Instructional Program Review
2019/20 UPDATE

Physics

Created on: 09/04/2019 11:09:00 AM PST
Last Modified: 01/10/2020 03:57:35 PM PST

Created with watermark

Table of Contents

General Information (Instructional Program Review 2019/20 UPDATE)

Created with watermark

2019/20 Instructional Program Review

SUBMISSION INFORMATION AND UPDATES (REQUIRED)

- Name of Lead Writer : Claude Mona
- Name of Liaison : Pegah Motaleb
- Department Chair : Don Barrie
- Name of Manager/Service Area Supervisor : Susan Topham
- Is this a CTE program? (State Yes or No) : No

This is the start of a new era in the physics department with the first hires of new contract faculty in over a decade. The program added three tenure track positions, filling the vacancies left by the retirement of two contract faculty over the past five years and preparing for the impending retirement of a third. The addition of new faculty reduces the excessive reliance on adjunct instructors and should lead to a more equitable division of administrative tasks within the program.

In the short term, the departure of one of the physical science ILTs will lead to scheduling issues but this is expected to be a temporary setback. The program still faces ongoing challenges related to availability of equipment and the sporadic funding produced by the BARC process. It would greatly improve the program's ability to plan for the long term if there were an alternate means of funding capital equipment.

OUTCOMES AND ASSESSMENT (REQUIRED)

Form: 2019/20 Program Review Outcomes and Assessment Section (See appendix)

File Attachments:

1. **JMalden equipstate.pdf**
   Student letter of concern re: condition of laboratory equipment.

PROGRAM ANALYSIS FOR EQUITY AND EXCELLENCE (REQUIRED)

Form: 2019/20 Program Review Instructional Program Analysis Section (See appendix)

File Attachments:

1. **Demographic Graphic PR2019.pdf**
   Breakdown of success among student populations.

PROGRAM GOALS (REQUIRED)

2018/2019 Physics Program Goals

Update and Innovate Laboratory Curriculum

Assuming the funding of a second, full time ILT position, the program needs to devote time and energy to developing new laboratory experiments with which to demonstrate the principles of physics.

Created with watermark

Mapping

CA- Mesa College Strategic Directions and Goals: Strategic Goal 1.1, Strategic Goal 1.4, Strategic Goal 1.6, Strategic Goal 4.1, Strategic Goal 4.2, Strategic Goal 6.2,

Institutional Learning Outcomes 2016/17: Communication, Critical Thinking, Information Literacy

Hire Contract Faculty

It has been 12 years since the last hire. Contract faculty are retiring and it is necessary to find new faculty to help the program maintain the standard of excellence and plan for future growth.

Mapping

CA- Mesa College Strategic Directions and Goals: Strategic Goal 1.1, Strategic Goal 1.2, Strategic Goal 1.3, Strategic Goal 1.4, Strategic Goal 1.5, Strategic Goal 1.6, Strategic Goal 2.1, Strategic Goal 2.2, Strategic Goal 3.2, Strategic Goal 3.3, Strategic Goal 4.1, Strategic Goal 4.2,

Institutional Learning Outcomes 2016/17: Communication, Critical Thinking, Information Literacy, Professional & Ethical Behavior

Adapt to Lab Spaces

Identify challenges particular to the laboratory environment in the new building and develop strategies/methods to ameliorate or minimize any negative impact on student learning.

Mapping

CA- Mesa College Strategic Directions and Goals: Strategic Goal 1.1, Strategic Goal 1.4, Strategic Goal 1.6,

Institutional Learning Outcomes 2016/17: Communication, Critical Thinking, Information Literacy

ACTION PLANS FOR GOALS (REQUIRED)

Actions

2018/2019 Physics Program Goals

Goal

Goal: Update and Innovate Laboratory Curriculum

Assuming the funding of a second, full time ILT position, the program needs to devote time and energy to developing new laboratory experiments with which to demonstrate the principles of physics.

Action: Increase Budget

Describe the actions needed to achieve this objective:	Budget Augmentation Request must be completed and submitted to the appropriate committee for review.
Who will be responsible for overseeing the completion of this objective:	Lead Writer

Created with watermark

Provide a timeline for the actions:	Request to be completed in 2018/2019 Program Review cycle
Describe the assessment plan you will use to know if the objective was achieved and effective:	If the program budget is increased and the program becomes able to reach the end of the year without greatly exceeding the allotted budget.
List resources needed to achieve this objective and associated costs (Supplies, Equipment, Computer Equipment, Travel & Conference, Software, Facilities, Classified Staff, Faculty, Other):	Additional funds must be made available to the physical sciences department.

