

Lamar University

Detailed Assessment Report 2016-17 BA/BS Physics

As of: 8/17/2017 10:10 AM CENTRAL

Student Learning Outcomes/Objectives, with Any Associations and Related Measures, Targets, Findings, and Action Plans

SLO 1: Critical Thinking

Undergraduate Physics students will develop proficiency in critical thinking as demonstrated by the use of structured processes while solving physics problems, starting from correctly identifying what the physics problem is asking for, and ending with the correct solution.

Rationale: The Physics faculty have determined that critical thinking is one of the most important skills in Physics.

Relevant Associations:

General Education/Core Curriculum Associations

- 1 Critical Thinking: Students will apply critical thinking appropriately to identify, analyze and resolve complex issues.

Strategic Plan Associations

Lamar University

- 1.2 Leverage our core strengths while elevating the overall quality of our education and scholarship

Related Measures

M 1: measures-Outcome#1

Outcome #1 will be tested in two senior level courses designed for the Physics majors: PHYS-4320 (Quantum Mechanics) and PHYS-4480 (Optics).

Students will be tested late in the semester, their written exams being collected and copied before being returned to them. The exam copies will be kept on file without student names. The following **Rubric** will be used by a panel of three judges before the grading will occur: the instructor of record and two other faculty members.

Target courses: PHYS-4320 and PHYS-4480

Skill	Level #1	Level #2	Level #3	Level #4
1) Attaching the correct meaning to the given information with proper	The student shows little understanding of what the problem	Some pieces of given information are assigned incorrect meaning	Almost all pieces of given information are attached correct meaning	The student identifies all the relevant pieces of information of the problem.

units	asks for.	and units	and units.		
2) Identifying what the physics problem is asking for	Student does not know what kind of answer is being asked for.	Student shows some gaps in understanding what the problem is about.	Student shows a pretty good understanding of what the problem is asking for.	Student identifies the goal of the problem.	
3) Identifying the physics relationships that need to be used	Student uses the wrong physical principles to solve the problem.	Student only uses some of the physical principles needed to solve the problem and doesn't justify why they are needed.	Student uses the exact physical principles that are needed to solve the problem but doesn't justify why they are needed.	Student uses the exact physical principles that are needed to solve the problem and justifies why they are needed.	
4) Correct application of mathematics and reaching the correct numerical solution	Student is unable to apply mathematics to obtain a solution.	Student makes one or more major mistakes.	Student makes minor mistakes in obtaining the solution.	Student obtains the correct numerical solution without making a single mistake.	

In each of these areas, students receive a score based on four skill levels:

- level 1: unacceptable – 1 point. The student's answer is very poor.
- level 2: poor – 2 points. The student's answer is acceptable.
- level 3: acceptable– 3 points. The student's answer has minor deficiencies.
- level 4: well done – 4 points. The student shows command of the subject.

In order to provide an objective score, the exam of each student will be graded by three judges (the instructor of record and two other faculty members). The student's score will be the average of the scores provided by the three judges.

Source of Evidence: Academic direct measure of learning - other

Target:

A minimum acceptable score is 12 points (averaging 3 points in all four areas investigated). In addition, we would like about 85% of our students to score on levels #3 and #4.

Rationale: By establishing a relatively high minimum acceptable score, we will be able to identify weaknesses in the program.

Finding (2016-17) - Target: Partially Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4480 (Optics) and PHYS-4320 (Quantum Mechanics). During the 2016-2017 period, nine students enrolled in PHYS-4480; and seven students enrolled in PHYS-4320, enabling evaluation of a total number of 16 students. The students have been tested, late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: For each student in each particular skill investigated, we obtained scores by averaging those received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4480 (9 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Attaching the correct meaning to the given information with proper units	0.0%	0.0%	14.8%	85.2%
2) Identifying for what the physics problem is asking	3.7%	7.4%	14.8%	74.1%
3) Identifying the physics relationships that need to be used	0.0%	7.4%	29.6%	63.0%
4) Correct application of mathematics and reaching the correct numerical solution	0.0%	29.6%	18.5%	51.9%

The results show all but two students with average scores above the minimum acceptable score of 12. We find this satisfactory. Last cycle we noted an uptick in the number of students scoring in Level #4 in skills 3 and 4. In this cycle, the averages trended back toward the historic means for skills 3 and 4. We note a slight uptick in the percentage of students scoring at level #2, in particular in Skill 4. Our goal is 85% at or above Level #3, however, in Skill 4, our average was 70.4% above Level #3. Overall, however, we find the results to be satisfactory.

TARGET COURSES: PHYS-4320 (7 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Attaching the correct meaning to the given information with proper units	4.8%	19.0%	23.8%	52.4%
2) Identifying for what the physics problem is asking	14.3%	9.5%	38.1%	38.1%
3) Identifying the physics relationships that need to be used	4.8%	33.3%	28.6%	33.3%
4) Correct application of mathematics and reaching the correct numerical solution	19.0%	28.6%	38.1%	14.3%

The results show three students with average scores below the minimum acceptable score of 12. This is higher than we would like from a class of seven students. Across the board we see an uptick in the number of students on Levels #1 and #2 compared to the historic averages, falling short of our goal of 85% at or above Level #3 in all Skills. This is most notable in Skill 4, a result similar to what was noted in target course PHYS-4480. This will be the target of an action item.

Since every year we test a relatively small number of students, it may be helpful to compare this year's results with the cumulative results of the past few years. Such cumulative results are as follows:

CUMULATIVE DATA FOR OUTCOME 1, 2009-2016 (91 Students)

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Skill	Level #1	Level #2	Level #3	Level #4
1) Attaching the correct meaning to the given information with proper units	0.0%	2.20%	14.29%	83.52%
2) Identifying for what the physics problem is asking	0.0%	2.20%	27.47%	70.33%
3) Identifying the physics relationships that need to be used	3.30%	3.30%	27.47%	65.93%
4) Correct application of mathematics and reaching the correct numerical solution	2.20%	9.89%	30.77%	57.14%

For PHYS-4320 and PHYS-4480 combined, this year's performance is a bit below the cumulative average; but relatively close for all but Skill 4. Combining both courses, we reached or came close to our goal of 85% at or above Level #3 for Skills 1-3. We were not successful in Skill 4. Thus, we consider that Outcome 1 is partially met.

Finding (2015-16) - Target: Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4480 (Optics) and PHYS-4320 (Quantum Mechanics). During the 2015-2016 period, nine students enrolled in PHYS-4480; and twelve students enrolled in PHYS-4320, enabling evaluation of a total number of 21 students. The students have been tested, late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: For each student in each particular skill investigated, we obtained scores by averaging those received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4480 (9 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Attaching the correct meaning to the given information with proper units	0%	0%	11.1%	88.9%
2) Identifying for what the physics problem is asking	0%	0%	11.1%	88.9%
3) Identifying the physics relationships that need to be used	0%	11.1%	11.1%	77.8%
4) Correct application of mathematics and reaching the correct numerical solution	0%	11.1%	22.2%	66.7%

The results show that all but one students are on levels #3 and #4. We find this satisfactory. Comparing to the 2014-2015 cycle, we note an uptick in the number of students scoring Level #4 in skills 3 and 4.

