1. Assessment information collected

Four years ago we completely redid our SLOA plan and rubric. Therefore there still is only a limited time record for the new instruments developed for evaluation of our program. Therefore this SLOA report will still have gaps in the data that will be filled in over the coming years as all of the instruments are exercised. Also, because of this many trends are not yet meaningful.

A list of the major data collection tools follows with some of the major results imbedded:

1) A national physics concepts exam, the FCI, is to be given at the beginning & end of PHYS 211x, introductory physics, at the end of PHYS 213x and just before graduation.

- The PHYS 211 class in 2016 showed a pre-test average FCI score of ~46% and a post-test average score of ~70%. This gives a normalized gain of 0.44 which is well above the national average (0.23 for traditional courses and 0.44 for interactive courses [Hake98]). In 2017 the pre-test average FCI score of ~47% and a post-test average score of ~77%. This gives a normalized gain of 0.56 which is also well above the national average (0.23 for traditional courses and 0.44 for interactive courses [Hake98]). In 2018 the pre-test average FCI score of ~46% and a post-test average score of ~72%. This gives a normalized gain of 0.47 which is also well above the national average (0.23 for traditional courses and 0.44 for interactive courses [Hake98]). Our pre-test average is consistent with (in fact, consistently a little above) the national pre-test averages (~44% for Universities [Hake98]), suggesting our students are not as poorly prepared as some say (though our variance is rather large suggesting a wide range of preparation and abilities). The post-test averages of 70%, 77% and 72% are all well above the 60% threshold for understanding Newtonian mechanics and above the national average. We have not yet separated out the students in these classes who are (or become) physics majors but we plan on doing so in the future. The normalized gains in the classes and the final scores suggest the desired learning outcome for the intro class is being well met.
- The Physics 213 classes had an average FCI score of ~71%, ~71% and ~72% again all well above the understanding Newtonian mechanics threshold and consistent with the 211 post-test results.

- The Graduation FCI testing results had an average of ~88%, 98%, and 93% (though in the last two years we did not get all the graduates to take the exam) which exceeds the standard threshold for Mastery of Newtonian mechanics and is actually better than the average FCI scores for our incoming graduate students.

2) Student presentations are evaluated with a presentation form (this is also part of the communications plan).

- In the past 2 years PHYS 381 presentations the student scores (from 26 scores) ranged from 1-5, covering the entire range. The average for the questions was about 3.9/5 from 16 forms in 2019 and 4.5 from 22 forms in 2018 with no notable areas of weakness.

- The physics program now has a capstone project with an oral presentation and a written paper as part of the requirements. Because it was made part of the program only 3 years ago, none of the graduating students in this period were required to do the project. However a few students graduating did choose to do so and have done the presentation and paper. The presentations were scored as uniformly excellent while the papers were overall excellent with a few minor weaknesses noted.

3) Exit interview evaluated with a written form that can be supplemented with an oral interview.

Some of the results are shown below with 5 being best and 1 worst (it should be noted that due to an error, a number of graduates did not receive the link to the form last year):
UAF as a whole provides a stimulating atmosphere for undergraduate study *
8 responses

I am pleased with the curriculum within my degree program *
8 responses

I can recommend my undergraduate physics degree program to another student *
8 responses
Faculty members in the physics department provide a stimulating atmosphere *
8 responses

The quality of instruction in the physics department is high *
8 responses

My advisor was accessible
8 responses
I learned basic physics principles
8 responses

I learned Problem solving/Research skills
8 responses

I learned Computer/Programming skills
8 responses
A few representative comments were:

“The atmosphere in the department was really great and it contributed a lot to our success. Thank you for a great time!”

“Society of Physics Students: Joining SPS was by far the most important decision I made in my undergraduate career. I forgo getting a second degree in math and doing more research so I could be more involved in SPS and this was a very good decision. The knowledge and skills I gained as being a part of SPS have been more important than any core physics class. While it probably didn't improved my academic scores and may even have lowered them, joining SPS brought me into the physics community, showed me how physics is actually done, introduced me to many prominent scientists, connected me with other students from all over the US, taught me most of my
leadership and communication skills, and inspired me to continue to pursue the field. While I know there are some student for whom joining the society may not be as beneficial I think it should be out of the norm not to be a part of SPS even if it is just in a small way. I think it is also very important for keeping underrepresented groups in the program because it offers a very friendly and inclusive community."

“The faculty was extremely friendly and I was able to connect to well with the community of physics students both pursuing a graduate and undergraduate degrees. I was given many opportunities to meet others in the field here and aboard given location of Fairbanks. I feel that there is a lot of opportunities to learn how to use mathematics and basic principles of physics to solve everyday problems but classes could use more emphasis on hands-on learning opportunities. Particular on higher level classes, the practice of gaining a genuine and deeper understanding was often buried with too much emphasis on the mathematics. A physicist should be able to explain a topic in a simple manner before tackling the technicalities of pursuing the exact answer. Giving the students the skill to communicate the essence of a physical phenomena should also be an important feature of the degree, even at higher levels of courses.”

