SECTION

1

TEACHING

Awards and Honors

SUU's Outstanding Educator *2016-2017*
This award is to recognize an individual, full-time faculty for demonstration of outstanding teaching effectiveness; scholarly activity; peer respect from fellow colleagues; sincere interest in students; and professional commitment and service to others and the University overall. It is the **highest honor** awarded to an SUU professor for influencing students in the classroom.

Outstanding Faculty Member, *Department of Physical Science 2016-2017*

Excellence in Teaching Award, *National Society of Leadership and Success, April 2017*
Awarded to a professor for inspiring students in the classroom

Evidence of Creation of a Well-Managed Learning Environment

Many of mine are busy pre-medical students. In light of this, I have attempted to create a class with meshes well with other demanding/time-consuming courses. The class structure I have adopted follow below.

Class Schedule: I provide every quiz and test date in the syllabus so they are known the first day of class. A 2 page table detailing every homework problem set by the date they are assigned for the semester appears at the end of my syllabus. This allows students to work ahead or to know what is assigned on a day they missed class without having to consult peers or online resources. The date, time and meeting place for the final exam is announced in the syllabus.

Tests: Tests are administered in the testing center over 2-day intervals. Tests are administered on Thursdays (when class is normally held) and Fridays (when class is *not* held). Classes do not meet on scheduled Thursdays in the event that the only time during a student's schedule available for a test is the class meeting time. They consist of 8-9 full written calculation problems written for roughly an hour. Students receive 2 hours to complete the exam. Four

such exams are administered through the semester. Test prep materials written by me are provided to the student about 1 week in advance of the examination. Notes are not allowed on any tests.

Homework: Homework is assigned daily and collected weekly as a bundle. All homework assignments, the dates they are given, and the date they fall due are disclosed day one in the syllabus.I only assign problems for which answers are provided in the back of the book allowing students to gauge if they understand the concepts: homework is for *practice* and for gaining command of material; I don't believe homework is where you test comprehension. I grade homework largely on completion and weight the final grade heavily (85%) on assessments. My flexible homework schedule allows my class to mesh well with other time-intensive courses: work for my course can be shifted around the week in a way to meet a student's busy schedule.

> "*I loved always knowing exactly what was expected of me.*
>
> -IDEA STUDENT REVIEW

I do *not* assign digital or online homework. This is becoming popular with some instructors probably only because it cuts down on grading time. Online homework does *not* check a student's work and so reinforces the idea that the *answer* is the *only* important part of the calculation. Online homework is among the most frustrating homework experiences a student may face: students do not feel they understand either why they got a problem wrong and a limits on the number of attempts averts risk-taking which is key to succeeding in any discipline. I grade strongly on the *completion* of a problem and *work shown* on student homework which is in alignment with my focus on *process* in problem solving.

> "*Love your class. Never know what's going to happen next!*
>
> -MIDTERM SURVEY

Lecture: The number one priority during lecture is making sure students are comfortable completing the homework for that night. We break this up with bad puns, terrible jokes and flashy, occasionally high-stake demonstrations. I believe attending lecture should be its own reward. Walter Lewin, a celebrated MIT physics professor lives by the motto "every lecture is an event." I like to surprise students with demonstrations or other activities to help students connect ideas as a continuous story.

Canvas: I used Canvas to post the syllabus, calendar and grades. I originally hadn't intended to use Canvas for grade posting, but did so when students requested this service through a mid-term in-class survey.

Because this was my first year teaching, all courses needed to be prepared *ab initio*. The following comprises a rough summary of the curriculum developed for my courses during this past year.

- PHYS 2010 (2 sections): created syllabus, class schedule, 4 test study guides, 4 tests (multiple versions) and 11 quizzes
- PHYS 2015 (4 sections): created syllabus, class schedule
- PHYS 2020 (2 sections): created syllabus, class schedule, 4 test study guides, 4 tests (multiple versions) and 10 quizzes
- PHYS 2025 (3 sections): created syllabus, class schedule, 2 new labs including an introduction to LaTex lab.
- PHYS 2215 (1 section): created syllabus, class schedule
- In Summer 2017, I completely rewrote the PHYS 2015 lab manual (130 pages of new lab content).

Teaching Philosophy

Points at the center of my **teaching philosophy** include:

- facillitating a **comfortable atmosphere** inside the classroom and **establishing trust** with my students
- creating a predictable course with **clear expectations**, allowing grade-conscious students to quickly discern how to allocate effort
- completely devoting lecture to ensuring all students **feel comfortable attempting the homework** for that night
- keeping students **surprised and guessing** with flashy demonstrations and in-class activities

I'm here to try make physics seem easy.

As I prepared for classes this past fall, I forced myself to acknowledge that not everyone would walk into class *wanting* to learn physics and that certainly not everyone would walk out *loving* it. That was a big pill to swallow, but I tried to give students a positive and enlarging experience with learning something difficult. I think my acknowledgement of this early on and my resulting approach allowed me to meet students on the level of their expectations and motivations. I believe a connection with students such as this is valuable for a productive learning environment.

Student trust is important to me and I try to create an "us vs. physics" feel to class. I try to avoid assuming a more antagonistic role; common enemies including standardize exams or physics itself are established early. This probably comes from my non-confrontational personality and is a weakness rather than strength, but I think students like the feeling of the professor being in the trenches with them. This has to be balanced with professional distance but if I am stern upfront about boundaries, students rarely ask for allowances.

A lot of stress in classes for me comes from nebulous expectations. These "scholastic" stresses, I feel, inhibit a student's ability to let their guard down and enjoy science during their coursework. I try to design "clean" courses with clear expectations to remove these detracting stresses.

My students are ambitious and grade-conscious. Because of this, students are intimidated by physics which has a reputation as a challenging course. I attempt to teach *resilience to stress* by using *humor and sarcasm in lecture*. I joke about my subject, about all the crazy expectations on their time and joke about the difficulty of the course itself or a given problem. I attempt to find over-the-top ways to carry out conventional demonstrations to add a comical factor. But it is also important to me to transmit that *laughing* at one's own predicament can be the best thing to make it more manageable.

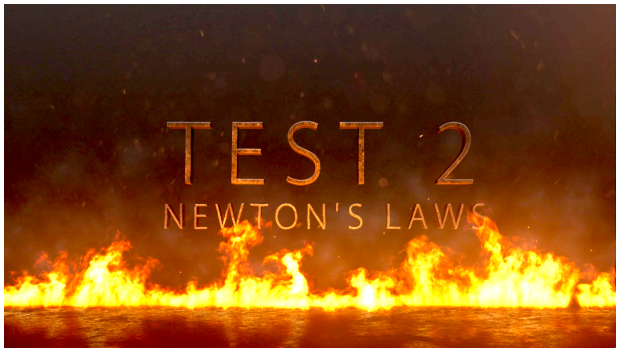
> "*You taught me that learning need not accompany stress and fear. Even on a hard day, I found myself laughing at the humor you brought to class.*
>
> -PHYS 2010, 2020 Student

There is much I need to learn and I don't consider my approach to teaching the best one. I need to earnestly consider how I will evaluate the rigor of my course against external standards though no equivalent of American Chemical Society (ACS) exams exist for physics. I will reflect on the honors I have received this past year later in this report, but I imagine they are partially due to my closeness to the student experience, a collection of insights which could be obsolete in time. I'm committed to improving my teaching ability under the tutelage and critiques of peers and don't see these honors as blanket endorsements of my teaching style.