TARGET COURSES: PHYS-4320 (12 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Attaching the correct meaning to the given information with proper units	0%	0%	25.0%	75.0%
2) Identifying for what the physics problem is asking	0%	0%	16.7%	83.3%

3) Identifying the physics relationships that need to be used	0%	8.3%	16.7%	75.0%
4) Correct application of mathematics and reaching the correct numerical solution	0%	16.7%	16.7%	66.7%

The results show that all but two students are on levels #3 and #4. We find this satisfactory. Comparing to the 2014-2015 cycle, we note a marked increase in the percentage of students scoring Level #4 in skills 3 and 4.

Since every year we test a relatively small number of students, it may be helpful to compare this year's results with the cumulative results of the past few years. Such cumulative results are as follows:

CUMULATIVE DATA FOR OUTCOME 1, 2009-2015 (54 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Attaching the correct meaning to the given information with proper units	0%	2.85%	12.85%	84.28%
2) Identifying for what the physics problem is asking	0%	2.85%	31.42%	65.71%
3) Identifying the physics relationships that need to be used	5.5%	1.9%	22.2%	70.4%
4) Correct application of mathematics and reaching the correct numerical solution	2.85%	8.57%	34.28%	54.28%

For both PHYS-4320 and PHYS-4480, this year's performance is about the same as the cumulative average. This shows that our action plan is working; and, from this point of view, we consider that Outcome 1 is met. However, the assessment process needs to continue because a larger amount of statistics is critical to a robust analysis of the action plan effectiveness.

Finding (2014-15) - Target: Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4320 (Quantum Mechanics) and PHYS-4480 (Optics). Six students were enrolled in PHYS-4320 in Fall 2013, whereas ten students were enrolled in PHYS-4480 in Spring 2014. Thus, a total number of **16 students** have been evaluated in 2014-2015. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4320. **Total number of students: 6**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper					

units			16.6%	83.3%	
2) Identifying what the physics problem is asking for			50%	50%	
3) Identifying the physics relationships that need to be used			83.3%	16.6%	
4) Correct application of mathematics and reaching the correct numerical solution			66.6%	33.3%	

The results show that for this course all the students are either on level #3 or level #4, which we find quite satisfactory.

TARGET COURSES: PHYS-4480. Total number of students: 10

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units				100%	
2) Identifying what the physics problem is asking for			20%	80%	
3) Identifying the physics relationships that need to be used			50%	50%	
4) Correct application of mathematics and reaching the correct numerical solution			80%	20%	

The results show that all the students are either on level #3 or #4, which we find very satisfactory.

Since every year we test a small number of students, it may be helpful to compare this year's results with the cumulative results of the past six years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 1 (2009-2015). Total number of students: 54

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given					

information with proper units		2.85 %	12.85 %	84.28 %	
2) Identifying what the physics problem is asking for		2.85 %	31.42 %	65.71 %	
3) Identifying the physics relationships that need to be used	5.5 %	1.9 %	22.2 %	70.4 %	
4) Correct application of mathematics and reaching the correct numerical solution	2.85 %	8.57 %	34.28 %	54.28 %	

For both PHYS-4320 and PHYS-4480, this year's performance is about the same as the cumulative average. Thus, we consider that Outcome 1 is met.

Finding (2013-14) - Target: Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4320 (Quantum Mechanics) and PHYS-4480 (Optics). Ten students were enrolled in PHYS-4320 in Fall 2013, whereas thirteen students were enrolled in PHYS-4480 in Spring 2014. Thus, a total number of **23 students** have been evaluated in 2013-2014. The students have been tested late in the semester, their written exams being collected and copied before being returned to them. For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4320. **Total number of students: 10**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units			10%	90%	
2) Identifying what the physics problem is asking for			80%	20%	
3) Identifying the physics relationships that need to be used			30%	70%	
4) Correct application of mathematics and reaching the correct numerical					

solution			30%	70%	
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The results show that for this course all the students are either on level #3 or level #4, which we find quite satisfactory.

TARGET COURSES: PHYS-4480. **Total number of students: 13**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units			15.39%	84.61%	
2) Identifying what the physics problem is asking for			30.8%	69.2%	
3) Identifying the physics relationships that need to be used			30.6%	69.2%	
4) Correct application of mathematics and reaching the correct numerical solution		23.1%	15.4%	61.5%	

The results show that the majority of students are in level #4, which we find very satisfactory. Only for skill #4 we find students in level #2, which we do not find worrisome.

Since every year we test a small number of students, it may be helpful to compare this year's results with the cumulative results of the past five years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 1 (2009-2014). **Total number of students: 54**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units		3.7 %	14.8 %	81.5 %	
2) Identifying what the physics problem is asking for		3.7 %	31.5 %	64.8 %	
3) Identifying the physics relationships that need to be used	5.5 %	1.9 %	22.2 %	70.4 %	
4) Correct					

application of mathematics and reaching the correct numerical solution	3.7 %	11.1 %	22.2 %	63 %	
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For both PHYS-4320 and PHYS-4480, this year's performance is about the same as the cumulative average. Thus, we consider that Outcome 1 is met.

Finding (2012-13) - Target: Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4320 (Quantum Mechanics) and PHYS-4480 (Optics). Fifteen students were enrolled in PHYS-4320 in Fall 2012, whereas eight students were enrolled in PHYS-4480 in Spring 2013. Thus, a total number of **23 students** have been evaluated in 2012-2013. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4320. Total number of students: 15

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units			60%	40%	
2) Identifying what the physics problem is asking for			53.33%	46.67%	
3) Identifying the physics relationships that need to be used			60%	40%	
4) Correct application of mathematics and reaching the correct numerical solution			73.33%	26.67%	

The results show that for this course all the students are either on level #3 or level #4, which we find quite satisfactory.

TARGET COURSES: PHYS-4480. Total number of students: 8

Skill	Level #1	Level #2	Level #3	Level #4	

1) Attaching the correct meaning to the given information with proper units			12.5%	87.5%	
2) Identifying what the physics problem is asking for			25%	75%	
3) Identifying the physics relationships that need to be used		12.5%	12.5%	75%	
4) Correct application of mathematics and reaching the correct numerical solution		12.5%	37.5%	50%	

The results show that the majority of students are on level #4, which is in line with last year's results and quite an improvement from the results of two years ago.

Since every year we test a small number of students, it may be helpful to compare this year's results with the cumulative results of the past three years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 1 (2009-2012). **Total number of students: 31**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units		6.45 %	16.13 %	77.42 %	
2) Identifying what the physics problem is asking for		6.45 %	16.13 %	77.42 %	
3) Identifying the physics relationships that need to be used	9.68 %	3.22 %	16.13 %	70.97 %	
4) Correct application of mathematics and reaching the correct numerical solution	6.45 %	9.68 %	22.58 %	61.29 %	

For PHYS-4320, this year's performance is about the same as the cumulative average. For PHYS-4480, this year's performance is better than the cumulative average. Therefore, the action plan we have implemented in PHYS-4480 for the past two years have solved the deficiencies that we found three years ago.

Finding (2011-12) - Target: Partially Met

This outcome has been tested in one senior level course designed for the Physics majors: PHYS-4480 (Optics). Seven students were enrolled in PHYS-4480 in Spring 2012. Thus, a total number of **seven students** have been evaluated in 2011-2012. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4480. **Total number of students: 7**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units				100%	
2) Identifying what the physics problem is asking for				100%	
3) Identifying the physics relationships that need to be used				100%	
4) Correct application of mathematics and reaching the correct numerical solution			14.28 %	85.71 %	

The results show that almost all students are on level #4, which is quite an improvement from last year.