Action: Innovation in the Laboratory

Describe the actions needed to achieve this objective:	Faculty and ILT meet and discuss ideas for new laboratory experiments. ILT and faculty collaborate to produce design parameters for required materials.
Who will be responsible for overseeing the completion of this objective:	ILT implements design and produces materials.
Provide a timeline for the actions:	After the filling of the ILT position originally requested in 2003.
Describe the assessment plan you will use to know if the objective was achieved and effective:	If new experiments are produced, the objective will have been achieved. Effectiveness will be determined by feedback based on laboratory experiences. Feedback will inform any modifications to equipment or procedure.
List resources needed to achieve this objective and associated costs (Supplies, Equipment, Computer Equipment, Travel & Conference, Software, Facilities, Classified Staff, Faculty, Other):	Classified Staff - Instructional Laboratory Technician Increased budget to repair and replace failing equipment.

Goal: Hire Contract Faculty

It has been 12 years since the last hire. Contract faculty are retiring and it is necessary to find new faculty to help the program maintain the standard of excellence and plan for future growth.

Action: New Faculty Hires

Describe the actions needed to achieve this objective:	Complete program review faculty requests Cross fingers and wait

Who will be responsible for overseeing the completion of this objective:	Lead Program Review Writer
Provide a timeline for the actions:	By December 1, 2017
Describe the assessment plan you will use to know if the objective was achieved and effective:	The program receives approval to hire new faculty.
List resources needed to achieve this objective and associated costs (Supplies, Equipment, Computer Equipment, Travel & Conference, Software, Facilities, Classified Staff, Faculty, Other):	Resources: 3 contract faculty.

Goal: Adapt to Lab Spaces

Identify challenges particular to the laboratory environment in the new building and develop strategies/methods to ameliorate or minimize any negative impact on student learning.

Action: Magnetic Signatures

Describe the actions needed to achieve this objective:	Create a map of the magnetic field in the electricity and magnetism laboratory space. Experimental results can be greatly affected by extraneous magnetic fields and it is important to identify regions of the laboratory space that are most affected.
Who will be responsible for overseeing the completion of this objective:	Physics 196 faculty and the ILT (if schedule permits)
Provide a timeline for the actions:	The last survey was completed about three years ago. It is hoped that the influences from the magnetized rebar used in the building construction will continue to decrease. Since changes are slight, a regular sampling schedule of about five years is adopted.
Describe the assessment plan you will use to know if the objective was achieved and effective:	When magnetic fields decrease to about the same level as the Earth's magnetic field, then they would have no discernible effect and could be ignored in the analysis of experimental data.
List resources needed to achieve this objective and associated costs (Supplies, Equipment, Computer Equipment, Travel & Conference, Software, Facilities, Classified Staff, Faculty, Other):	Time. Nothing practical can be undertaken to speed up the process.

Created with watermark

GOAL STATUS REPORT (REQUIRED)

Action Statuses

2018/2019 Physics Program Goals

Goal

Goal: Update and Innovate Laboratory Curriculum

Assuming the funding of a second, full time ILT position, the program needs to devote time and energy to developing new laboratory experiments with which to demonstrate the principles of physics.

Action: Increase Budget

Describe the actions needed to achieve this objective:	Budget Augmentation Request must be completed and submitted to the appropriate committee for review.
Who will be responsible for overseeing the completion of this objective:	Lead Writer
Provide a timeline for the actions:	Request to be completed in 2018/2019 Program Review cycle
Describe the assessment plan you will use to know if the objective was achieved and effective:	If the program budget is increased and the program becomes able to reach the end of the year without greatly exceeding the allotted budget.
List resources needed to achieve this objective and associated costs (Supplies, Equipment, Computer Equipment, Travel & Conference, Software, Facilities, Classified Staff, Faculty, Other):	Additional funds must be made available to the physical sciences department.

Status for Increase Budget

Current Status:	In Progress
If the Current Status was marked Completed, what was the impact of the completed objective on your program:	
If the Current Status was not marked Completed,	Budget Augmentation is necessary to maintain fully functional laboratory spaces. With no increase in the program budget for the past fifteen years, the

Created with watermark

what are the implications and next steps:	program is beginning to experience equipment failure and is unable to replace equipment in a timely fashion. As such, the request for budget augmentation will be repeated until such time as it is granted.