Evidence of Creative Methods/Materials

The following are evidence of my creative methods:

- Created **new PHYS 2015 laboratory lab manual** during summer 2017 (solo project).
- Created new external class website which details course structure and aims. Description follows below:
- Some wear (evidence if you will) appears on the front table in SC114 from my "creative" teaching "methods."
- Announcing tests and other major events with mock movie trailers created in Adobe After Affects



Mock movie trailers were created to announce tests.

Easing the Transition: External Class Website

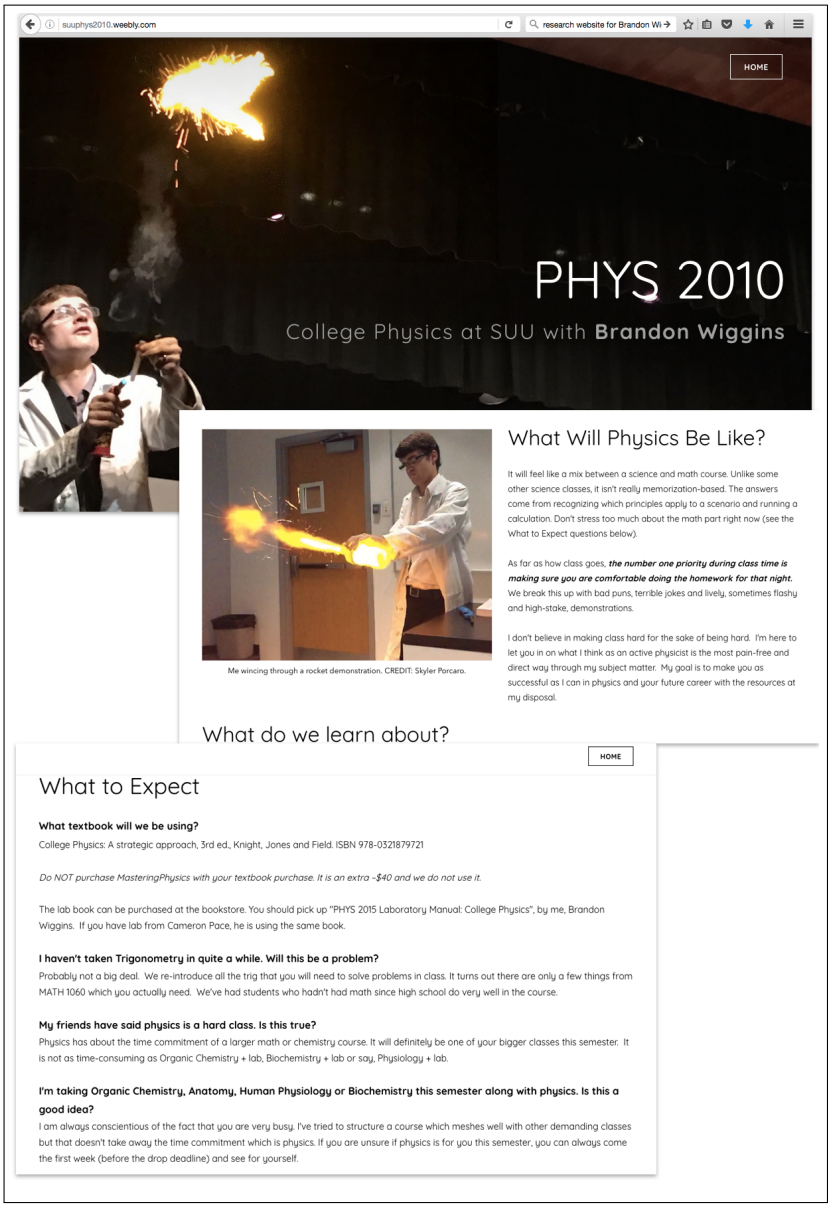
Physics, perhaps not wrongfully, has a **stigma for being difficult** with most students feeling intimidated by the prospect of committing to it for a semester. Some of this anxiety is caused by not knowing the structure or character of the course before the first day. To remove this mystification, I've created a cheesy **website to which I directed enrollees** this past summer. This practice has already received positive feedback with some enrolled students going out of their way to tell me that they wish "all professors would do something like this." Based on this information, students are free to decide if physics will work for them a given semester.

This external, single-page, google-searchable class website contains:

- textbook information
- homework/testing policies
- what we will learn about
- my teaching philosophy
- description of workload
- a discussion on how the class might fit into a busy pre-med or pre-professional schedule
- my contact information

Some layer screenshots of this free website appear at right. You can visit it at:

`suuphys2010.weebly.com`



Evidence of Seeking and Receiving Feedback From Students and Others

I received feedback from several sources:

1. IDEA Survey results. See Figure 1.1 and Table 1.1 (next page).
2. Mid-term anonymous student surveys administered in class or online (e.g. survey monkey)
3. Peer evaluations (Prof. Kim Weaver, Prof. Daniel Eves)
4. Seeking feedback on the course from students during office hours

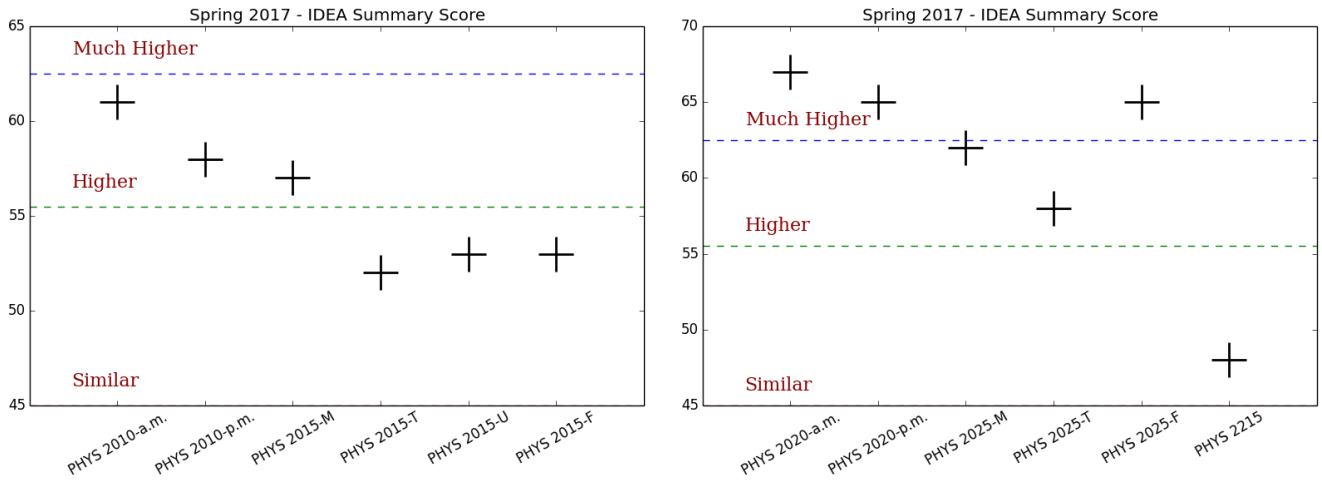


Figure 1.1: IDEA summary scores by class. Scores broken down by criteria appear in Table 1.1.