Since every year we test a small number of students, it may be helpful to compare this year's results with the cumulative results of the past three years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 1 (2009-2012). **Total number of students: 24**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units		8.33 %	20.83 %	70.83 %	

2) Identifying what the physics problem is asking for		8.33 %	20.83 %	70.83 %	
3) Identifying the physics relationships that need to be used	12.50 %	4.16 %	20.83 %	62.5 %	
4) Correct application of mathematics and reaching the correct numerical solution	8.33 %	12.50 %	25.00 %	54.16 %	

Clearly, this year's performance is much better than the cumulative average, and therefore the action plan we implemented this year is working well.

Finding (2010-11) - Target: Partially Met

This outcome has been tested in one senior level course designed for the Physics majors: PHYS-4480 (Optics). Seven students were enrolled in PHYS-4480 in Spring 2012. Thus, a total number of **seven students** have been evaluated in 2011-2012. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4480. **Total number of students: 7**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units				100%	
2) Identifying what the physics problem is asking for				100%	

3) Identifying the physics relationships that need to be used				100%	
4) Correct application of mathematics and reaching the correct numerical solution			14.28 %	85.71 %	

The results show that almost all students are on level #4, which is quite an improvement from last year.

Since every year we test a small number of students, it may be helpful to compare this year's results with the cumulative results of the past three years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 1 (2009-2012). Total number of students: 24

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units		8.33 %	20.83 %	70.83 %	
2) Identifying what the physics problem is asking for		8.33 %	20.83 %	70.83 %	
3) Identifying the physics relationships that need to be used	12.50 %	4.16 %	20.83 %	62.5 %	
4) Correct application of mathematics and reaching the correct numerical solution	8.33 %	12.50 %	25.00 %	54.16 %	

Related Action Plans (by Established cycle, then alpha):

For full information, see the *Details of Action Plans* section of this report.

Extra Assignment in PHYS-4320

Established in Cycle: 2016-17

A higher-than-desired number of students scored below Level #3 for SLO #1 in PHYS-4320 and PHYS-4480, in particular for Skill ...

SLO 2: Developing mathematical models and standard derivations in physics

Students should be able to develop mathematical models and standard derivations in physics, in a logically structured manner.

Rationale: The Physics faculty have determined that analytical skills are essential to a physics major.

Relevant Associations:**General Education/Core Curriculum Associations**

- 1 Critical Thinking: Students will apply critical thinking appropriately to identify, analyze and resolve complex issues.
- 2 Quantitative Thinking: Students will demonstrate mastery of quantitative reasoning and algorithms used to address applied problems

Strategic Plan Associations**Lamar University**

- 1.2 Leverage our core strengths while elevating the overall quality of our education and scholarship

Related Measures**M 2: measures-Outcome#2**

This Outcome will be tested in two senior level courses designed for the Physics majors: PHYS-4320 (Quantum Mechanics) and PHYS-4370 (Solid State Physics)

Target courses: PHYS-4320 and PHYS-4370

Skill	Level #1	Level #2	Level #3	Level #4	
1) Gathering information and notation (symbol assignment and units)	Student is unable to translate most of the problem's statement into math.	Student is able to translate some parts of the problem's statement into math.	Student is able to translate most of the problem into math.	Student is able to translate the statement of the problem into math.	
2) Stating and applying relevant principles, laws, or relationships	Student is unable to identify the physical principles needed to solve the problem	Student identifies only some of the physical principles needed to solve the problem, and doesn't justify why he uses them.	Student identifies the physical principles needed to solve the problem, but doesn't justify why they are needed.	Student identifies the exact physical principles that are needed to solve the problem, and justifies why they are needed.	
	Student is unable to write down the necessary mathematical	Student writes down only a few of the mathematical manipulations needed to	Student writes down all the mathematical manipulations needed to	Student writes down all the mathematical manipulations needed to reach the solution	

3) Mathematical Developments (math skills)	manipulations needed to reach the solution.	reach the solution and/or makes several mistakes.	reach the solution but makes small mistakes	without making a single mistake.	
4) Logically structured presentation	Student's derivation doesn't have an internal logic.	Many steps in the student's derivation are not justified.	Almost all steps in the student's derivation follow logically from one another.	Each step in the student's derivation follows logically from its predecessor.	

In each of these areas, students receive a score based on four skill levels:

- level 1: unacceptable – 1 point. The student's answer is very poor.
- level 2: poor – 2 points. The student's answer is acceptable.
- level 3: acceptable– 3 points. The student's answer has minor deficiencies.
- level 4: well done – 4 points. The student shows command of the subject.

In order to provide an objective score, the exam of each student will be graded by three judges (the instructor of record and two other faculty members). The student's score will be the average of the scores provided by the three judges.

Source of Evidence: Academic direct measure of learning - other

Target:

A minimum acceptable score is 12 points (averaging 3 points in all four areas investigated). In addition, we would like about 85% of our students to score on levels #3 and #4.

Rationale: By establishing a relatively high minimum acceptable score, we will be able to identify weaknesses in the program.

Finding (2016-17) - Target: Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4370 (Solid State Physics) and PHYS-4320 (Quantum Mechanics). During the 2016-2017 period, seven students enrolled in PHYS-4370; and seven students enrolled in PHYS-4320, enabling evaluation of a total number of 14 students. The students have been tested, late in the semester, their written exams being collected and copied before being returned to them. As part of an action item, an additional assignment was given in PHYS-4320, earlier in the semester. This allows us to track the performance of the students across the conclusion of the semester and also enable a better interpretation of their performance with a more diverse assessment.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: For each student in each particular skill investigated, we obtained scores by averaging those received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4370 (7 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Gathering information and notation (symbol assignment and units)	0.0%	0.0%	4.8%	95.2%

2) Stating and applying relevant principles, laws, or relationships	0.0%	0.0%	0.0%	100%
3) Mathematical Developments (math skills)	0.0%	0.0%	14.3%	85.7%
4) Logically structured presentation	0.0%	4.8%	33.3%	61.9%

The results show all students on levels #3 and #4 with most on level #4. We find these results quite satisfactory. Comparing to the 2015-2016 cycle, we note this maintains the outstanding performance seen earlier.

TARGET COURSES: PHYS-4320 (7 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Gathering information and notation (symbol assignment and units)	0.0%	23.8%	19.0%	57.1%
2) Stating and applying relevant principles, laws, or relationships	4.8%	33.3%	33.3%	28.6%
3) Mathematical Developments (math skills)	4.8%	19.0%	47.6%	28.6%
4) Logically structured presentation	4.8%	28.6%	19.0%	47.6%

The results show all but two students on levels #3 and #4. We find these results satisfactory. As part of an action item, a tracking assignment was administered mid-way through the semester. This tracking assignment was designed to test the same concepts as the assignment administered at the end of the semester. In the mid-semester assignment, only a single student scored in Level 3 or above. Thus, the results show marked improvement across the course of the semester, which we consider a success. We also note that for most (if not all) of the students tested, here, PHYS-4320 provides a first encounter of a new set of very challenging mathematical concepts. We interpret the marked improvement across the course of the semester as students transitioning from an initial struggle with the concepts to a final level of competency at the end of the semester.