Action: Innovation in the Laboratory

Describe the actions needed to achieve this objective:	Faculty and ILT meet and discuss ideas for new laboratory experiments. ILT and faculty collaborate to produce design parameters for required materials.
Who will be responsible for overseeing the completion of this objective:	ILT implements design and produces materials.
Provide a timeline for the actions:	After the filling of the ILT position originally requested in 2003.
Describe the assessment plan you will use to know if the objective was achieved and effective:	If new experiments are produced, the objective will have been achieved. Effectiveness will be determined by feedback based on laboratory experiences. Feedback will inform any modifications to equipment or procedure.
List resources needed to achieve this objective and associated costs (Supplies, Equipment, Computer Equipment, Travel & Conference, Software, Facilities, Classified Staff, Faculty, Other):	Classified Staff - Instructional Laboratory Technician Increased budget to repair and replace failing equipment.

Status for Innovation in the Laboratory

Current Status:	In Progress
If the Current Status was marked Completed, what was the impact of the completed objective on your program:	
If the Current Status was not marked Completed, what are the implications and next steps:	This process is never expected to reach completion. As new ideas emerge from Physics Education Research, best practices change and the program adopts and implements them. This requires continual reevaluation of the equipment used and the experimental procedures set forth to gather the data. Chronic underfunding of the Physical Sciences Department budget has created a scenario where equipment fails faster than it can be replaced. BARC requests are far too fickle to be used for long term planning.

Goal: Hire Contract Faculty

It has been 12 years since the last hire. Contract faculty are retiring and it is necessary to find new faculty to help the

Created with watermark

program maintain the standard of excellence and plan for future growth.

Action: New Faculty Hires

Describe the actions needed to achieve this objective:	Complete program review faculty requests Cross fingers and wait
Who will be responsible for overseeing the completion of this objective:	Lead Program Review Writer
Provide a timeline for the actions:	By December 1, 2017
Describe the assessment plan you will use to know if the objective was achieved and effective:	The program receives approval to hire new faculty.
List resources needed to achieve this objective and associated costs (Supplies, Equipment, Computer Equipment, Travel & Conference, Software, Facilities, Classified Staff, Faculty, Other):	Resources: 3 contract faculty.

Status for New Faculty Hires

Current Status:	Completed
If the Current Status was marked Completed, what was the impact of the completed objective on your program:	The first new hires in over a decade have provided the physics program with a reprieve from the 'adjunctification' of the core courses used to prepare students for transfer to a four year institution in pursuit of a STEM degree. New collaborations are producing exciting opportunities for our student's success.
If the Current Status was not marked Completed, what are the implications and next steps:	

Goal: Adapt to Lab Spaces

Identify challenges particular to the laboratory environment in the new building and develop strategies/methods to ameliorate or minimize any negative impact on student learning.

Action: Magnetic Signatures

Describe the actions needed to achieve this	Create a map of the magnetic field in the electricity and magnetism laboratory space. Experimental results can be greatly affected by extraneous magnetic fields

Created with watermark

objective:	and it is important to identify regions of the laboratory space that are most affected.
Who will be responsible for overseeing the completion of this objective:	Physics 196 faculty and the ILT (if schedule permits)
Provide a timeline for the actions:	The last survey was completed about three years ago. It is hoped that the influences from the magnetized rebar used in the building construction will continue to decrease. Since changes are slight, a regular sampling schedule of about five years is adopted.
Describe the assessment plan you will use to know if the objective was achieved and effective:	When magnetic fields decrease to about the same level as the Earth's magnetic field, then they would have no discernible effect and could be ignored in the analysis of experimental data.
List resources needed to achieve this objective and associated costs (Supplies, Equipment, Computer Equipment, Travel & Conference, Software, Facilities, Classified Staff, Faculty, Other):	Time. Nothing practical can be undertaken to speed up the process.

Status for Magnetic Signatures

No Status Added

Request Forms

CLASSIFIED POSITION, BARC AND FACULTY POSITION REQUEST

Created with watermark

Reviewers

LIAISON'S REVIEW

Form: Instructional Program Liaison's Review 2019/20 UPDATE

MANAGER'S REVIEW

Form: Instructional Program Manager's Review 2019/20 UPDATE

Created with watermark

Appendix

A. **2019/20 Program Review Outcomes and Assessment Section** (Form)
B. **2019/20 Program Review Instructional Program Analysis Section** (Form)

Created with watermark

Form: "2019/20 Program Review Outcomes and Assessment Section"

Created with : Taskstream
Participating Area: Physics

(REQUIRED) Program name

Physics

(REQUIRED) Are you on target with your assessment schedule?