“Computer programming: I feel having a good computer background coming out of a physics degree is one of the most important skills to have these days. In my opinion more important than the skills from any one other physics class. While I have finished my degree having learning a lot of computer programming skills this has almost all been self taught. I would have really like to see more programming homework problems, once a week for the core physics classes would have been great and well worth the sacrifice of other problems. I am certainly not going to remember some random problem from quantum mechanics or E&M, but having consistent programming problems helps maintain and grow ones computer skills."

4) Enumeration of number of students pursuing Education at next level ... or ... Employment of graduating students into appropriate careers enumerated.

- Last year (2019) 2 of our 9 students continued on to graduate school. 2 more are pursuing graduate school and 1 is working in a STEM area (astronomy). The remaining students are unknown.

- This year (2020) at least one of the four students we have graduating in the spring is going on to graduate school, one is preparing for graduate school and one is employed in a technical area.
5) Enumeration of the number of students involved in faculty research.

- In the 2018-20 time frame, at least 9 of our undergraduate students have been involved in research in the physics department with a few more doing research in other UAF STEM departments.

6) An annual survey of student perception of their learning in the program.

The mean score was 3.95 over the last 4 years and 4.4 over the past 2 years.
A few representative comments were:

“The physics department at UAF has some of the most unique opportunities for a physics student or any student interested in the sciences. We live in such a one-of-a-kind place and the department uses this environment to teach and to allow students of any level explore their interests in physics. The faculty is amazing and supportive and make learning the traditionally difficult subject very engaging and fun; piquing curiosity with every class. The labs can be difficult to follow at times but otherwise they are very engaging and push students to understand the subjects being taught through the use of practical application.”

“A better introduction to coding would be helpful; while the current computational physics course is decent, it can be tough for those who have not had sufficient prior coding experience. If adding a coding course prerequisite would be too much, a strong recommendation that students take a coding course prior to taking PHYS 220 would be helpful. Additionally, it would be helpful if there was more continued applications for the skills acquired in 220.

Being sure that students are aware of which module courses may need more background experience would also be helpful (knowing that the plasma physics module is very heavy on applied E&M, for example).

Overall, the program is very rigorous and provides an excellent level of thoroughness. I feel that the quality of the program is such that I would be comfortable placing my problem solving skills in a work/research environment with those of a similar student from any other university, and I would feel well prepared for it.”

“Reaching out to the potential students about the diverse uses this degree offers in the workforce afterwards. Getting more enrollment into the department.”

“A larger variety of instructors.”

“I wish there was a few more Physics degrees available.”

“Better and more opportunities for undergraduates, particularly around research. We have the optics and advanced lab. It would be cool to have one also serve as a general undergraduate learning lab. I also feel like there is no one field or area that the undergraduate program really excels. I do like a good general program, but I also don’t feel like there is anything pulling out-of-state students to the UAF physics program vs. other schools. Why would an undergraduate pick UAF over another school with a good, small physics department?”

“The department has been very helpful and friendly, showing sincere interest in helping me pursue my degree. This personal interest in the student has been incredibly helpful, and it is in my opinion one of the best strengths of the UAF physics department.”
7) **Enumeration of presentations and publications.**

- Our Undergraduate students have been authors on at least 2 research publications.
- Our UG students gave at least 10 presentations including national poster sessions and journal club talks.

8) **A survey of alumni both for their status and their perception of the success of the program evaluated using an alumni survey form - after 1 and 5 years.**

To date there have been 19 responses which is still too little for longitudinal analysis, however there is a great deal of very useful information. A selection of this is below:
Current Status
19 responses

- In full time educational program [graduate school, professional school etc] (fill in section 4, 6 and 7)
- In part time educational program [graduate school, professional school…]
- Employed (fill in section 5, 6 and 7)
- Unemployed and seeking employment (fill in section 6 and 7 if appropriate)
- Unemployed and not seeking employment (fill in section 6 and 7 if a…)

If in educational program:
9 responses

- In Graduate school in Physics or Astronomy - Masters program
- In Graduate school in Physics or Astronomy - PhD program
- In Graduate program in other STEM field
- In Education program
- In other post graduation educational program

Which of the following employment sectors best describes your employer?
13 responses

- Educational Institution
- Government
- Private Sector or Industry
- Other
We use dual questions to assess usefulness of skill and then preparation. (Instructions are: There are two parts to each question. First, which category most closely describes how frequently you use the following knowledge and skills or perform the following activities in your current position (1 = rarely or never, 5 = daily), followed by how well our undergraduate program prepared you for that skill (1= not prepared to 5=well prepared)). A few useful examples follow:

### Frequency of use of “Technical writing”
19 responses

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### Preparation for “Technical writing”
19 responses

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<td>4</td>
<td>21.1%</td>
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<tr>
<td>5</td>
<td>2</td>
<td>10.5%</td>
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We could do better on this fairly important area.
We do quite well on this important area.
We do quite well on this very important area.
We could do better on this fairly important area.
A few representative comments were:

“I felt prepared in my computer/coding skills because much of what I learned was self taught. I wish there had been more computer integration into some of the core physics classes.  