Since every year we test a relatively small number of students, it may be helpful to compare this year's results with the cumulative results of the past few years. Such cumulative results are as follows:

CUMULATIVE DATA FOR OUTCOME 2, 2009-2016 (100 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Gathering information and notation (symbol assignment and units)	0.0%	3.00%	15.00%	82.00%
2) Stating and applying relevant principles, laws, or relationships	0.0%	4.00%	36.00%	60.00%
3) Mathematical Developments (math skills)	0.0%	5.00%	33.00%	62.00%
4) Logically structured presentation	0.0%	6.00%	25.00%	69.00%

Combining the scores for PHYS-4320 and PHYS-4370, this year's performance is similar to the cumulative average. All skills are within two standard deviations of our goal of 85% at or above Level #3. Thus, we consider that Outcome 2 is met. Performance for Skill 4 is still a bit below our desired level, so we will continue with the existing action

plan to improve upon Skill 4.

Finding (2015-16) - Target: Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4370 (Solid State Physics) and PHYS-4320 (Quantum Mechanics). During the 2015-2016 period, nine students enrolled in PHYS-4370; and twelve students enrolled in PHYS-4320, enabling evaluation of a total number of 21 students. The students have been tested, late in the semester, their written exams being collected and copied before being returned to them. For PHYS-4370, an additional assignment was given earlier in the second half of the semester. This allows us to track the performance of the students across the conclusion of the semester and also enable a better interpretation of their performance with a more diverse assessment.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: For each student in each particular skill investigated, we obtained scores by averaging those received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4370 (9 Students)

Skill	Level #1	Level #2	Level #3	Level #4
EARLY ASSESSMENT (7 Students)				
1) Gathering information and notation (symbol assignment and units)	0%	0%	0%	100%
2) Stating and applying relevant principles, laws, or relationships	0%	0%	14.3%	85.7%
3) Mathematical Developments (math skills)	0%	0%	0%	100%
4) Logically structured presentation	0%	0%	28.6%	71.4%
LATE ASSESSMENT (9 Students)				
1) Gathering information and notation (symbol assignment and units)	0%	0%	0%	100%
2) Stating and applying relevant principles, laws, or relationships	0%	0%	22.2%	77.8%
3) Mathematical Developments (math skills)	0%	0%	11.1%	88.9%
4) Logically structured presentation	0%	0%	22.2%	77.8%

The results show all students on levels #3 and #4 with most on level #4. The results are quite consistent across the course of the semester, as well. We find these results quite satisfactory. Comparing to the 2014-2015 cycle, we note this maintains the outstanding performance seen earlier. Concerning the two assignments assessed for 2015-2016, the second is much more difficult than the first in terms of mathematical and physics rigor. The results show that on the second assignment the students performed comparably well to the first assignment, which is a good outcome. These results are satisfactory. The purpose of giving the two assignments was to test the student capability to solve a more difficult assignment later in the semester. However, in order to get a more quantitative insight into the student improvement during the semester, next year we are planning to test them early and late in the semester, with two assignments of equal difficulty.

TARGET COURSES: PHYS-4320 (12 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Gathering information and notation (symbol assignment and units)	0%	8.3%	25.0%	66.7%
2) Stating and applying relevant principles, laws, or relationships	0%	8.3%	33.3%	58.3%
3) Mathematical Developments (math skills)	0%	8.3%	25.0%	66.7%
4) Logically structured presentation	0%	16.7%	25.0%	58.3%

The results show that all but two students are on levels #3 and #4. We find this satisfactory. Comparing to the 2014-2015 cycle, we note an increase in the percentage of students scoring Level #4 in skills 2 and 3. We would like to improve the performance in skill 4 and will implement an action item for the next cycle.

Since every year we test a relatively small number of students, it may be helpful to compare this year's results with the cumulative results of the past few years. Such cumulative results are as follows:

CUMULATIVE DATA FOR OUTCOME 2, 2009-2015 (62 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Gathering information and notation (symbol assignment and units)	0%	3.22%	16.12%	80.64%
2) Stating and applying relevant principles, laws, or relationships	0%	4.83%	41.93%	53.22%
3) Mathematical Developments (math skills)	0%	6.45%	33.87%	59.67%
4) Logically structured presentation	0%	6.44%	29.03%	64.51%

For both PHYS-4320 and PHYS-4470, this year's performance is in-line with the cumulative average. This shows that our action plan is working; and, from this point of view, we consider that Outcome 2 is met with a plan to improve upon skill 4 in PHYS-4320. However, the assessment process needs to continue because a larger amount of statistics is critical to a robust analysis of the action plan effectiveness.

Finding (2014-15) - Target: Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4320 (Quantum Mechanics) and PHYS-4370 (Solid State Physics). In Fall 2014, six students were enrolled in PHYS-4320, whereas eleven students were enrolled in PHYS-4370. Thus, **17 students** were evaluated in 2014-2015. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSE: PHYS 4320. Total number of students: 6

Skill	Level #1	Level #2	Level #3	Level #4	
1) Gathering Information and Notation (symbol assignment and units)			33.33%	66.67 %	
2) Stating and applying relevant Principles, Laws, or Relationships			50 %	50 %	
3) Mathematical Developments (math skills)			50 %	50 %	
4) Logically structured presentation			33.33%	66.67%	

The results show that all students are either in level #3 or #4, in line with the improvement we saw last year. This shows that the improved action plan that we implemented for this outcome worked again this year.

TARGET COURSE: PHYS 4370. Total number of students: 11

Skill	Level #1	Level #2	Level #3	Level #4	
1) Gathering Information and Notation (symbol assignment and units)				100 %	
2) Stating and applying relevant Principles, Laws, or Relationships			9.09 %	81.81 %	
3) Mathematical Developments (math skills)			45.45 %	54.54 %	
4) Logically structured presentation				100 %	

The results show that, except for Skill 3, the vast majority of students are on level #4. Even on Skill 3 the majority of students are on level #4. We find these results very satisfactory.

It is always helpful to compare this year's results with the cumulative average of the past six years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 2 (2009-2012).Total number of students: 62

Skill	Level #1	Level #2	Level #3	Level #4	
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1) Gathering information and notation (symbol assignment and units)		3.22 %	16.12%	80.64 %	
2) Stating and applying relevant Principles, Laws, or Relationships		4.83 %	41.93 %	53.22 %	
3) Mathematical Developments (Math skills)		6.45 %	33.87 %	59.67 %	
4) Logically structured presentation		6.44 %	29.03 %	64.51 %	

Comparison of the cumulative data with this year's data shows that the results of PHYS-4370 and PHYS-4320 are in line with the cumulative average, which shows that our actions plans for these two courses have worked out well.

Finding (2013-14) - Target: Partially Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4320 (Quantum Mechanics) and PHYS-4370 (Solid State Physics). In Fall 20123 ten students were enrolled in PHYS-4320, whereas eight students were enrolled in PHYS-4370. Thus, **18 students** were evaluated in 2013-2014. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level. \

TARGET COURSE: PHYS 4320. **Total number of students: 10**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Gathering Information and Notation (symbol assignment and units)				100 %	
2) Stating and applying relevant Principles, Laws, or Relationships			10 %	90 %	
3) Mathematical Developments (math			10 %	90 %	

skills)					
4) Logically structured presentation			10 %	90%	

The results show that the vast majority of the class (90% or above) is in level #4, a tremendous improvement from the last two years. This shows that the improved action plan that we implemented for this outcome is working.