Yes. The physics program continues to gather data on course learning outcomes in all sections of all classes, each semester. We are on track to complete the assessment cycles on time.

(REQUIRED) What have your assessments revealed about your courses/programs/service area/school/division/office?

One the one hand, the assessments tell us nothing that we did not already know after years of physics education research. Physics is difficult for many students, for a variety of reasons. Deficits in reading comprehension, language deficits, mathematical deficits and inability to employ deductive reasoning hamper student success when taken separately. When combined, these deficits almost guarantee that students will not successfully complete the physics sequence required for transfer without repeating one or more courses. In the case of the physics general education courses (PHYS100) the effects of poor mathematical preparation are far less pronounced, but the rest of the impediments to student success remain though the lack of emphasis on mathematical ability ensures that the success and completion rates are higher in this course than others.

On the other hand, the assessments have revealed some granular data about the nature of these deficits. For example, the difficulty many calculus students have with performing simple algebraic operations is unexpected but revealed by the assessments. Documented confusion regarding fundamental mathematical operations and principles show that some physics students have passed the prerequisite courses without gaining any real understanding of the material. This hinders their ability to benefit from (or complete) the physics course work since they are often too confused by the mathematics to enable them to understand the larger point.

Poor reading abilities limit the ability to translate the problem statement into a solvable framework and leads to difficulty in following written instructions in the laboratory. Anecdotal evidence from meetings among program faculty show instructors have resorted to reading laboratory instructions to students, often several times. These are not isolated events. Poor reading comprehension also affects exam scores as students misread problem statements and offer incorrect solutions as a result. Limited abilities to analyze graphical data (calculating and interpreting slope values and intercepts) produced in the laboratory lead to misconceptions or foster confusion about the subject matter. This is especially troubling as the main purpose of the laboratory exercises in physics are to demonstrate the general principles that are developed in the lecture sessions and are designed to reduce confusion and clarify the main points of an admittedly abstract subject.

The data also shows that these deficits and misconceptions are amazingly resistant to change through faculty interventions. Faculty have used past assessment results to target known areas of confusion and misunderstanding with the expectation that the assessment results would show positive effects of such targeted interventions. Not only has this not been the case, in some expectation-defying instances the results have gotten worse. There is some inherent logic to this situation, however.

In the US education system students typically encounter physics in their last year of high school and many do not take any physics classes at all. This is especially true among traditionally under represented student populations. The percentages of high school graduates who had taken biology courses is 96%, chemistry 70% and physics a mere 36% (https://nces.ed.gov/fastfacts/display.asp?id=97). Among those graduating high school, only 26% of African Americans and 26% of Hispanics took any physics classes. In comparison, 62% of African Americans and 56% of Hispanics took chemistry courses (http://www.nsf.gov/statistics/seind06/append/c1/at01- 18.pdf).

By the time students reach a Mesa College physics course, their mathematical, reading and analytic skills are highly resistant to the rapid changes that are often required to reach a level of understanding required to succeed within a single semester. Anecdotal evidence does suggest that students learn from their failures in physics, often citing a need to relearn some fundamental mathematics in preparation for their next attempt. Sometimes failure can be a catalyst for prioritizing education over employment as students come to realize that success in STEM fields requires a significant time investment and recall of information presented in prerequisite courses. This necessarily disadvantages the 'pump and dump' approach to education in which cramming and short term retention of material in pursuit of a passing exam grade fail to pay long-term dividends as students leave significant gaps in their knowledge base.

The success rates for the various course levels would seem to bear out at least part of this interpretation of results. The first semester of the engineering physics sequence has the lowest success rates, while students that succeed in the first semester are unlikely to fail in the subsequent courses as they have acquired the necessary skill set. Again, data is limited, but conversations between faculty and students does seem to support the notion that the first semester of engineering physics can serve as a 'wake-up call' that highlights self-defeating techniques or over-estimation of academic abilities without significant effort. Failure is usually not viewed as a growth opportunity, yet that is exactly what physics demands of the students. Too many students view lack of immediate success as evidence that they are ill-suited to pursue a STEM education. Struggle is viewed as anathema.

