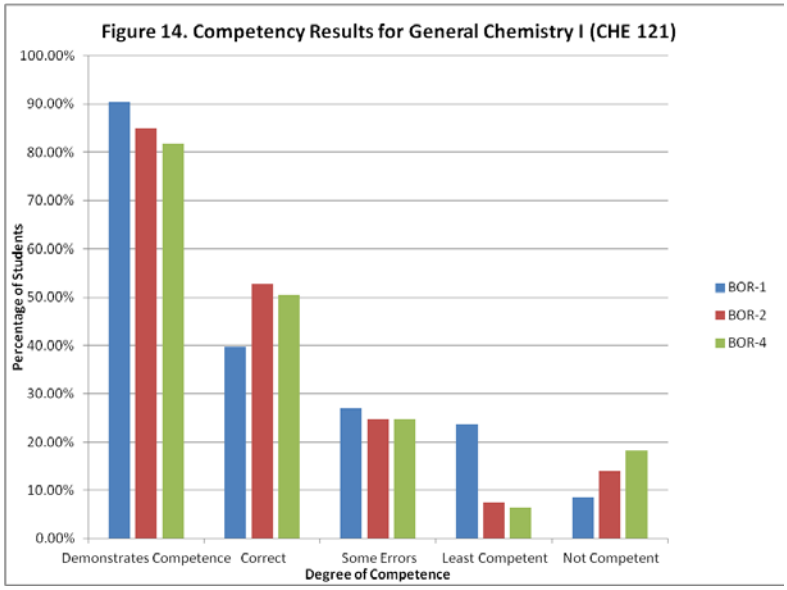


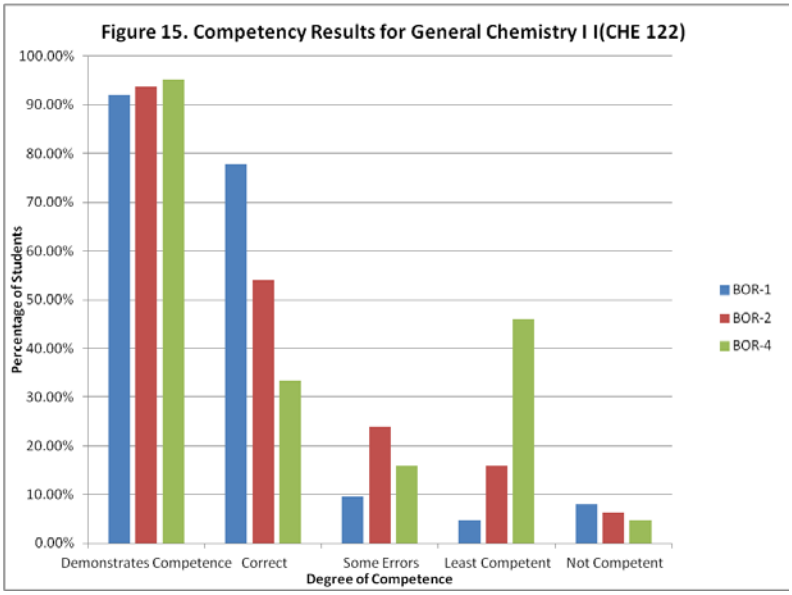
Students in all chemistry courses performed well for the BOR outcome 2 with an average of 87% meeting the competency, while on average 48% of them made perfect scores. Fifty four percent (54%) of the CHE 122 students made perfect scores on the BOR outcome 2 assessment questions, which were taken from the ACS standardized exam. These results suggest the use of models to communicate scientific knowledge and solve scientific problems is effectively applied in the courses.

Finally, 85% of the chemistry students met the competency for the BOR outcome 4. A slightly lower percentage of students (41%) scored perfect grades on this competency. The lower scores on the BOR outcome 4 as compared to the BOR outcome 1 and 2 may be attributed to the extent that the scientific method is discussed in the courses. Since CHE 111 is a multi-section course, the emphasis placed on the scientific method and the reasons that scientific hypotheses and theories are refined or replaced is unknown. Typically, a discussion of this topic is covered early