TARGET COURSE: PHYS 4370. Total number of students: 8

Skill	Level #1	Level #2	Level #3	Level #4	
1) Gathering Information and Notation (symbol assignment and units)				100 %	
2) Stating and applying relevant Principles, Laws, or Relationships			37.5 %	62.5 %	
3) Mathematical Developments (math skills)			12.5 %	87.5 %	
4) Logically structured presentation			37.5 %	62.5 %	

The results show that all students are either on level #3 or on level #4, which is a good result.

It is always helpful to compare this year's results with the cumulative results of the past five years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 2 (2009-2012).Total number of students: 45

Skill	Level #1	Level #2	Level #3	Level #4	
1) Gathering information and notation (symbol assignment and units)		4.4 %	17.8%	77.8 %	
2) Stating and applying relevant Principles, Laws, or Relationships		4.4 %	48.9 %	46.7 %	
3) Mathematical Developments (Math skills)		8.9 %	28.9 %	62.2 %	
4) Logically structured presentation		8.9 %	35.6 %	55.5 %	

Comparison of the cumulative data with this year's data shows that the results of PHYS-4370 and PHYS-4320 are in line with the cumulative average, which shows that our actions plans for these two courses are working.

Finding (2012-13) - Target: Partially Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4320 (Quantum Mechanics) and PHYS-4370 (Solid State Physics). In Fall 2012, fifteen students were enrolled in PHYS-4320, whereas six students were enrolled in PHYS-4370. Thus, **21 students** were evaluated in 2012-2013. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level. \

TARGET COURSE: PHYS 4320. Total number of students: 15

Skill	Level #1	Level #2	Level #3	Level #4	
1) Gathering Information and Notation (symbol assignment and units)		26.67%	33.33 %	40 %	
2) Stating and applying relevant Principles, Laws, or Relationships		33.33%	33.33 %	33.33%	
3) Mathematical Developments (math skills)		20 %	46.67 %	33.33 %	
4) Logically structured presentation		46.67%	20%	33.33%	

The results show that about one third of the class are on level #2, which should be addressed.

TARGET COURSE: PHYS 4370. Total number of students: 6

Skill	Level #1	Level #2	Level #3	Level #4	
1) Gathering Information					

and Notation (symbol assignment and units)			50 %	50 %	
2) Stating and applying relevant Principles, Laws, or Relationships			50 %	50%	
3) Mathematical Developments (math skills)			33.33%	66.67%	
4) Logically structured presentation			33.33 %	66.67%	

The results show that all students are either on level #3 or on level #4, which is a good result.

It is always helpful to compare this year's results with the cumulative results of the past three years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 2 (2009-2012). **Total number of students: 27**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Gathering information and notation (symbol assignment and units)		7.41%	29.63%	62.96%	
2) Stating and applying relevant Principles, Laws, or Relationships		7.41%	66.67%	25.92%	
3) Mathematical Developments (Math skills)		14.81%	40.74%	44.44%	
4) Logically structured presentation		14.81%	44.44%	40.74%	

Comparison of the cumulative data with this year's data shows that in PHYS-4370 we have had better results than last year, which shows that our action plan for this course is working. However, for PHYS-4320 the results show no improvement with respect to the previous year, which shows that we need to improve the action plan for this course.

Finding (2011-12) - Target: Partially Met

This outcome has been tested in one senior level course designed for the Physics majors: PHYS-4370 (Solid State Physics). **Five students** were enrolled in PHYS-4370 in Fall 2011. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSE: PHYS 4370. Total number of students: 5

Skill	Level #1	Level #2	Level #3	Level #4	
Gathering Information and Notation (symbol assignment and units)			60 %	40 %	
Stating and applying relevant Principles, Laws, or Relationships			100 %		
Mathematical Developments (math skills)		20 %	60 %	20 %	
Logically structured presentation		20 %	80 %		

The results show that one student was on level #2.

Since drawing conclusions from the performance of five students is difficult, it may be helpful to compare this year's results with the cumulative results of the past two years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 2 (2009-2012).Total number of students: 22

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units		9.09 %	22.72 %	68.18 %	
2) Identifying what the physics problem is asking for		9.09 %	59.09 %	31.81 %	
3) Identifying the physics relationships that need to be used		13.63 %	36.36 %	50 %	
4) Correct application of mathematics and reaching the correct numerical solution		13.63%	36.36 %	50 %	

Comparison of the cumulative data with this year's data shows that this year we have had a larger portion of our students scoring on level #2 and not many on level #4, which should be addressed.

Finding (2010-11) - Target: Partially Met

This outcome has been tested in one senior level course designed for the Physics majors: PHYS-4320 (Quantum Mechanics). **Three students** were enrolled in PHYS-4320 in Fall 2010. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSE: PHYS-4320 and PHYS 4370. **Total number of students: 3**

Skill	Level #1	Level #2	Level #3	Level #4	
Gathering Information and Notation (symbol assignment and units)		33.33 %		66.67 %	
Stating and applying relevant Principles, Laws, or Relationships		33.33 %		66.67 %	
Mathematical Developments (math skills)		33.33 %	33.33 %	33.33 %	
Logically structured presentation		33.33 %		66.67 %	

The results show that one student was on level #2.

Since drawing conclusions from the performance of three students is difficult, it may be helpful to compare this year's results with the cumulative results of the past two years. Such cumulative results are as follows:

CUMULATIVE DATA for OUTCOME 2 (2009-2011). **Total number of students: 17**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units		11.76 %	11.76 %	76.47%	
2) Identifying what the physics problem is asking for		11.76%	47.05 %	41.17 %	

3) Identifying the physics relationships that need to be used		11.76%	23.52 %	58.82 %	
4) Correct application of mathematics and reaching the correct numerical solution		11.76%	29.41 %	64.70 %	

Comparison of the cumulative data with this year's data shows that this year we have had a larger portion of our students scoring on level #2, which should be addressed.

Finding (2009-10) - Target: Partially Met

All Physics tenured, tenure-track and non-tenured faculty have met and discussed the evaluations. For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the same Rubric format. For each skill, the percentages add up to 100%. We describe the procedure of calculating the percentages in the next paragraph (**How were results reviewed?**).

TARGET COURSE: PHYS-4320 and PHYS 4370

Skill	Level #1	Level #2	Level #3	Level #4	
Gathering Information and Notation (symbol assignment and units)		7.14 %	14.28 %	78.57 %	
Stating and applying relevant Principles, Laws, or Relationships		7.14 %	57.14 %	35.71 %	
Mathematical Developments (math skills)		7.14 %	28.57 %	64.28 %	
Logically structured presentation			35.71 %	64.28 %	

How were results reviewed?

This year (2009-2010), we have continued using the procedure

that we used in the past two years. The results are given in terms of how the student scores are distributed on the skill levels #1 to #4. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

The results show that about 7.14% of the students are on level #2, while 92.86 % are on levels #3 and #4. In addition, only one student overall score was not acceptable (below 12 points, averaging less than 3 in all three skills).

