GE Standard II: Critical Thinking Standard

Courses seeking to meet the Critical Thinking Standard must:

(i) Require students to engage in particular activities, and
(ii) Use direct assessment to demonstrate improvement of student skills in particular areas

To meet the Standard, courses must address *each* of the five areas listed on the following pages. Direct assessment must be used in *each* area.

The specific requirements for addressing and assessing each Area follow, and are listed under the Area headings themselves. One page is devoted to each of the five Areas.

Physics 161: Physics I

Area 1: Logical Consistency

Briefly describe contexts in which your course will require students to do one or more of the things listed in the following bullet points:

- Understand that concepts share a logical framework. That is, understand that one idea makes sense given another.
- Understand that, given a logical propositional system, no theorem of the system contradicts another.

> Given the logical framework of Newtonian Mechanics, students are asked to predict what will happen in various situations. In essence, students are asked to identify ideas related to motion that follow directly from the propositions of Newtonian Mechanics.

Your course is asked to demonstrate improvement in one or more of the following student skills:

- The ability to offer or evaluate an argument by providing reasons that support the conclusion and employing logically sound argumentation
- The ability to offer or evaluate an argument without allowing a false inference to follow from true premises
- When offering or evaluating an argument, the ability to show that the argument can be proved or at least sufficiently supported by data
- When offering or evaluating an argument, the ability to show that the premises of the argument are true in the actual world
- When discussing an argument, the ability to identify whether the right question or questions are being asked.

Describe what direct assessments you will use in order to demonstrate improvement of such skills among your students.

> Bullets 1&2: In the context of a laboratory on projectile motion, students are presented with a false premise. They are then asked to write a paragraph critiquing the premise, and stating whether or not they agree with it. Students then complete a full analysis of the problem, including an experimental exploration of the problem. Finally, students are allowed to re-analyze the initial premise, altering their conclusion if they wish. Students disagreeing with the premise must describe how a contradictory conclusion follows logically from true premises. The relevant pieces of the Critical Thinking VALUE rubric are used to score student performance pre- and post-.

Area 2: Clarity of Argumentation

Briefly describe contexts in which your course will require students to do one or more of the things listed in the following bullet point:

- Demonstrate an understanding of the process of developing or presenting an argument

Students are asked to formulate proofs and/or "disproofs" on several quizzes that occur throughout Physics 161.

Your course is asked to demonstrate improvement in one or more of the following student skills:

- The ability to clearly state one point at a time
- The ability to elaborate upon a statement if asked
- The ability to provide examples that connect the student's thoughts to life experiences
- The ability to use analogies and metaphors to help people connect the student's ideas to a variety of things that they already understand
- The ability to demonstrate the sequential steps in developing or presenting an argument.

Describe what direct assessments you will use in order to demonstrate improvement of such skills among your students.

Bullet 5: 5 Quiz questions given throughout the term (Weeks 3-14) require the construction of formal proofs, and are tagged as "P" questions. Initial average student score on "P" questions is tracked and compared with final "student average score" on "P" questions. Percentage of students improving is also tracked.

Area 3: Ability to Assess Evidence

Briefly describe contexts in which your course will require students to do one or more of the things listed in the following bullet point:

- Demonstrate the skills required to estimate the value of evidence:

Throughout Physics 161, students are asked to report the uncertainties associated with all data that they measure. They must then consider such uncertainties when drawing conclusions based upon the data.

Your course is asked to demonstrate improvement in one or more of the following student skills:

- The ability to evaluate whether claims are supported by the data provided
- The ability to compare and contrast information that opposes an author's position and that which supports it
- The ability to evaluate whether all information used is clear, accurate, and relevant to the question at issue
- The ability to evaluate whether an author has gathered sufficient information in making an argument
- The ability to assess the extent and weight of any evidence provided

Describe what direct assessments you will use in order to demonstrate improvement of such skills among your students.

Bullet 1: Three laboratories in particular ask students to evaluate whether claims are supported or falsified by the data that they collect. These laboratories involve free-fall motion (Week 4), projectile motion (Week 7), and conservation laws (Weeks 9 and 10). The relevant pieces of the Critical Thinking VALUE rubric are used to score students for each of the three laboratories, and class average performance is tracked and reported for weeks 4, 7, 9, and 10.

Area 4: Ability to Apply Evidence

Briefly describe contexts in which your course will require students to do one or more of the things listed in the following bullet point:

- Demonstrate the skills required to apply evidence during argumentation.

These skills are required throughout the course, and in particular must be employed during the completion of laboratory activities.

Your course is asked to demonstrate improvement in one or more of the following student skills:

- The ability to restrict claims made to those supported by the available data
- The ability to search for and uncover information that opposes your position as well as that which supports it
- The ability to ensure that all information used is clear, accurate, and relevant to the question at issue
- The ability to ensure that sufficient information has been gathered when formulating an argument or position
- The ability to adequately explain the extent and weight of any available evidence

Describe what direct assessments you will use in order to demonstrate improvement of such skills among your students.

Bullet 1: Three laboratories in particular ask students to draw conclusions based solely on data that they collect. These laboratories involve free-fall motion (Week 4), projectile motion (Week 7), and conservation laws (Weeks 9 and 10). The relevant pieces of the Critical Thinking VALUE rubric are used to score students for each of the three laboratories, and class average performance is tracked for weeks 4, 7, 9, and 10.

Area 5: Ability to Reflect upon Assumptions, Including one's Own

Briefly describe contexts in which your course will require students to do one or more of the things listed in the following bullet point:

- Examine assumptions critically, and suspend the conclusions that follow from a particular assumption in order to consider the viability of alternative assumptions and/or propositions.

During the course, students are asked periodically to consider the predictions of theories outside the realm of Newtonian Mechanics. In particular, the predictions of special relativity and quantum mechanics are considered, and the degree to which these predictions differ from those of Newtonian Mechanics is examined critically.

Your course is asked to demonstrate improvement in one or more of the following student skills:

- The ability to recognize the relevance and/or merit of alternative assumptions and perspectives
- The understanding of the process of analyzing, reconsidering, and questioning assumptions

Describe what direct assessments you will use in order to demonstrate improvement of such skills among your students.

Bullet 1: On several quiz questions (tagged "RQM") that occur throughout the term (Weeks 3-14), students are asked to estimate quantitatively how various predictions would change if the ideas of Newtonian Mechanics were suspended and replaced with those of quantum mechanics and/or special relativity. Initial student average performance on RQM questions is reported, as is final student average performance.