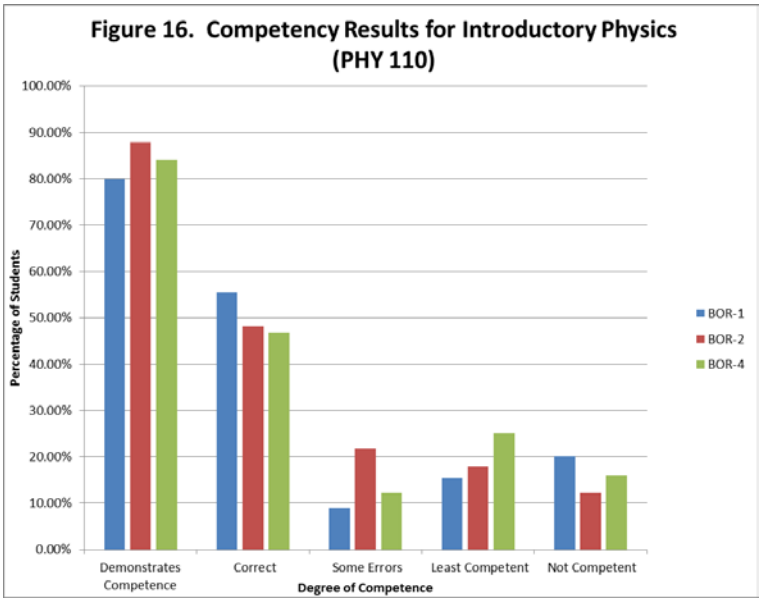
in the course and the amount of time spent is probably limited. Since the assessment was given near the end of the semester and it is unlikely students reviewed early concepts, the results are not surprising. This is also the case for General Chemistry I but to a lesser extent. It is possible that the connection between the old and new theory is not emphasized enough for students to recognize it as part of the scientific method. In contrast, discussions in General Chemistry II revolve around the current theories and the refinements of them are often topics for more advanced courses.

The assessment suggests continued integration throughout the course in the use representations and models to communicate scientific knowledge and solve scientific problems will improve student performance in this area. This is also true for the BOR outcome 4. Further, it will be important to develop assignments, particularly in multi-section courses, that directly assess course learning outcomes, which are directly aligned with the BOR outcomes.