Fall 2016

PHYS 2010-01: IDEA survey results were largely positive. Students score me quite highly as an instructor ("much higher" band) while the course itself is given a less-high, though still respectable ("higher" band) rating. Students evaluated their progress on my objects uniformly as "higher" compared to group averages at SUU. Students commented that grades could be posted quicker to Canvas and asked me to attempt to improve my ability to explain some concepts clearly. Students appreciated my apparent concern for students inside and outside of class, my "fair" grading scheme, my use of demonstrations, and my "passion" for my subject.

PHYS 2010-02: The afternoon physics lecture was given reasonably high rating with the trend of instructor ratings surpassing course ratings holding. Afternoon ratings are somewhat lower than morning ratings. I am not familiar enough with IDEA surveys to know if this difference is statistically significant, but I think I noticed a difference in class dynamic during teaching. Student criticisms of the course were essentially the same as the morning class: they wished grades would be posted faster on Canvas was the primary point.

PHYS 2015-01: The students rated both me and the lab well. Students reported progress on my objectives as "lower" or "higher" than comparable classes at SUU. Again, students systematically rated the instructor better than the course. Some students commented that I was "stretched thin": many students had questions and orbiting to all lab stations was difficult. This difficulty was mitigated in Spring by hiring TAs. Some students also pointed out that lab instructions weren't that great. To address this, I revamped the lab manual myself in full (we will discuss this later).

PHYS 2015-02: Students rated me well in this lab, but did *not* find the course worthwhile (they rated the course as "similar" or "lower" and their progress on my objectives as "similar." *Many* students in this section commented

Table 1.1. IDEA Survey Results

Class	Progress on Objs	Excellent Teacher	Excellent Course	Average	Summary
Fall 2016					
PHYS 2010-a.m. *Raw*	4.7 **much higher**	5.0 **higher**	4.4 **higher**	4.7 **higher**	4.7 **higher**
PHYS 2010-a.m. *Adj*	4.5 **higher**	5.0 **much higher**	4.5 **higher**	4.8 **higher**	4.7 **higher**
PHYS 2010-p.m. *Raw*	4.4 **higher**	4.8 **higher**	4.5 **higher**	4.7 **higher**	4.6 **higher**
PHYS 2010-p.m. *Adj*	4.3 **higher**	4.8 **higher**	4.5 **higher**	4.7 **higher**	4.5 **higher**
PHYS 2015-T *Raw*	4.5 **higher**	4.9 **higher**	3.7 **similar**	4.3 **similar**	4.4 **higher**
PHYS 2015-T *Adj*	4.1 **similar**	4.8 **higher**	3.4 **lower**	4.1 **similar**	4.1 **similar**
PHYS 2015-M *Raw*	4.3 **higher**	4.7 **higher**	4.3 **higher**	4.5 **higher**	4.4 **higher**
PHYS 2015-M *Adj*	4.2 **similar**	4.8 **higher**	4.4 **higher**	4.6 **higher**	4.4 **higher**
PHYS 2015-U *Raw*	4.4 **higher**	4.7 **higher**	4.2 **similar**	4.5 **higher**	4.5 **higher**
PHYS 2015-U *Adj*	4.1 **similar**	4.7 **higher**	4.0 **similar**	4.4 **similar**	4.3 **similar**
PHYS 2015-F *Raw*	4.2 **similar**	4.9 **higher**	3.8 **similar**	4.4 **similar**	4.3 **similar**
PHYS 2015-F *Adj*	4.1 **similar**	4.8 **higher**	3.8 **similar**	4.3 **similar**	4.2 **similar**
Spring 2017					
PHYS 2020-a.m. *Raw*	4.7 **much higher**	4.9 **higher**	4.7 **much higher**	4.8 **much higher**	4.8 **much higher**
PHYS 2020-a.m. *Adj*	4.8 **much higher**	5.0 **much higher**	5.0 **much higher**	5.0 **much higher**	5.0 **much higher**
PHYS 2020-p.m. *Raw*	4.8 **much higher**	5.0 **higher**	4.8 **much higher**	4.9 **much higher**	4.9 **much higher**
PHYS 2020-p.m. *Adj*	4.7 **much higher**	4.9 **higher**	5.0 **much higher**	5.0 **much higher**	4.9 **much higher**
PHYS 2025-M *Raw*	4.5 **higher**	5.0 **much higher**	4.5 **higher**	4.8 **higher**	4.7 **higher**
PHYS 2025-M *Adj*	4.4 **higher**	5.0 **much higher**	4.8 **much higher**	4.9 **much higher**	4.7 **higher**
PHYS 2025-F *Raw*	4.5 **higher**	5.0 **higher**	4.6 **similar**	4.8 **higher**	4.7 **higher**
PHYS 2025-F*Adj*	4.6 **higher**	5.0 **much higher**	5.0 **similar**	5.0 **higher**	4.9 **higher**
PHYS 2025-T *Raw*	4.4 **much higher**	5.0 **much higher**	4.0 **higher**	4.5 **much higher**	4.5 **much higher**
PHYS 2025-T *Adj*	4.3 **higher**	5.0 **much higher**	4.1 **much higher**	4.6 **much higher**	4.6 **much higher**
PHYS 2215 *Raw*	3.9 **similar**	4.7 **higher**	4.1 **similar**	4.4 **higher**	4.2 **similar**
PHYS 2215 *Adj*	3.6 **lower**	4.6 **higher**	3.9 **similar**	4.3 **similar**	4.0 **similar**

Note. — Full IDEA survey data available from Brandon Wiggins upon request. Classes inside of double horizontal rules are lecture courses.

that labs were much too long for lab time and asked for quicker turn-around times on graded labs. Interesting, quite a few students mentioned they liked out "24-hour" rule: all lab reports are due 24 hours from the end of lab, so students can't stress about the lab through the week. This rule also encourages students to complete lab work while the lab is fresh in their minds and to use lab time effectively. I will be working on improving the timescale of grading this semester. I have addressed the former complaint about the length of the labs in my new edition of the lab manual.

PHYS 2015-03: I was rated in the "higher" band while the course and progress on objectives fell in the "similar" bands. One student commented that I should be given a raise, and I respectfully concur. Students asked for better turn-around times on labs and there were several poisonous comments about the lab manual including that labs were "boring" or felt like "busy work". A student mentioned that an even tighter correlation with lecture would be nice. I will describe how I attempted to address these points when I talk about my new lab manual.

PHYS 2015-04: My IDEA scores in this section were about the same as PHYS 2015-03. Students reported "similar" progress on key objectives. I got many comments on the old lab manual: students wishing for better instructions and more relevance to lecture. One student sums it up my scores nicely: "nice professor, terrible course." One direct student comment was that "whoever wrote this manual should be fired." Frustration with the old manual was almost tangible in lab. Something had to be done.

Spring 2017

PHYS 2020-01: Students rated me in the "much higher" band on their IDEA evaluations and placed the course and their progress in the "much higher" bands. Compared to other courses at SUU, students rated their progress on my objectives as "much higher." One person suggested I take homework off the books and base grades completely on exams. This same student complained that I killed them with homework. While I will be retaining homework, I have trimmed some extraneous problems from the PHYS 2010 syllabus for Fall 2017. Gratefully, students complimented me that I prepared them well for standardized tests. Students liked my review sessions and quizzes as methods to study for exams. Kim Weaver observed my class during a test review session. He was complimentary and suggested that I be careful about ensuring my board picture align with my discussion. This scatter-brained tendency of mine which leads to occasional inconsistencies is something I hope disappears with additional practice in front of a classroom.