Related Action Plans (by Established cycle, then alpha):

For full information, see the *Details of Action Plans* section of this report.

Tracking assignment in PHYS 4320 and PHYS 4370

Established in Cycle: 2015-16

Our previous action plan has targeted SLO #2 in PHYS-4370 and PHYS-4320, giving an additional assignment targeting the noted d...

SLO 3: Communicating physics processes in writing

Students should be able to correctly draw graphs of physical processes, write equations and use notations and symbols. Writing skills are particularly important (clarity, sentence structure, spelling), and they mostly refer to the students' ability to express their ideas in a scientific manner.

Rationale: The Physics faculty have determined that technical writing is an skill all physics majors should master.

Relevant Associations:

General Education/Core Curriculum Associations

3 Communication: Students will develop written and oral presentations that are clear, precise, organized, efficient and appropriately adapted to audience and purpose.

Strategic Plan Associations

Lamar University

1.2 Leverage our core strengths while elevating the overall quality of our education and scholarship

1.5 Tell Lamar University's story to connect the communities we serve with our mission, our accomplishments, and our aspirations

Related Measures

M 3: measures-Outcome #3

This Outcome will be tested in three senior level courses designed for the Physics majors: PHYS-4310 (Experiments in Physics), PHYS-4370 (Solid State Physics), and PHYS-4480 (Optics).

Students will be tested late in the semester, their written exams being collected and copied before being returned to them. The exam copies will be kept on file without student names. The following **Rubric** will be used by a panel of three judges, before the grading will occur: the instructor of record and two other faculty members.

Target courses: PHYS-4310, PHYS-4370, and PHYS-4480

Skill	Level #1	Level #2	Level #3	Level #4	
1) Technical correctness of graphs, equation, notation, and symbols	Student doesn't organize graphs, equations, notation and symbols correctly.	Some mathematical symbols and equations are missing or are incorrect.	Most of the technical aspects of the answer are correct.	All the technical aspects of the answer are correct and logically organized.	
		The format of the answer	The answer's presentation has some	The student's	

	2) Organization and neatness of the presentation and/or software skills.	The student's answer is messy and unclear.	makes it difficult to understand it.	minor deficiencies (e.g., it is cramped).	answer is clearly organized.	
	3) Writing skills (clarity, sentence structure, spelling).	After a couple of readings, it is still unclear what the student is trying to say.	You need to re-read the student's answer in order to understand it.	Except for some minor flaws, the student's answer reads well.	There is no problem in understanding the answer.	
	4) Technical and literary merit of any conclusions and/or results.	Student draws either trivial or incorrect conclusions.	Student gives a superficial interpretation.	Student gives the correct interpretation to the solution of the problem but his explanation is incomplete.	Student gives the correct interpretation to the solution of the problem.	

In each of these areas, students receive a score based on four skill levels:

- level 1: unacceptable – 1 point. The student's answer is very poor.
- level 2: poor – 2 points. The student's answer is acceptable.
- level 3: acceptable– 3 points. The student's answer has minor deficiencies.
- level 4: well done – 4 points. The student shows command of the subject.

In order to provide an objective score, the exam of each student will be graded by three judges (the instructor of record and two other faculty members). The student's score will be the average of the scores provided by the three judges.

Source of Evidence: Academic direct measure of learning - other

Target:

A minimum acceptable score is 12 points (averaging 3 points in all four areas investigated). In addition, we would like about 85% of our students to score on levels #3 and #4.

Rationale: By establishing a relatively high minimum acceptable score, we will be able to identify weaknesses in the program.

Finding (2016-17) - Target: Met

This outcome has been tested in two senior level courses designed for the Physics majors: PHYS-4480 (Optics) and PHYS-4370 (Solid State Physics). During the 2016-2017 period, nine students enrolled in PHYS-4480 and seven students enrolled in PHYS-4370 for a total of 16 students available for assessment. The students have been tested, late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: For each student in each particular skill investigated, we obtained scores by averaging those received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4480 (9 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols	0.0%	0.0%	37.0%	63.0%
2) Organization and neatness of the presentation and/or software skills	0.0%	3.7%	37.0%	59.3%
3) Writing Skills (clarity, sentence structure, spelling)	0.0%	7.4%	33.3%	59.3%
4) Technical and literary merit of any conclusions and/or results	0.0%	14.8%	44.4%	40.7%

The results show only a single student with an average below 12. We find these results quite satisfactory. Comparing to the 2015-2016 cycle, we note this maintains the outstanding performance seen earlier.

TARGET COURSES: PHYS-4370 (7 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols	0.0%	0.0%	19.0%	81.0%
2) Organization and neatness of the presentation and/or software skills	0.0%	0.0%	14.3%	85.7%
3) Writing Skills (clarity, sentence structure, spelling)	0.0%	0.0%	19.0%	81.0%
4) Technical and literary merit of any conclusions and/or results	0.0%	0.0%	23.8%	76.2%

The results show all students with averages above 12. We find these results quite satisfactory. Comparing to the 2015-2016 cycle, we note this maintains the outstanding performance seen earlier.

CUMULATIVE DATA FOR OUTCOME 3, 2009-2016 (142 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols	0.70%	4.93%	16.90%	77.46%
2) Organization and neatness of the presentation and/or software skills	0.0%	5.63%	26.11%	66.19%
3) Writing Skills (clarity, sentence structure, spelling)	0.0%	7.04%	33.80%	59.15%
4) Technical and literary merit of any conclusions and/or results	0.0%	9.85%	40.14%	50.00%

Compared to the cumulative average, this year's performance increased the number of students in Levels #3 and #4 in all Skills. Thus, we consider that Outcome 3 is met.

Finding (2015-16) - Target: Met

This outcome has been tested in one senior level course designed for the Physics majors: PHYS-4480 (Optics). During the 2015-2016 period, PHYS-4310 (Experiments in Physics) did not meet the requisite number of students to make. Additionally, given the consistently excellent performance noted over the last few cycles, we decided for 2015-2016 to redirect PHYS-4370 (Solid State Physics) to an additional assessment for outcome 2 for which performance has not been as consistent. PHYS-4310 will meet in Fall 2016, however, giving us another assessment of outcome 3 for the next cycle. Nine students enrolled in PHYS-4480. The students have been tested, late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the Rubric. In calculating the percentages, we used the following procedure: For each student in each particular skill investigated, we obtained scores by averaging those received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4480 (9 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols	0%	11.1%	0.0%	88.9%
2) Organization and neatness of the presentation and/or software skills	0%	0%	11.1%	88.9%
3) Writing Skills (clarity, sentence structure, spelling)	0%	0%	11.1%	88.9%
4) Technical and literary merit of any conclusions and/or results	0%	0%	33.3%	66.7%

The results are excellent with only a single student on level #2 for a single skill. We find this very satisfactory, consistent with previous years.