(REQUIRED) Based on your assessments, what resource needs have you identified?

Student success in physics can be directly related to time on task, though time is not the sole determinant of success. Unguided self study can be inefficient and sometimes counter productive. Too often, our students turn to solutions manuals, Chegg or other resources that deprive them of the chance to develop resilience and mastery of the material. The formation of a learning community is an important catalyst for the development of a deeper understanding of the core material that forms the basis of all engineering disciplines, since discussion and explanation do far more to develop comprehension than copying someone else's solution.

It is often the case that student to student interactions can effect changes in student comprehension more effectively than can occur in the classroom setting. Peer interactions are less organized and afford more opportunity to explore matters only tangentially related to the course material, such as the aforementioned mathematical, language and reading comprehension deficiencies. Peer interactions also allow for discussions about the material at any number of different levels (conceptual, analytical, philosophical) that are required to achieve mastery. Peer mentoring is more effective than traditional tutoring methods for enabling student success in STEM fields, and the development of the physics peer mentor program was a direct response to these assessment outcomes. Permanent financial support of the peer mentor program is critical for the promotion of student success. It should be noted that while the physics faculty play an integral part in grooming potential mentors and providing the materials used in the peer mentoring sessions, the peer mentoring program is not funded by the physics program.

Please provide any other comments.

It has been stated before and is important enough to be repeated. The difficulties that many students encounter when studying physics often have very little to do with physics itself. The aggregate effect of skill deficits in multiple areas is to make passing a physics course a significant challenge. The faculty are dedicated to doing everything within their locus of control to enable student success, but a significant amount of effort is required on the part of the student. Anything that can assist students to self-identify and correct these deficits - math workshops, peer mentoring, etc - will be a boon.

Another boon would be laboratory equipment that takes advantage of the technological advances of the past two decades. With the current equipment, rudimentary investigation of fundamental principles is undertaken, and the results are used to 'close the loop' between the classroom discussion and the physical world. While this certainly satisfies the minimum requirements of the course curriculum, there are missed opportunities to increase student comprehension and improve understanding. The lack of a stable funding mechanism for capital equipment purchases and the cumulative effects of a decade or more of under funding the Physical Sciences Department budget have led to a situation where the existing equipment is failing faster than it can be replaced. There is no opportunity for long-term planning and a complete inability to upgrade any of the useable but often archaic equipment. In the modern physics course, these missed opportunities are significant and one of our students took it upon himself to write a letter detailing his concerns. The letter is quoted here in full and a copy is attached to the program review.

========

Jacob VanMalden

Student ID # 5699218

Phone: (603)617-6996

Email: jacob.vanmalden@gmail.com

June 4th, 2019

To Whom It May Concern,

It is difficult to start to learn how the world works through physics. Trying to understand how things work together in ways that we are unable to see. This is especially difficult for people like me that are visual learners. I can read the material and listen to a lecture, but the lab portion is where the lesson comes to life for me. Lab time has always been extremely important to me throughout my education.

This spring I have had the pleasure of attending Professor Mona's Physics 3 class (PHYS 197). This class contained the hardest material for me to learn out of all the physics classes because not only were the concepts hard to understand but it was combined with lab time that was interrupted due to broken, damaged or defective equipment. Almost every lab we had that required any type of specialty tool (beyond a ruler, scale or similar instruments) was damaged or missing due to it previously being damaged. The effects due to the lack of equipment could be seen almost instantly. Groups of two or three students would have to be turned into four or more and, most of the time, two students were only able to interact with the equipment. I would see students sitting and waiting to take down a measurement almost completely detached from what was going on in the lab. This was not due to lack of desire but too many students piled on equipment because another group's equipment broke down. I participated in many labs where I would only be able to interact with the equipment shortly and then forced to take only measurements because we already had too many students for the equipment.

The biggest example of this issue personally was the spectroscopy lab. We were in a group of four students on one piece of equipment. Due to the nature of the spectroscope, to get the most accurate data it was calibrated to only one student with another student to assist. While two of the students in my group used the spectroscope and took data the other student and I worked what we could in the lab and patiently waited for more the data to be collected so we could continue. The part of this the affected me the most was when we were trying to determine the element through the diffraction pattern. I waited to take down the information from the other students. From the data I received, I was unable to correctly determine what element the unknown was. I feel that if I was able to be more involved with the lab I would have been able to better identify what the element was.