PHYS 2020-02: The IDEA evaluations were encouraging. I was rated as "much higher" on my teaching and course structure. Students reported "much higher" progress on objectives against classes at SUU. I was grateful that students reported I had "high expectations" in several comments. I wonder about that, especially when a course shows signs of becoming popular. One student said they wished I taught bio-chemistry. I am glad I do not. One student mentioned that they wished that my homework (given in a textbook) would be even more tightly tied to tests (written by me). This summer I have **been preparing my own homework questions** for PHYS 2010, but these were not ready for release by the start of Fall 2017.

PHYS 2025-01: Students rated both me and the course in the "much higher" bands on IDEA surveys. They graded their progress against other SUU courses similarly. The praise for the course itself is likely over-stated; by this time I was in very "good standing" with the students and praise was probably spilling over in areas where it wasn't warranted. The student comments against the lab book made clear what the bubbles didn't. Completely rewriting the lab manual for the first semester lab was a mammoth undertaking, but I will be working to rework the 2nd semester lab book this fall.

PHYS 2025-02: Adjusted IDEA scores for the course and instructor were in the "much higher" bands. Students rated their progress on objectives from "similar" to "much higher" when compared to SUU courses. Some student feedback included requests for labs being handed back quicker, a practice I will improve this semester. I attempted to adjust the sheer amount of work to be completed in our short 2 hour lab between fall and spring semesters: this improvement was recognized by at least one student who complimented this olive-leaf. Lab applicability to lecture seems to have improved between semesters according to student responses. There were again some comments and the negative character of the lab manual: a revision of the 2nd semester lab manual will *also* be necessary.

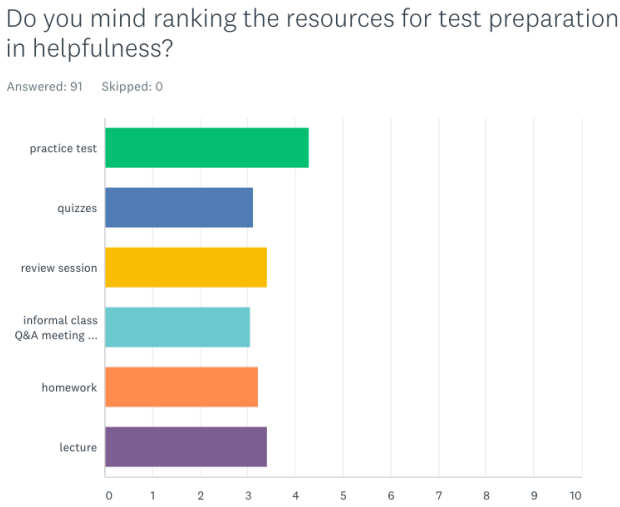
PHYS 2025-03: Adjusted IDEA scores for the instructor were in the "much higher" band, the course was rated

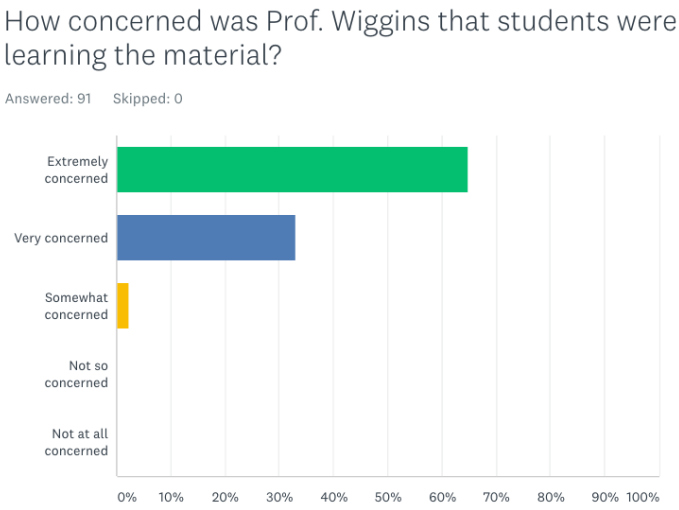
"similar". Students rated their progress between "similar" to "much higher" when compared with SUU courses. Students requested again that labs be more clear and that assignment were graded faster. Students systematically rated the course higher than previous semester with one student comment even saying that it was "much better." Two lab students suggested we should just "throw the lab book away."

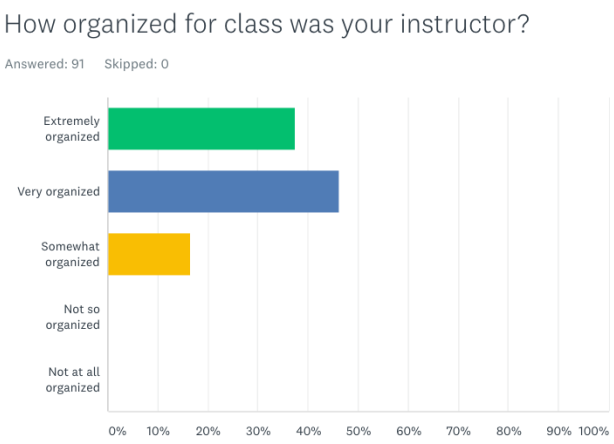
PHYS 2215-01: Students reported "low" progress on key objectives on their IDEA surveys. The instructor was graded in the "higher" band, the course itself falling in the "similar" band. One student reported that I was absent from lab longer than they liked. While the purpose of lab is exploration without hand-holding from the instructor, I have resolved to be in the lab room during the duration of lab. This was a calculus-based physics lab which wasn't linked to one of my lectures.

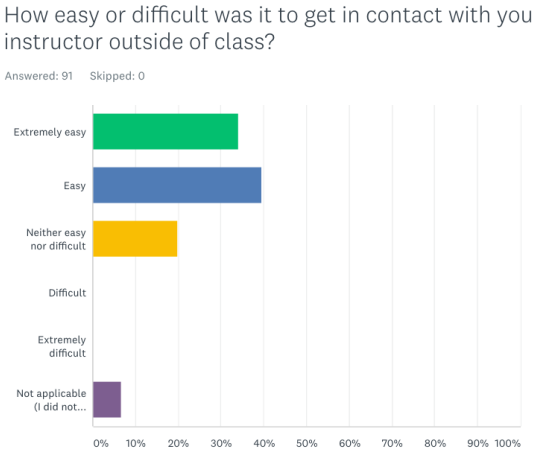
Midterm Survey Results

I used Survey Monkey to administer my surveys or used paper surveys in class. I include some select results of one such mid-term survey administered on Survey Monkey. Because the survey is administered online, analytics are readily available. In particular, I am able to see distributions of student response including *skew* or possible bimodality which is not reported in the pithy IDEA results summary page. 91 of my about 110 students responded to this particular survey. The actual survey contained some 10 questions. I include all student comments to an open ended question **(text with a yellow background)**. I include all 88 comments here because of the ease of including them (they are already digital), **not as an indication of my weighting these responses as more valuable than IDEA survey results.**









What do you like about this course (PHYS 2010)? What do you feel could be improved?

The explosions are exciting. No improvement needed.

My favorite thing about the class is the fact that the material that we are learning is taught in an applicable manner. You do a good job of helping us see how the principles of physics apply to the real world (spiders). It makes it easier to remember these principles. The tests usually cover a lot of material so maybe more review questions could be give from the earlier chapters as the test approaches.