“Great preparation for any field. While I don’t use the direct knowledge I got from the degree in my job, the way of thinking about problems that getting a physics degree taught me helps me every day. Thank you!”  

“Hope the undergraduate lounge is still available to the undergrads.”  

“The opportunity to become involved in research as an undergraduate, especially in research where I was allowed some freedom to explore, was immensely valuable. Many of the skills and intuitions developed during that period have played important roles in my subsequent work.”  

“I appreciated my time at UAF and would choose to do it again. I feel like this survey doesn’t capture what I viewed as the benefits of the program and why I would choose to do it again. The small class sizes were great for added one-on-one with the professors. Most of the faculty were easily approachable and willing to give help where needed. The interdisciplinary nature of research led to many opportunities in other departments at UAF that I wouldn’t have had at many other institutions. My area of interest was Physical Oceanography. My advisor pointed me to an Oceanographer contact at UAF that allowed me to get 3 years of hands-on experience during my undergrad before going to grad school.”  

“Enthusiastic professors who love the material and love teaching are what lay the foundation for our success as students”  

“The small class sizes and approach-ability of the faculty really created an interactive learning environment and helped prepare me for grad school & work after.”

9) Outreach presentations (enumerated and or described) and science fair participation (enumerated and or described).  

- Over the last 2 years the UG Physics students have been involved in many outreach presentations including: more than 6 students each year participating in the Science Potpourri, at least 7 students each year organizing and participating in the Star Party. The UG Physics students were the driving force behind building the Planet walk going from the GI to the Wood center, an educational walk valuable to our students, our community and visitors.
2. Conclusions drawn from the information summarized above

Overall the program is strong with strength in most of the areas we deem important. The FCI results and the number of students continuing on to graduate school suggest that basic physics is being well taught. That said, from the surveys, interviews and comments there are some areas that should be strengthened. 1) More diverse options in physics. 2) More training in writing and presentations. 3) Better training in computational physics.

3. Curricular changes resulting from conclusions drawn above

First we will discuss the changes implemented from the last SLOA. For the first area of improvement which was "increased diversity of options", we introduced a new program (put together by Physics and Secondary Education Faculty and modeled on successful accredited PhysTec programs across the country) called PhysTEC aimed at allowing a career path for physics teachers. This was specifically in response to the interest expressed by our students as well as the documented Alaska and national demand. Very quickly it attracted 6 students. Unfortunately the very long time it is taking to get the program approved has led to the lose of 4 of the students with others who have expressed interest not joining until they feel certain it will go forward. For the second area which was "more information on career paths". We proposed a new one credit class aimed at exploring career paths, CV writing, interviewing etc. Again due to the long time to get the class approved, it is finally being offered this semester for the first time. For the third and fourth areas which were "more training in writing and presentations" and "more research and problem solving experience", we have instituted a comprehensive communication program spanning the entire curriculum. All the students will get instruction and experience in writing, and presenting technical material and material aimed at a general audience. There will be a series of classes in which the writing, web projects and presentations are a significant part of the course. This will culminate with a final capstone research project that should incorporate all the aspects, technical writing, public technical speaking and the ability to present the material to a general audience as well as the research and problem solving skills.

The changes we will implement based on this year’s conclusions are as follows. For the first area of improvement, we will continue pushing for the PhysTec program as that has demonstrated demand and importance to the state. Additionally, we will explore adding a few other applied physics concentrations that are in high demand nationally, namely bio-physics and engineering physics. For the second area of improvement we
will continue with the changes implemented last time culminating with the capstone project. Since we are still in the first cycle of these changes, we will add some more emphasis to the iteration process for papers and presentations and will get more student feedback on what works. For the final area of improvement, we will work to add more computational problems in our upper division classes as suggested by the students building on the computational physics class. Finally, it should be noted that all of these initiatives would be greatly facilitated by a less severely constrained faculty size.

4. Identify the faculty members involved in reaching the conclusions drawn above and agreeing upon the curricular changes resulting

This summary was collected and compiled by the Physics Undergraduate SLOA committee:
Ataur Chowdhury - chair,
Chung-Sang Ng,
Hui Zhang,
David Newman

It was then discussed and agreed to by the entire physics faculty.

5. Has your SLOA plan been updated to include assessment of the program’s Communication Plan, as required by Faculty Senate motion? (required for baccalaureate programs only)

Yes