Without the help from Professor Mona I feel that I would have not been able to succeed. His ability to make this material exciting helped filled in the gap made by inadequate lab time. Professor Mona provided tremendous help during the class. During many labs I watched Professor Mona piece together or try to fix lab equipment so that students would be able to continue to learn.

Next year I am transferring to a four-year institution and I am worried that it will be difficult to compete with other students that have had access to better lab equipment. Their labs could have provided an understanding of the material that I missed out on. From my experience the quality of the equipment tremendously impacts student's ability to better understand the material. It helps them see how the material relates to their everyday life.

Sincerely,

Jacob VanMalden

Form: "2019/20 Program Review Instructional Program Analysis Section"

Created with : Taskstream
Participating Area: Physics

Program Name

(REQUIRED) Type your program name.

Physics

Part A: In this section, please analyze your program in terms of course success metric. Start by disaggregating the available data by race, gender, and any other parameters of interest to your program and answer the following questions.

(REQUIRED) A1. What patterns do you notice with regard to equity in course success at the program level by race/ethnicity?

You may also conduct analysis by course and/or by modality.

Equity Gap: When a group of students who share a common characteristic (e.g. race/ethnicity) have lower access and/or outcome rates than their peers. The size of the equity gap along with the size of the group determine whether that gap is significant. Larger groups should, statistically, have smaller gaps and therefore when gaps are present (even small ones) they may be significant. Smaller groups will see wider variation in outcomes, therefore gaps should be seen consistently over time and/or reviewed by looking at multiple years in aggregate to determine if they are significant.

As a prelude to the discussion, it should be noted that the populations of 'unreported' or 'other' identifiers add a certain amount of uncertainty in analyzing the rest of the data. In the case that the unreported group enjoys success rates higher (or lower) than one of the identified populations, the natural question is to ask 'how many of the unreported group belonged to the identified population'? Would their inclusion in the appropriate data set change the outcomes at all? Similar issues arise with the 'other' group. From a data perspective, having two ill defined categories hinders any potential analysis.

Given their 'wild card' nature, these two group will be excluded from discussion even though they are typically groups that meet or exceed target levels for student success in the physics program and are present in larger numbers than some of the well defined populations. While this renders much of the analysis suspect, there is no other reasonable way to deal with data that cannot be disaggregated.

===

The long view is that success rates decline as more mathematical ability is required to develop the course content. Success rates in PHYS100 are around 81%. For the PHYS125/126 series, that rate declines slightly to 77%. For the engineering physics sequence - PHYS195/196/197 - the average success rate dips to 69% overall. Possible explanations for this phenomenon are discussed at length in the preceding sections of the program review.

It is important to note that the lowest success rate is in the first semester of a sequence, regardless of whether it is 125/126 or 195/6/7. This dip in success is true for all demographic groups. This could be interpreted to mean that physics is a challenging subject irrespective of prior academic success, and anecdotal evidence would suggest this is a reasonable interpretation. The success rates increase for subsequent semesters for all demographic groups in all courses, though the population sizes decrease. This could mean that some number of students are dropping out of STEM disciplines that require physics as a prerequisite for transfer, or it could mean that these students are attempting the courses at another campus in the district. Those that remain have found ways to overcome the difficulties that hampered success in the first semester, as indicated by greater success rates overall. This could be seen as validation for the view that students needs to reassess how they approach education and engage with the course material. It definitely underscores the reality that pursuing a STEM career is challenging, perhaps even more so for a student population that often cannot afford to be a full time student in truest sense. Competing demands for time on task, family and employment may disadvantage students in the physics program.

Overall, the White and Asian populations show the greatest success rates at 79%, followed by the Filipino (75%) and Latinx (68%) populations. African American students are present in very small numbers, but have success rates similar to the Latinx students (68%). Again, the role of early exposure to competent mathematics and physics education has been discussed in a previous section, and may serve to explain some of the differences in outcomes.

Within each population, women succeed at higher rates than men. In the Asian and White populations, this difference is fairly small, about 3%. For Latinx students, the difference increases to 5%, while Filipinos show a 6% spread between the success rates of men and women. The gap increases to 8% in the African American population. Is this because the women that go into STEM fields have already self-selected the best and hardest working into those disciplines? Could it be that men have an exaggerated idea of their academic abilities? Research has shown that males are more likely to be referred to as 'smart', though paradoxically this leads to a mindset which is counterproductive to success in STEM fields. The fixed ability mindset posits that ability is innate, whereas research has shown that change mindset produces better results for dealing with difficult material. While smart and hard-working is the best combination of traits, students that are 'hard-working' and devote sufficient time on task will out perform any 'smart' students. It is possible that women are better prepared to 'work hard' than their male counterparts and succeed more often as a result. Why this should be more pronounced in certain demographic group than in others is impossible for us to divine.