I know what to expect as far as homework, quizzes, tests. I would suggest a little more time to review for the tests.

This last test was extremely difficult. The problem that i ran into was that the practice test had questions similar to real test, except they had one more step. That extra step, i feel like was not clearly taught or understood. I understand that test are meant to be hard and make you think, but it should be over material that people understand.

My favorite part of class is the demonstrations that bring physics to life so I can understand principles and the PRACTICE TESTS. I feel like that's where things come together for me.

My favorite things about class is the fact that he breaks down the chapter of what he exactly thinks is important, teaches us it, and gives examples to know how to apply. I also like the demonstrations. I would suggest changing some of the homework problem selections. Some questions are not relevant of what we learned or being tested on, and there time consuming and waisting.

Considering the previous question I would suggest offering more MCAT or standardized test questions within the physics subject. Your exams are great however the physics questions that we will encounter on standardized exams especially entrance exams I feel will be much less work involved and more understanding of concepts and questions asked.

The lecture is fun and exciting. Slow down while teaching sometimes you go really fast

I liked the demonstrations and explosions shown in class. I am a visual learner, so it helps seeing demonstrations.

I enjoy the examples that you do. Due to the fact that I am a hands on learner. And I pay more attention during them then during lecture.

I love the lectures. They are engaging and I love the demos. Having a practice test helps me so much. I should be more brave and raise my hand to say this, but there have been several times that you have gone too fast for me. Especially with your work on the board.

Physic is hard class but Pro Wiggins make it very easy and he lets students love physic

everything all right, I like Prof. Wiggins experiment at the lecture class, and how he explain question for us. He is the best professor in the world.

I really like the demonstrations, it makes class more exciting, especially since excitement level for me at 4pm is not high. I also like how you joke around and relate to us as students a lot more than a lot of the other professors do. I would suggest trying to get class started earlier/more on time, just so we can cover the material better and not feel rushed at the end of class.

My favorite thing about class is working through problems on the board and being able ask questions. To improve class, I suggest involving students in the back rows more. Like ask them questions.

My favorite part is the concern the professor has for the students' learning. For improvement, try and think of more real world application for the plug and chug sections. It's good to know how to get through the problems, but the Application makes it stick. (Thinking beyond a box on ice examples.

Well I disliked physics very much before this class because of past experiences. Being completely honest, I actually thoroughly enjoy physics, probably more than any other course i'm currently taking at the moment. I don't think much more can be done to improve, I honestly think that you just present the information very clearly making it easy to learn.

My favorite part about the class is that I feel like it is very practical. I feel that there is absolutely no sense of busy work, which can be found in many other courses. I feel like you make a real effort to make sure everything is worth our time and is actually beneficial. One thing that I really appreciate is that you only assign odd numbered questions for our homework. It is SO helpful! I understand why other professors would think it is a good idea to mix it up, because the thought of cheating, but in all reality the tests will solve that issue quickly. But it helps me a ton that I am able to check my work. I also really appreciate all the times you have given us an extra day to get our homework done. Again, such a good way to help a student learn! Better to have the student get their homework done, then not at all! The only suggestion that I can currently think of is that as we go into concepts throughout the lecture, maybe write on the board the specific section number that the topic is under? (i.e. 10.3) I have noticed as I look through my notes that it can kind of be hard to separate things from each other. And sometimes chapters too. Thank you!

My favorite thing is that Professor Wiggins expects us to learn and work hard, but at the same time he understands that we have a lot going on and he adjusts things accordingly to help us not have too much or too little homework and other stuff. As far as improvement, the only thing I would say is it would be helpful to go over more of the harder homework problems in lecture. I dont always have time to get help with them and I end up having some questions unanswered on my homework.

I really enjoy the demos, and how well we are prepared for test. I would really enjoy more demos and maybe more applicable demos, as far as pertaining to the material we are studying. I know this is difficult, but I would really enjoy it if it were possible! Thank you! You're my favorite professor.

quiz was so helpful to understand lecture

Conservation of energy. It would be better if the teacher posts up the grades faster.

I love how entertaining class is. I always find myself surprised at how quick the hour goes. I can tell Wiggins is very passionate and cares a lot.

Pro. Wiggins makes class interesting and actually helps you learn but making you understand why something is the way it is. He is a great professor. The only improvement I would have is, having an extra time each week for just help on the homework, just incase if a student cannot come into office hours.

The lectures done with practical demonstrations are my favorite thing about class. I always look forward the lecture for this reason. Just please don't make the class at four in he afternoon next semester.

Wiggins always finds little interesting experiments to bring into class that are pretty cool to watch. I think lecture is very informing and you answer questions very well. I would like to see practice tests that are a bit shorter and more relevant to the exams as far as length and specifics. Overall you are a great teacher and I would definitely recommend you.

I really like that you do demonstrations in class it makes the material more interesting. There is nothing I would improve.

I like that Professor Wiggins not only shows us the equations, but he also gives example problems that we might see. I would suggest doing some more difficult problems in class that we would see on our tests/homework.

The lectures are interesting and fun. I like that you can keep it light yet still teach what's necessary to know. I don't feel like I'm in a lecture yet when I go home I can do the homework without difficulty because of your lecture. I dread going to other lectures but your lecture I make sure I go to. My only issue in the class is time management. I have a hard time doing homework on time. I like that you have all the homework due at the beginning of the week

because I'd do a lot worse if I had to turn it in every day. My only recommendation for imrovement is feedback on canvas. I don't know my standing in the class. I feel that I'm doing really well, because I've done well on the exams, but I don't know because I can't see it uploaded on canvas. Other than that keep doing what you're doing. I really enjoy your class and feel like I've learned a lot without stressing about learning.

I was a little worried about this class to be honest but it has actually been my favorite class this semester. My favorite part has been the demonstrations, of course, but I also like to see how what we're learning actually relates to real-life situations. When it comes to improvement, I can't really think of anything that I'd like to see change. The one thing I was going to mention was that it would be nice to see things on Canvas but that has already been addressed. I really learn by repetition so maybe it would be nice to do more examples on the board of specific concepts. We already do quite a few but more examples never hurt anyone, especially for the more difficult concepts.

I like the demo's. I think they are fun and a good way to cement a principle. Breaking us into groups and having us compete is a good way to practice working fast.

I like all the demos and learning how to solve problems. I don't like the homework because they are different styles than the tests.

The explosions. You always keep class entertaining. And I enjoy showing up every day.

I love when professor shows the experiment in the class that really helps me to undetstand the concept

I love how you lecture. I haven't even had to read the book yet. You explain things so well and in such an interesting way and also make it applicable to real life. I don't see that improvements are necessary, so I don't have any improvements to suggest.

my favorite thing about the class is how Professor Wiggins teaches. he teaches very very clearly. my suggestion would be to explain all the ways we might see questions for different sections.

Professor Wiggins is so great! He's so funny and knowledgeable. He makes lectures fun and entertaining. My favorite professor I've ever had. The only thing that's ever wrong is when there aren't markers available. The amount of homework is perfect and the tests cover the important points of the course. I thought for a long time about what to change but I really can't think of anything! I hear people outside of class all the time talking about how great this class is.

I like the fact the professor wants us to be successful. I like that the amount of homework is reasonable. I feel that when certain topics are covered, it's done too fast. I feel like the professor rushes through some of the information that we need to know.