Since every year we test a relatively small number of students, it may be helpful to compare this year's results with the cumulative results of the past few years. Such cumulative results are as follows:

CUMULATIVE DATA FOR OUTCOME 2, 2009-2015 (133 Students)

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols	0.75%	4.51%	18.04%	76.69%
2) Organization and neatness of the presentation and/or software skills	0%	6.01%	27.12%	64.66%
3) Writing Skills (clarity, sentence structure, spelling)	0%	7.51%	35.34%	57.14%
4) Technical and literary merit of any conclusions and/or results	0%	10.52%	40.60%	48.87%

This year's performance is at or above the level of the cumulative average. This shows that our action plan is working, and from this point of view, we consider that Outcome 3 is met. However, the assessment process needs to continue because in order to get a good statistics, we need a larger amount of data.

Finding (2014-15) - Target: Met

In 2014-2015, this outcome has been tested in three senior level courses designed for Physics majors: PHYS-4480 (Optics), PHYS-4370 (Solid State Physics), and PHYS-4310 (Experiments in Physics). Ten students were enrolled in PHYS-4480 (Optics), eleven students were enrolled in PHYS-4370 (Solid State Physics), and four students were enrolled in PHYS-4310 (Experiments in Physics). Thus, a total number of **25 students** have been evaluated in 2013-2014. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the same Rubric format. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSE: PHYS-4480

Total number of students: 10

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols				100 %
2) Organization and neatness of the presentation and/or software skills			40 %	60 %
3) Writing Skills (clarity, sentence structure, spelling)			40 %	60 %
4) Technical and literary merit of any conclusions and/or results			40%	60 %

Clearly, these are excellent results.

TARGET COURSE: PHYS-4370

Total number of students: 11

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols				100 %
2) Organization and neatness of the presentation and/or software skills			18.18 %	81.81 %
3) Writing Skills (clarity, sentence structure, spelling)			36.36 %	63.63 %
4) Technical and literary merit of any conclusions and/or results			36.36 %	63.63 %

These are also excellent results.

TARGET COURSE: PHYS-4310

Total number of students: 4

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation,		50 %		50 %

and symbols				
2) Organization and neatness of the presentation and/or software skills		50%	25 %	25 %
3) Writing Skills (clarity, sentence structure, spelling)		50 %		50 %
4) Technical and literary merit of any conclusions and/or results		25 %	50 %	25%

These results are not as good as in the previous two courses. However, since the number of students tested in Physics 4310 is small (just four students, compared to 21 students in the other two courses), we don't find it worrisome.

As in the previous outcomes, it is illuminating to compare this year's results with the cumulative results of the past six years:

CUMULATIVE DATA for OUTCOME 3 (2009-2014). Total number of students: 108

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units	0.92 %	3.7 %	22.22 %	73.14 %	
2) Identifying what the physics problem is asking for		5.55 %	26.92 %	64.81 %	
3) Identifying the physics relationships that need to be used		7.4 %	36.11 %	56.48 %	
4) Correct application of mathematics and reaching the correct numerical solution		12.03 %	40.74 %	47.22 %	

From the above charts, we can see that this year's results are about the same as the average of the previous years, which prompts us to conclude that this target has been met.

Finding (2013-14) - Target: Met

In 2013-2014, this outcome has been tested in three senior level courses designed for Physics majors: PHYS-4480 (Optics), PHYS-4370 (Solid State Physics), and PHYS-4310 (Experiments in Physics). Thirteen students were enrolled in PHYS-4480 (Optics), eight students were enrolled in PHYS-4370 (Solid State Physics), and

ten students were enrolled in PHYS-4310 (Experiments in Physics). Thus, a total number of **thirty one students** have been evaluated in 2013-2014. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the same Rubric format. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSE: PHYS-4480

Total number of students: 13

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols			23 %	77 %
2) Organization and neatness of the presentation and/or software skills			23 %	77 %
3) Writing Skills (clarity, sentence structure, spelling)			38 %	62 %
4) Technical and literary merit of any conclusions and/or results			31%	69 %

Clearly, these are excellent results.

TARGET COURSE: PHYS-4370

Total number of students: 8

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols				100 %
2) Organization and neatness of the presentation and/or software skills			13 %	87 %
3) Writing Skills (clarity,				

sentence structure, spelling)			25 %	75 %
4) Technical and literary merit of any conclusions and/or results			50 %	50 %

These are also excellent results.

TARGET COURSE: PHYS-4310

Total number of students: 10

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols			30 %	70 %
2) Organization and neatness of the presentation and/or software skills			30 %	70 %
3) Writing Skills (clarity, sentence structure, spelling)			80%	20 %
4) Technical and literary merit of any conclusions and/or results		10 %	70 %	20%

Similar to the previous courses, these are excellent results.

As in the previous outcomes, it is illuminating to compare this year's results with the cumulative results of the past five years:

CUMULATIVE DATA for OUTCOME 3 (2009-2014). **Total number of students: 83**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units	1.2 %	2.4 %	28.9 %	67.5 %	
2) Identifying what the physics problem is asking for		4.8 %	30.1 %	65.1 %	
3) Identifying the physics relationships that need to be used		7.2 %	37.3 %	55.5 %	
4) Correct application of mathematics and reaching the correct numerical solution		14.4 %	41 %	44.6 %	

From the above charts, we can see that this year's results are as good or better than the average of the previous years, which prompts us to conclude that this target has been met.

Finding (2012-13) - Target: Met

In 2012-2013, this outcome has been tested in three senior level courses designed for the Physics majors: PHYS-4480 (Optics), PHYS-4370 (Solid State Physics), and PHYS-4310 (Experiments in Physics). Eight students were enrolled in PHYS-4480 (Optics), six students were enrolled in PHYS-4370 (Solid State Physics), and seven students were enrolled in PHYS-4310 (Experiments in Physics). Thus, a total number of **twenty one students** have been evaluated in 2012-2013. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the same Rubric format. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSE: PHYS-4480

Total number of students: 8

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols				100%
2) Organization and neatness of the presentation and/or software skills			37.5%	62.5%
3) Writing Skills (clarity, sentence structure, spelling)			25%	75%
4) Technical and literary merit of any conclusions and/or results			25%	75%

Clearly, these are excellent results.

TARGET COURSE: PHYS-4370

Total number of students: 6

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols			50%	50%
2) Organization and neatness of the presentation and/or software skills			33.33%	66.67%
3) Writing Skills (clarity, sentence structure, spelling)			33.33%	66.67%
4) Technical and literary merit of any conclusions and/or results		33.33%	50%	16.67%

These are also excellent results, except for Skill 4), which we do not find to be a serious concern.

TARGET COURSE: PHYS-4310

Total number of students: 7

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols			57.14%	42.86%
2) Organization and neatness of the presentation and/or software skills			57.14%	42.86%
3) Writing Skills (clarity, sentence structure, spelling)			42.86%	57.14%
4) Technical and literary merit of any conclusions and/or results			42.86%	57.14%

Similar to the previous courses, these are excellent results.

As in the previous outcomes, it is illuminating to compare this year's results with the cumulative results of the past three years:

CUMULATIVE DATA for OUTCOME 3 (2009-2012). **Total number of students: 52**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with	1.92%	3.84%	34.62%	59.62%	

proper units					
2) Identifying what the physics problem is asking for		7.69%	34.62%	57.69%	
3) Identifying the physics relationships that need to be used		11.53%	30.77%	57.69%	
4) Correct application of mathematics and reaching the correct numerical solution		21.15 %	36.54%	42.31%	

From the above charts, we can see that this year's results are better than the average of the previous years, which prompts us to conclude that this target has been met.