Data analysis by course shows differences in demographics and overall performance that illustrate the statements made on the matter so far. Attached are a series of graphs that show the success rates by various populations in the different courses offered by the physics program. They illustrate the differences described, but as mentioned earlier, the Unreported and Other groups add difficulty to the data analysis.

(REQUIRED) A2. Do these patterns persist over time (e.g., look at the last five years)? Describe if equity gaps are increasing, decreasing, or staying the same?

The rates of student success in the various courses are remarkably stable over a five year span. While there certainly are year to year fluctuations, by and large the outcomes seem resistant to classroom-centered efforts to shift the averages. This is a recurring conclusion of Physics Education Research papers, namely that students come to physics with many preconceived ideas about physics and these ideas persist despite instruction and laboratory experiments that demonstrate why these ideas are incorrect. Late or nonexistent exposure to the principles and applications of physics before enrolling in a college level physics course leads to increased difficulty with course material. Underrepresented students are more likely to have no exposure to physics and tend to struggle more. By contrast, students have had mathematics education continuously for years prior to entering a college calculus course and while they may still struggle, the ideas and methodologies of the discipline are not completely foreign to them. This reinforces the argument that physics should occupy an earlier place in high school curriculum, but the 'Physics First' movement is facing difficulties in implementation. This has a direct impact on the success rates of under represented students enrolled in the physics program.

(REQUIRED) A3. What factors may have influenced these results? What are your most significant findings?

The data would tend to lend support to the observation that physics is a multi-faceted discipline that combines multiple academic modalities in order for students to succeed. Weaknesses in any of the academic skill sets used in the course work would negatively affect success rates. The nature of the course work is such that there are limited opportunities to significantly correct preexisting academic deficits and so the same groups of students are running afoul of knowledge and skill gaps that persist from prerequisite course work and/or lack of prior exposure to physics concepts.

These skill gaps are not merely hypothetical. Program level discussions between faculty show a consistent set of issues that negatively affect student success, and most of them are not inherently 'physics related'. Time and again, program faculty return to the same issues as being impediments to students success. Namely, weakness in fundamental mathematical skills such as fractions, percentages and algebraic techniques for solving systems of equations negatively impact student success in the physics courses. At the engineering physics level, confusion about the differences between integration and differentiation and a lack of understanding of what calculus 'does' also act to decrease student success rates. There seems to exist a disconnect between the mathematical operations and the underlying reason for undertaking the operations in the first place. For example, students may be able to execute a first derivative test but do not understand what the test accomplishes and what may be inferred from the result.

These observations are supported by the weekly reports from the peer mentoring program. Peer mentors often report that a physics session will become a 'how to do mathematics' session instead of an opportunity to explore course material further. By way of analogy, this would be similar to holding a workshop on how to write an effective English paper but having to spend the workshop time on the differences between nouns and verbs, or why capitalization and punctuation are important to clarity in writing.

Given that many of the traditionally under represented student populations are not attending high schools blessed with an abundance of resources, this can significantly disadvantage them in the physics courses. Not only must they contend with what is an abstract subject, they must do so without a full 'toolbox'. Again, the differences in success rates as the course work becomes more mathematical seem to bear out this interpretation, though it is not the only factor responsible for the existence of the gap.

(REQUIRED) A4. How have you/might you alter practices to increase student success and reduce equity gaps?

In keeping with the latest results from Physics Education Research best practices, considerable effort has been expended to make the classroom time more student-centered. While these efforts have yielded improvement among the students who were already succeeding, there is little that can be done within the confines of the program courses to ameliorate the chronic academic deficiencies that plague many of our students. In response to this situation, the development of the physics peer mentoring program was undertaken in an attempt to provide students with an arena in which these 'preexisting conditions' could be addressed and perhaps corrected. If nothing else, it could highlight the importance of the prerequisite mathematics courses to the success (or failure) of students enrolled in physics program courses.

