Assessment Data Mathematical, Information and Computer Sciences
General Education: Physics

Learning Outcome:

1e. Quantitative Reasoning: Students will be able to solve problems that are quantitative in nature

Components of this outcome as defined by the department:
- Translation of words or into equations and conclusions
- Calculations and mathematical reasoning
- Reasonable and realistic view of nature

Outcome Measure:

Final exam questions embedded in the following general education courses: University Physics (PHY241), General Physics (PHY141), and Cosmos (PSC105). Select questions throughout the semester in tests, quizzes, and homework were compiled for use in Earth Science (PSC103).

Criteria for Success:

At least 70% of students will have an average above 2.5 on each area of the Physics and Engineering Quantitative Reasoning Rubric. These aspects of quantitative reasoning in a scientific context are as follows: (1) translating graphs and words into equations and conclusions (2) calculation and mathematical reasoning (3) reasonable view of nature.

Scale Used:
0   Unsatisfactory - Completely Incorrect
1   Low Satisfactory - Missed more than one key concept or step
2   Satisfactory - Missed one key concept or step
3   High Satisfactory - Made a minor error
4   Outstanding - Completely correct

Longitudinal Data:

		Translation words or graphis into equations and conclusions	Calculations and mathematical reasoning	Reasonable and realistic view of nature
PHY141	Fall 2009	100%	100%	86%
PHY141	Fall 2010	93%	96%	72%
PHY141	Fall 2012	98%	100%	82%
PHY141	Fall 2013	98%	100%	75%
PHY141	Summer 2014	100%	100%	67%
PHY141	Summer 2015	100%	100%	83%
PHY141	Summer 2016	98%	90%	88%
PHY141	Summer 2017	100%	100%	100%
PHY141	Fall 2017	95%	85%	90%
PHY142*	Spring 2017	70%	90%	75%
PHY142*	Summer 2017	84%	100%	68%
PHY142*	Spring 2018	90%	95%	85%
PHY241	Spring 2015	100%	96%	100%
PHY241	Spring 2017	100%	100%	95%
PHY241	Spring 2018	84%	100%	89%
PSC103	Fall 2014	87%	87%	77%
PSC103	Fall 2015	79%	77%	87%
PSC103	Fall 2016	95%	89%	95%
PSC105	Fall 2015	96%	92%	100%
PSC105	Spring 2016	57%	85%	86%
PSC105	Fall 2016	100%	65%	88%
PSC105	Spring 2017	90%	100%	95%
PSC105	Fall 2017	95%	95%	90%
PSC105	Spring 2017	85%	90%	90%
PSC110	Fall 2016	95%	75%	100%
PSC110	Spring 2017	90%	95%	95%
PSC111	Fall 2017	90%	95%	95%

*PHY142 assessment was redesigned in the spring of 2017 and the questions were computationally significant. The first question was focused on translation of words into equations.

Note that the following changes have been made in the GE course offerings:
- PSC103 Earth Science has been eliminated as a GE class
- PSC110 Physical Science has been eliminated as a GE class
- PSC111 Physical Science for Teachers has been added as a GE offering focused specifically on the preparation of elementary school teachers.
- PHY113 The Physics of Sound and Music has been added as will be assessed in 2018-19.

Conclusions Drawn from Data:
Overall PSC classes (Earth Science and Cosmos) tend to have a lower level of success on calculation and mathematical reasoning within a scientific context then the introductory physics classes. This is not surprising in that PHY141, PHY142 and PHY241 have significant mathematical pre-requisites, and it is observed that these students are succeeding at applying these skills in a scientific context.

The PSC courses tend to emphasize the reasonable view of nature category, and the corresponding student understanding can be observed in the measures used. PHY141 and PHY241 include a considerable amount of quantitative reasoning. The measures used in these courses are not calibrated to the PSC courses, but are instead designed to identify areas of potential improvement within the context of the expected level of these courses. The measures used tended to be of a more sophisticated nature. This being said, PHY141 consistently shows low success in a reasonable view of nature. The measures used in the this course in this category tend to focus on the correction of misconceptions that students may hold coming into class, and some of these misconceptions tend to be held even after completing the class.

Changes to be Made Based on Data:
Prior to 2014-15, PSC103 did not incorporate significant aspects of calculation (the second criteria). This was increased in the last few years.

Prior to 2015-16, PSC105 did not incorporate significant use of quantitative reasoning. These skills were integrated and measured in 2017-18.

Note that the Physical Science GE courses have been reshaped for the 2017-18 academic year and include an increased emphasis on quantitative reasoning.

Rubric Used

Physics and Engineering Quantitative Reasoning Rubric

	Outstanding (4)	High Satisfactory (3)	Low Satisfactory (2)	Unsatisfactory (1)
Translating words or graphs into equations or conclusions	No mistakes	Few mistakes, mostly correct	Several mistakes, some understanding	Many mistakes, not interpreting information
Calculation and Math Reasoning	No mistakes	Few mistakes	Several mistakes	Many mistakes (incorrect use of data and equations)
Reasonable and realistic view of nature (sense of scale etc.)	Good understanding	Minor misunderstandings	Some clear understandings mixed with some misunderstandings	Significant misunderstandings