My favorite part about class is that the tests are relevant to what we are learning and that you prepare us for them in the best way possible. The only improvement I think would be helpful is that we do more of the homework style problems on the board. I know we do a lot of problems on the board and they are amazing, but I sometimes find when doing the homework, I run into problems with the questions and how to solve them.

he sometimes do some experments during the class. It is very helpful to understand.

I love the demonstrations in class and doing lots of practice questions on the board. Feedback online

The practice tests are most useful on helping me succeed

I love the teaching style and how the material is easy to understand (this is my second time around in this class and it is so much easier than before). I also love that professor Wiggins is always willing to help his students no matter what. To improve, I would say try to be a little bit more clear when writing the practice exam and answers. Seems like not a huge deal since it is just practice but these help me the most on exams so when it is clear it is a lot more reassuring.

Demonstrations

I have really enjoyed this class. I love all of the demos and how much you enjoy teaching. I can tell that you love this subject. Don't ever lose that! That is the most important thing a teacher can have for their students is excitement to be here.

Hands on experiments

Professor Wiggins concern for the students success is nice to see in a teacher. Improvement= keep it up

As much as it might make it hard for me I would like the homework to be due the next day so I don't procrastinate it tell Sunday night. My favorite thing is the way you teach! It makes since to me and I love the demo's!

Demonstrations are awesome. Improvement? I have nothing to suggest.

This has been my favorite class of my college career so far and I'm about half way through. I wish I had something to complain about(not really) so you could have something to work on, but you are seriously just killing it! I've learned so much and you've made a very hard subject clear to learn and understand. My hat is definitely off to you. Just keep doing what you're doing because it's awesome.

I love all of the demos. I think it would be beneficial to spend more time doing hard practice problems in class. Even harder than those that may be on the test, but similar in design and idea.

My favorite thing so far has probably been forces just because I found it pretty interesting. I've enjoyed class quite a bit so far. Everyone has a little room for improvement. Sometimes I think it would help if we slowed down a little during the practice problems in lecture because sometimes you lose me, but this is something that isn't usually a problem if I've already read the chapter, so it might be more of something that I should be working on myself. Other than that, great job! You give fair exams, you're easy to talk to, you grade things in a fair manner, and you try to keep things fun. I would highly recommend you to any student. Thank you!

I love lecture. I never thought that I would love physics so much and I do. You have converted me. I think maybe going over more difficult problems in class would be helpful to help me finish my homework.

I know class is short but maybe more class participation and visual aids... those always help me.

I love the demonstrations, so even though I may not understand certain parts of the mathematical pieces, the concepts are very clearly displayed. Plus they're fun.

I have enjoyed the demos over anything else. I would recommend minimizing the likelihood of overexertion. Thank you for your excellent work!

I really enjoy prof. Wiggins enthusiasm and love of physics. I do not plan to go into physics but it makes class more interesting, exciting, and engaging knowing that my professor loves what he does. Something to improve on would be grading homework and quizzes sooner so I can have a better idea of my strengths and weaknesses and how to compensate correctly for them.

So far I like the demonstration, they provide a lot of why and how the concepts can be applied. They help me understand the concepts better. The only improvements is that sometimes I wasn't sure what section you were coving during lecture. So writing what section your teaching about would be nice. Although I know the books sections are weird and some are redundant. I enjoy this class and can't wait to take the second semester with you.

My favorite thing is Prof. Wiggins' sense of humor. He could improve in staying on track with his syllabus.

I like the way he organized the homework and the quizzes

I like all your object lessons. It seems like we have one daily (at least for every new subject).

I love all the demonstrations. Professor Wiggins does a terrific job of explaining the material and the lecture period is always exciting. I feel like I have learned a lot.

I have been very happy with Prof Wiggins. He is my favorite professor. Sometimes in lecture i think he assumes we are following him and we get lost, but every time someone in the class has asked a question and he clears it up right away and makes it easy to understand. The only concern I've had was when he was gone for about a week. The substitute professors didn't really help. It was a weird transition and I think that contributed to me not feeling ready and prepared sufficiently for this last test that we took (Test 3). Other than that I'm happy!

Your attitude and demeanor are contagious. Keep it up! We feel excited if you are and not excited if you are seemingly not caring. Review quizzes once you grade them. Tests too! Still a bit bitter about the extra credit/review game for last exam-that was so unfair that one group got like a dozen extra points and the rest of us got 1 or 2. Not cool.

The class overall is great, it is one of my favorite classes.

My favorite part was the laws. I think you went through the first part of the class a little slow compared to how hard the material is but then started going faster once the material became harder

I like the way you teach.The only improvement I would like to see is that the grades are posted to canvas. That would be extremely helpful

Professor Wiggins is my favorite thing about class. He creates fun and effective learning atmosphere. Sometimes when doing problems on the board he goes way too fast and I get lost.

I really like how he is so close to our age and is relatable. He has so much energy and always has fun demos. I really enjoy him.

They way he teaches, makes it easy for the student to learn very relaxed approach. More problems in class to better prepare for homework would be more helpful

I have been extremely impressed with Professor Wiggins. He has been able to teach me physics in a way that I understand. I know that he wants me to succeed and is willing to help me in any way he can. I have loved every single thing about Professor Wiggins teaching methods and found success through how his class is set up.

the demonstrations and overdramatic trailers for the test

I love the format of class. This is difficult material to grasp on your own, so willingness to meet up outside of regular class time and overall friendliness and class atmosphere make it a great place to learn. I would really like yo have more application type problems that we could do in class. Usually I feel fine with the concepts, but applying them to story problems on my own is difficult.

How awesome and cool Professor Wiggins is. You can tell that he really cares about his students, their questions, and wanting us to succeed. The experiments he shows in class are helpful as well. I like the way the class has been organized. I also like how he helps us get prepared for the exams in many different ways. Especially the practice test and review sessions. One suggestion I do make however, is that on the exam itself. Try putting the equations sheet on a page by itself so we can tear it off and use it, rather then it be on the back page of questions and have to keep flipping back and forth to it. Other than that, this class has been awesome! Thanks for all the help and willingness to help us and wanting us to succeed! I will highly recommend Professor Wiggins to other students and definitely take another class from him.

I really enjoy just coming to class. I like that quizzed are scheduled so I don't walk into class and stress until class is over to see if there's a quiz. I like the demonstrations. As far as improvements, I think that some of the assigned homework problems are somewhat irrelevant.

Professor Wiggins is literally my favorite part of class. I would dread going to class every day if someone else taught

the class but Prof. Wiggins is hilarious and teaches me without me even feeling like I am being taught.

The demonstrations. Nope doing well!

Dr. Wiggins' sense of humor! Definitely makes the class lots of fun to be in. Can't think of anything really that could improve the class!

I really enjoy the demonstrations. They help me understand the material we are learning.

I would say professor Wiggins sarcasm. He knows how to explain the material well. I was concerned for this year because math isn't my best thing. But professor Wiggins made it clear! One way I would say is that to change the lab to fit the course.

How relatable the teacher is with the class.

I like the examples done in class. The exam study guides need to be posted way sooner though, because with my class and work schedule, I don't usually have time to come and get help with things for the test if we're only given a day or two before the test

How organized it is.

I love the demonstrations and Professor Wiggin's witty remarks. He teaches extremely well!

The professor is the only thing getting me through the class. Amazing professor

Honestly nothing. Professor Wiggins is my favorite professor.

The way you teach, you teach toward pre-Ned students and the needs they have, considering most in the class are pre-something, it is very valuable.