Finding (2011-12) - Target: Met

This outcome has been tested in three senior level courses designed for the Physics majors: PHYS-4480 (Optics), PHYS-4370 (Statistical Physics), and PHYS-4310 (Experiments in Physics). Seven students were enrolled in PHYS-4480 (Optics), five students were enrolled in PHYS-4370 (Statistical Physics), and five students were enrolled in PHYS-4310 (Experiments in Physics). Thus, a total number of **seventeen students** have been evaluated in 2011-2012. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the same Rubric format. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4480, PHYS-4370, and PHYS-4310
number of students: 17

Total

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation,		5.88%	29.41 %	64.70 %

and symbols				
2) Organization and neatness of the presentation and/or software skills		11.76 %	29.41 %	58.82 %
3) Writing Skills (clarity, sentence structure, spelling)		17.64 %	17.64 %	64.70 %
4) Technical and literary merit of any conclusions and/or results		23.52 %	29.41 %	47.05 %

The results show that almost all students are on levels #3 and #4. Although about 15% of the students scored on level #2, we do not feel that there is a serious issue to be address here, because about 60% of the students scored on level #4.

As in the previous outcomes, it is illuminating to compare this year's results with the cumulative results of the past two years:

CUMULATIVE DATA for OUTCOME 3 (2009-2012). Total number of students: 35

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units	2.85 %	2.85 %	37.14 %	57.14 %	
2) Identifying what the physics problem is asking for		5.71 %	37.14 %	57.14 %	
3) Identifying the physics relationships that need to be used		8.57 %	37.14 %	54.28 %	
4) Correct application of mathematics and reaching the correct numerical solution		20 %	40 %	40 %	

From the above two charts, we can see that this year's results are in line with the previous two years. We can also see that, except for skill 4, over 90% of the students scored on either level #3 or #4, which prompts us to conclude that this target has been met once again this year.

Finding (2010-11) - Target: Met

This outcome has been tested in one senior level course designed for the Physics majors: PHYS-4480 (Optics). **Six students** were enrolled in PHYS-4480 in Fall 2009. The students have been tested late in the semester, their written exams being collected and copied before being returned to them.

For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the same Rubric format. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

TARGET COURSES: PHYS-4480

Total number of students: 6

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols	16.67 %		33.3 %	50 %
2) Organization and neatness of the presentation and/or software skills			50 %	50 %
3) Writing Skills (clarity, sentence structure, spelling)			66.67 %	33.33 %
4) Technical and literary merit of any conclusions and/or results		33.33 %	33.33 %	33.33 %

The results show that almost all students are on levels #3 and #4. Although in Skill 1 one student scored on level #1 and in Skill 4 two students scored on level #2, we do not feel that there is a serious issue to be address here. We will however watch carefully the results of next year, in order to see if we have some students consistently scoring on levels #1 and #2.

As in the previous outcomes, it is illuminating to compare this year's results with the cumulative results of the past two years:

CUMULATIVE DATA for OUTCOME 3 (2009-2011). **Total number of students: 18**

Skill	Level #1	Level #2	Level #3	Level #4	
1) Attaching the correct meaning to the given information with proper units	5.56 %		44.44 %	50 %	
2) Identifying what the physics problem is asking for			44.44 %	55.56 %	
3) Identifying the physics relationships that need to be used			55.56 %	44.44 %	
4) Correct application of mathematics and reaching the correct numerical solution		16.67%	50 %	33.33 %	

From the above two charts, we can see that this year's results are in line with the previous two years. We can also see that about 85% of the students scored on either level #3 or #4, which we consider acceptable.

Finding (2009-10) - Target: Partially Met

All Physics tenured, tenure-track and non-tenured faculty have met and discussed the evaluations. For each area investigated, the results below are given in terms of how the student scores are distributed on the skill levels #1 to #4. Their distribution is indicated with percentages in the same Rubric format. For each skill, the percentages add up to 100%. We describe the procedure of calculating the percentages in the next paragraph (**How were results reviewed?**).

TARGET COURSES: PHYS-4480 and PHYS-4310

Skill	Level #1	Level #2	Level #3	Level #4
1) Technical correctness of graphs, equations, notation, and symbols			50 %	50 %
2) Organization and neatness of the presentation and/or software skills			41.67 %	58.33 %
3) Writing Skills (clarity, sentence structure, spelling)			50 %	50 %
4) Technical and literary merit of				

any conclusions and/or results

8.33 %

58.33 %

33.33 %

How were results reviewed?

This year (2009-2010), we have continued using the procedure that we used in the past two years. The results are given in terms of how the student scores are distributed on the skill levels #1 to #4. In calculating the percentages, we used the following procedure: for each student in each particular skill investigated, we took the average score obtained by averaging the scores received from the three faculty members. Then, for each area investigated, we calculated the percentage of students that fall within each skill level.

The results show that about most students are on levels #3 and #4. In addition, all students' overall scores were acceptable or very good (above 12 points, averaging more than 3 in all three skills).

Details of Action Plans for This Cycle (by Established cycle, then alpha)

Tracking assignment in PHYS 4320 and PHYS 4370

Our previous action plan has targeted SLO #2 in PHYS-4370 and PHYS-4320, giving an additional assignment targeting the noted deficiencies. The plan has worked nicely in bringing up the scores in both courses. However, a higher-than-desired number of students still scored on Level #2 for SLO #2 in PHYS-4320. This target focuses on the mathematical skills of our students; and we would like to understand better how those skills develop, as the course progresses. We will therefore implement a tracking assignment, similar to what was done, this year, in PHYS-4370. We will assess for SLO #2 an assigned problem around the midway point of the semester in addition to a problem at the end of the semester. This will allow us to gauge the mathematical skills at two different points in the semester to track development. We will also continue to implement this procedure in PHYS-4370.

2016-2017 UPDATE: Our first implementation of this occurred in the Fall 2016 semester. We noticed in PHYS-4320 that students showed marked improvement from the middle of the semester to the end of the semester. We feel this action has already improved our understanding of student development, thus, we will continue to implement this action item for the next cycle, looking for ways to leverage this to improve instruction for SLO #2.

Established in Cycle: 2015-16

Implementation Status: In-Progress

Priority: High

Relationships (Measure | Outcome/Objective):

Measure: measures-Outcome#2 | **Outcome/Objective:** Developing mathematical

models and standard derivations in physics

Responsible Person/Group: Jim Drachenberg/Bogdana Bahrim

Extra Assignment in PHYS-4320

A higher-than-desired number of students scored below Level #3 for SLO #1 in PHYS-4320 and PHYS-4480, in particular for Skill 4. This target focuses on the application of mathematics to reach the correct solution. Following in the manner of previously successful action items, we will implement an extra assignment in PHYS-4320, targeted toward mathematics application. This assignment will be targeted toward the beginning of the semester, when the mathematical formalism of quantum mechanics is presented for the first time. The students will be able to leverage the extra practice toward improved performance in SLO #1 skills across the course of the semester.

Established in Cycle: 2016-17

Implementation Status: Planned

Priority: High

Relationships (Measure | Outcome/Objective):

Measure: measures-Outcome#1 | **Outcome/Objective:** Critical Thinking

Responsible Person/Group: Jim Drachenberg