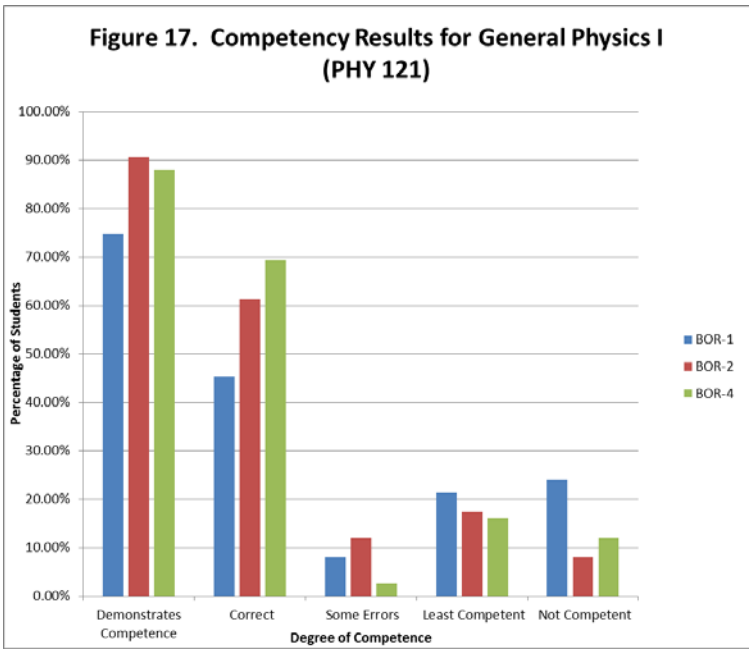




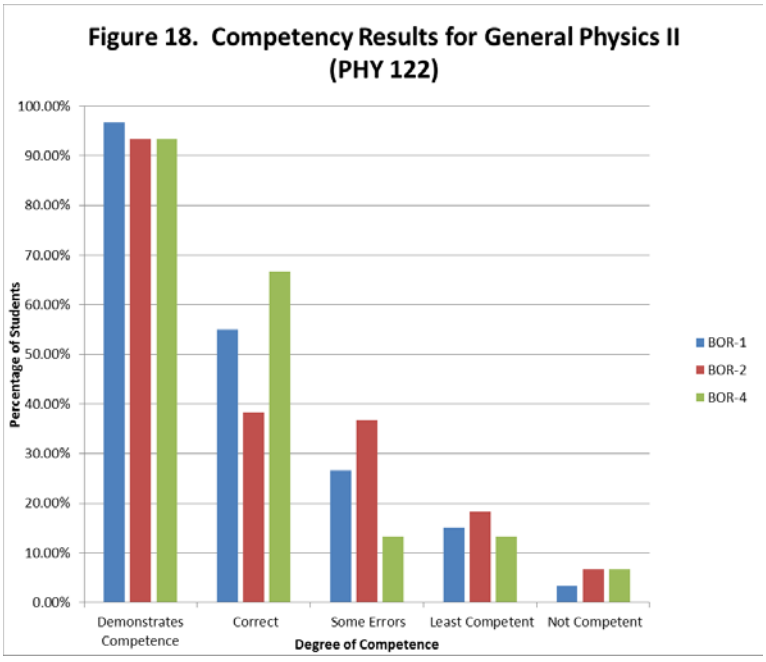
Physics



The demonstration of some competence between 80% and 90% is a good result overall, however the relatively high percentage—around 20%--of students with least and not competent answers is a problem. PHY 110 is for students who usually struggle in mathematics or have little interest in physics. This suggests that it is reasonable to see a higher percentage giving answers demonstrating lower competency than other science courses. This is also the likely cause of the slight peak in the frequency of least competent answers. This breaks up the preferred trend of ever decreasing number of answers that demonstrate less competence; a trend that demonstrates effective learning. The fact that struggling students are more likely to take PHY 110 mitigates some of these results. However, if more active learning such as group worksheets, think-pair-share, etc. are utilized, these students will likely improve.



In this one section of PHY 121, the demonstration for some overall competence is good as it is between 75% and 91%. Most of the students taking PHY 121 are engineering technology majors or are planning on being technicians. For reference, the competency goals of engineering and technician courses laid out for the Accreditation Board for Engineering and Technology is 70%. The percentage of answers that are least or not competent is concerning however. This may not be significant as during the semester that this data was taken there was only one section of PHY 121 being run. As with PHY 110, some of these results could improve with more active learning such as group worksheets, think-pair-share, etc.



PHY 122 has very good overall results with the demonstration of some competence being between 90% and 95%. The level of fully correct answers is lower than some of the other science courses however; most notably the astronomy courses. There is another good sign in that the data does not show much of a bump in least and not competent answers.
As with PHY 121 however, both the good results and the bad results have to be considered with caution, as there was only one section of this course due to under-enrollment. There are active learning techniques being applied in PHY 122, which likely explains the good results. The active learning that is applied is not as complete or coherent as the astronomy course. As active learning becomes more integrated into PHY 122, it is very likely that the number of answers that demonstrate full competency will increase to the 70% mark. These results may also be mitigated by the fact that both general physics courses are more rigorous and more difficult than the astronomy courses.

Conclusions

In summary, the assessment confirmed that the majority of the students have met the BOR outcomes 1, 2, and 4. The results also indicate that students in all levels from introductory or concepts to the higher levels were successful in achieving these competencies, which suggests the pedagogy in the various courses was also successful. However, this study suggests several changes that may improve student performance as well as simplify the collection of this information. As in any process improvement strategy, the integration of assessments into courses such that evaluations of BOR competencies may be performed seamlessly in the future should be developed. In this way, if properly integrated into the course, future assessment tools may be able to include the assessment of complicated or dense material such as course projects or laboratory reports. Instructors could simply report those items needed by an assessment committee and a separate assessment tool will not be needed. However, the tool used here was sufficient. The issue of simply guessing at a multiple-choice exam is belied by the very consistent pattern of an exponential decrease in the frequency of answers that demonstrate lower competence. This trend is seen in all of the graphs despite the many and very different courses from which the data was collected. This trend is also not artificially built into the assessment as individual instructors as experts in their field wrote all of the questions.

In order to further student competency, courses should continue to integrate and reinforce the scientific terminology and theories as well as improve the use of models to ensure stronger performance in BOR learning outcome 2. This may be accomplished through improved communication with instructors regarding the importance of emphasizing all of the BOR outcomes in classroom discussions and will be particularly important in multi-section courses. Professional development activities may be a good avenue to achieve this. In some courses, additional models are needed and should be purchased. In addition, the development of robust assignments and rubrics that will enable direct assessment of course SLOs, which are directly aligned with BOR SLOs, should be an ongoing part of the process of continuous improvement.

Finally, assessments for online courses must be examined. The inability to obtain the required data from online courses using Blackboard was problematic. Instructors or a lead instructor should consult with our Distance Learning Director regarding the means of collecting individual

student responses to assessment questions. Once this is known, professional development activities would be an effective way to disseminate the information.