I like the clear and fair expectations and the demos. Work on explaining the concepts a bit more clearly

Evidence of Thoughtful Reflection on Feedback

The View From 10,000 Feet

Averages of IDEA evaluations in key areas appear in Figures 1.2 and 1.3. Figure 1.2 averages ratings over all classes where Figure 1.3 breaks down averages by lecture- or lab-type classes. While averages improve between semesters, some of this is due to lower-achieving students not enrolling in 2nd semester courses. But I do believe some improvement between semesters is "real." My "product-testing" stage during my first semester was over and I had honed in on some attributes of the classroom experience that students valued:

- Canvas was updated with grades quicker
- I provided some pedagogical, high-quality lecture notes for difficult lectures to assist student note-taking
- I implemented tutor-center office hours: I had one office hour a week I spent in the tutor center to work on homework or study for exams with a larger group of students. This office hour was chosen by polling student availability
- I chose an even more demo-heavy approach than Fall semester, sometimes sharing as many as 5 or 6 demonstrations in a single hour

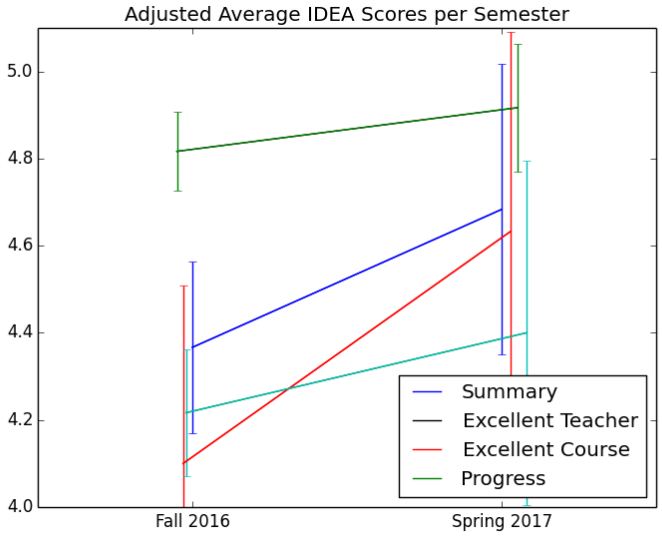


Figure 1.2: IDEA 5-point scores averaged over **all classes** in a given semester. While average IDEA scores in all categories see improvement, not all improvements are statistically significant, i.e. "progress on relevant objectives" and "excellent teacher." Some of this "improvement" is likely selection bias: lower-tier or antagonistic students in 2010 didn't take 2020. The reader is warned that trend-lines drawn between 2 data points are pretty worthless.

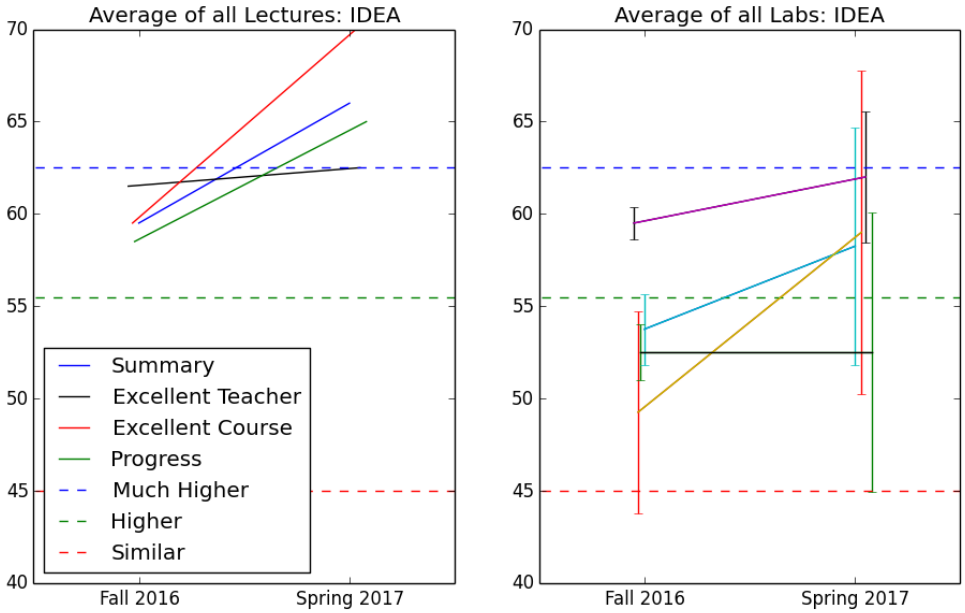


Figure 1.3: Average of IDEA student ratings for **lecture (left) and labs (right)**. "Improvement" is seen, but we cannot disentangle selection biases from student responses. Labs are systematically lower rated than lectures.

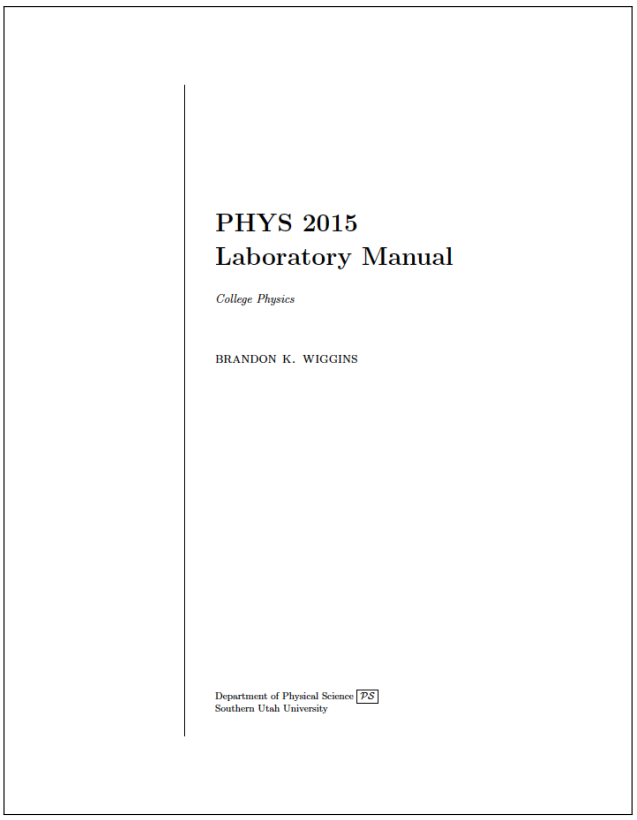
- Attempted to utilize group activities during lecture

Lab classes were evaluated systematically lower than lectures. I used the old lab manual which was grossly ineffective on many fronts. The second semester sees some improvement to lab scores (for the most part) possibly because we

implemented a final project which was well-received and I introduced 2 new labs for second semester college physics lab which were more relevant for the students. I revamped a fluid dynamics lab and introduced a LaTeX type-setting lab.

About those labs...