Currently, the physics program faculty are exploring ways to identify common issues and plan to work with the math department to develop means to address the mathematical issues. It must be stated that any such efforts will obviously only be of value for those students that completed their mathematics prerequisite at Mesa. Since the physics program has a solid reputation for properly preparing students for success after transfer, there are many students enrolled that have completed mathematics courses elsewhere. This makes the issue of 'inadequate mathematical preparation' exceedingly difficult to address without a significant investment of time on the part of the students. Any intervention that requires the student to self-identify as needing assistance and then requires them to invest out of class time on a regular basis makes it difficult to generate an enthusiastic buy-in on the part of most students. Those that need it the most are often those least able to accommodate the demands such interventions make on their schedules.

(REQUIRED) A5. How does your program contribute to the College's identity of being a Hispanic Serving Institution?

This is an interesting question. On the one hand, science is prized for its objectivity. Data is data and mathematical models are not dependent on one's race or ethnicity. By that measure, there is absolutely no contribution to the College's identity of being a HSI.

On the other hand, it is well known that success in physics is influenced by early academic interactions and the program faculty are well aware of cultural differences in the roles of family and school in the Hispanic population. Many Hispanic students are among the first in their family to attend college and as such can benefit from increased faculty interactions and efforts made to develop a sense of community. The peer mentoring program is one such vehicle for enabling student success, helping students to form a learning community with their peers and providing them with a venue in which to explore their understanding of course material and a resource to help address any potential academic shortcomings.

As result of a focus on teaching STEM in an HSI, our faculty have begun to transition their teaching methods to impact High Context learners. This has included more group work activities in which students are responsible for their own learning and the learning of others. These in class activities have included problem solving, worksheets with discussion questions, laboratory-type activities, library projects, simulations and video analysis.

(REQUIRED) A6. Have you identified resource needs? If yes, please list.

Yes, but these needs are primarily in the realm of laboratory equipment and Instructional Laboratory Technician support. A search committee has been assembled and the ILT position should be filled in the near future. As for the persistent shortfall between equipment needs and BARC allocations, there doesn't seem to be a method by which the program can reliably close this gap.

To incorporate more group work, instructors have been limited by a lack of resources for student use. In particular, students do not seem to have their own lap top computers to run simulations, analyze data or write collaborative essays. In the interim, the program ILT repairs and re purposes equipment as necessary to maintain the laboratory learning goals. In the long term, such a strategy is untenable. BARC funds are too irregular to form the basis of a long term plan for bringing the laboratory equipment into the current era. Likewise, the persistent under funding of the Physical Sciences Department budget is finally becoming critical as old equipment continues to fail and there are insufficient funds to repair or replace these essential pieces of equipment.

(REQUIRED) A7. Do any of your program goals address these implications or needs? If not, please develop a new goal that addresses your findings and subsequent reflection.

Yes. The physics program has had an ongoing stated goal of procuring sufficient equipment for use in the laboratory to enhance student success by reducing the size of the laboratory group. We are continually in the process of revising experiments to try and increase student comprehension of fundamental physics principles and the needs of the program as regards new equipment are well documented in the program review and the long series of recurring BARC requests.

Part B: In this section, look at the area of focus you identified in last year's program review and answer the following questions.

(REQUIRED) B1. How have you developed this focus? Are you seeing any results? What are your next steps?

The program focus has been twofold. First, find contract faculty to reduce the dependence on adjunct faculty. Second, procure enough equipment to properly outfit each of the laboratory sections associated with a particular course. While the struggle for equipment is ongoing and haphazard due to the vagaries of the BARC process, success has come on the faculty front. Three full time faculty have been added to the program over the past year. Integration is going well, given that all of the new hires have worked for the program in the past. The introduction of 'fresh blood' has created opportunities for planning beyond the next scholastic term. New courses have been added to the program offerings and there have been more informal and formal faculty meetings than at any time in the past five years.

New faculty have already started to pay dividends to the students by having regularly attended office hours in excess of those that can be provided by our adjunct faculty. Increased coordination within the program has led to the development of new laboratory exercises that are developed with an emphasis on situations similar to those developed in the lecture portion of the physics courses. The administrative burden of CLOs, PLOs, BARC requests and Program Review is being shared in a more equitable fashion and with increased input from different perspectives.

These changes have led to some lively debate about the best practices to be used to maintain the program's success for the students it has typically served well while improving outcomes for those students that may have 'fallen though the cracks' in the past due to an over reliance on adjunct faculty to teach some of the mathematically and conceptually challenging courses that form the engineering physics sequence.