Evaluations primarily urge **improvements to lab classes.** While my teaching performance in lab wasn't *poor* per se, students systematically rated labs more poorly in lecture. In labs, students rate my teaching fine, but students correctly surmised that the value of the course wasn't equal to the lecture. Part of this would be my inexperience in running a lab (perhaps one of the reasons for the small improvement in some classes between semesters) but a dominant issue was that **old physics lab manual rendered lab time ineffective and negatively impacted the student learning experience.**


PHYS 2015
Laboratory Manual

College Physics

BRANDON K. WIGGINS

Department of Physical Science PS
Southern Utah University

Our **old physics lab manual was locally written** by Laura Cotts and later adapted by Nathan Hansen. It was prepared in MS Word and contains some labs which were prepared in haste and which were not revisited for revision. Because of this, lab instructions/introductions were cluttered and had **no uniform format.** Lab instructions were mixed with theory, had **pages of philosophical/historical content irrelevant to lab** with lab instructions having only undergone a first or second draft. The learning objectives of each lab were unclear: one lab had 4 self-declared purposes. The book contains no guidance on how students should focus work. The lab manual **communicates expectations poorly**, a fact which can be exploited by the lab instructor to maintain the liberty of deducting points on arbitrary "lab quality" criteria. In short, students struggled against an undisclosed grading rubric, densely-written and sometimes poorly-organized lab instructions and inconsistent MS Word formatting. These difficulties are reflected in comments and low ratings in the *course* despite decent instructor ratings.

This past summer, **I have rewritten the trig-based physics lab manual** in an effort to address these issues. This project amounted to creating some **130 pages of new lab content**, a new, transparent discussion of lab expectations in the front of the book, applying a uniform format for all labs and separating critical information into visibly-accessible places. I attempted to **prepare the manual with the busy student in mind.** The not-trivial endeavor yielded a lab manual with the following "features:"

Abbreviated Lab Introductions

Only content relevant to the lab is included in introductions. New student-friendly introductions are now written to be read "last minute." A new major feature is the "just-in-time briefing" which are given on the *worksheets themselves* in square boxes. To be sure, the ideal is that we all read the lab beforehand, but the labs are now better written so that students can efficiently get your bearings in the catastrophic scenario.

New Visually-Appealing Pedagogical Formatting

Hints, instructions on how to set up equipment and examples are visually separated from lab instructions in easy-to-find boxes. This better allows the student brain to pin point the snippet of information they need at that moment quickly.

New Theory Sections

Previous versions of the lab book mixed theory into the lab instructions. These are now separated to better allow

students to sift through material more quickly. A new, very short theory section *briefly* highlights *only* equations and background relevant for that particular lab. Lab instructions follow in a conspicuously labeled "How To Do The Lab" section.

Professional LaTeX Type-Setting
Previous versions of the lab book contained equations typed out in MS Word. Now the equations, captions, figures and tables in the manual bear the professional look which can only be provided by LaTeX.

A proof copy (probably still with some typos) of the lab manual follows this FAAR in the hard copy version delivered to the department office.

This lab manual will undergo testing this year. I imagine I will be reporting on this in my next FAAR.

Students asked for quicker feedback on labs. I will make a special effort to return graded labs in a timely fashion.

Post-Mortem: What Went Well And What Did Not?

This past year I was awarded several teaching honors including the lofty **Outstanding Educator** distinction for 2016-2017 year. Because I know very little about how the process of nomination and selection took place, I actually don't know the specific things the selection committee or the nominators found appealing about my teaching. A danger here is taking these honors as a blanket endorsement for my teaching style: I am noticing, for instance, that what I feel went well about the course is **markedly different** than what students thought went well.

Positive reviews referenced first my **care for students inside and outside the classroom.** This surprised me. I guess it surprised me first because *I* didn't know I cared. But upon some introspection I now think I really do. That was not an influence I set out to create, which leads me to believe there were some factors of similar predicament which caused that informal connection with my students to emerge. The second reason it surprised me is I had no idea this point actually mattered. I thought my lectures were rather great[1], but this isn't what students cared about most. Of all the praise I have gotten, this was the thing which meant the most: "He really seems to care about our success" "He teaches to pass" "I've never had a professor care so much..." and so on dominate positive student comments.

> "*I have never had a professor that cared so much about my individual success both in academics and life.*
>
> -IDEA STUDENT REVIEW

In a way, I actually worry about that. First, I don't know if this is reproducible because I didn't *know* I was so caring. The second, as horrible as it sounds, is that I don't know that I wanted to *be* the professor who cares so much about his students. I roll my eyes when I hear talk about how we need to feel warm, fuzzy and "accepted" before "learning" can take place. But I have discovered that I am more invested in my students than I realized. My students impacted my life in great ways. All the self-help teaching books hold this up as the holiest mindset of teaching, but I still lack wisdom as to the ideal **balance between being "caring" and being appropriately tough**. To my relief, several students mentioned that I held "high expectations" in student comments. I imagine I will struggle with this question for as long as I teach.

Other people referenced my wealth of **study aids** which I created throughout the course. For better or worse, I view my course as a *product* which requires *marketing*, great *customer service* and a plan to "win the moment" as they say in business. The courses have clear-defined expectations that I feel comfortable advertising on a website (and I do!). I survey all my classes at the beginning of lecture to determine the placement of my office hours. I turn one or two of those office hours into tutoring hours in the tutor center to increase my "surface area" with my limited time. I give the "illusion of abundance" by tempering expectations on services at the start of the semester and then over-delivering. I cast my role in the class as a helpful guide against the common enemy of physics or standardized exams, and I am very careful never assume a lecture-room role of grade gate-keeper. Tests are returned within 24 hours of me receiving them.

[1] i.e. outright masterpieces.

Students loved the demonstrations, though this isn't the primary thing they were in love with. I try to choose a mix of demonstrations which have a high entertainment/wow factor and those which facilitate a good class discussion. Students commented that these demonstrations helped illustrate the abstract concepts very effectively. I will be using the same demonstration-heavy approach as I teach these same classes this coming year.

Students wish I was better at explaining some things, and I imagine this will improve with practice and time. The claim that not all homework was helpful or relevant to tests is a concern I share with my students. I ultimately wish to move to homework exercises prepared by me which vertically align with my assessments. Some students have commented that I "killed them with homework" during Fall semester. I have reviewed my syllabus and my homework assignments from fall semester and have removed some exercises which caused more confusion than elucidation and which were ultimately irrelevant to my assessments. Though my 24-hour test grading time is impressive, I will attempting to post grades quickly to Canvas to allow students their most current standing in my classes.

Students appreciated my discussion of the applications of physics to "real world" scenarios. This semester I have planned some additional topics in biophysics, biomechanics and astrophysics to solidify physics concepts in student's minds.

SECTION

2

SCHOLARLY ACTIVITY

Overview of Research Activity: 2016-2017

Publications in 2016-2017: 3 **Grants:** 1 **External High Performance Computing Allocations:** 2 **External Proposals:** 2

External Grant

$33,009 through university contract (#433324) from Los Alamos National Laboratory to SUU to fund my research activities at Los Alamos National Laboratory during Summer 2017. Contract money comes from an internal grant at LANL for which I was a Co-I: Simulations of Multi-scale Accretion of Massive Black Holes Through Cosmic Time

Funding of similar amounts will be dispersed Summer 2018 and Summer 2019.

Peer-Reviewed Publications

Lyman-alpha Emission from Infant Black Holes in the Early Universe
B. K. Wiggins, Joseph M. Smidt, Jarrett L. Johnson, 2017, Journal of the Utah Academy, 93, 207

Ab Initio Simulations of CR7 as an Active Black Hole
Joseph Smidt, B. K. Wiggins, Jarret L. Johnson, 2016, Astrophysical Journal, 829, L6

Extreme Supernova Models for the Super-luminous Transient ASASSN-15lh
E. Chatzopoulus, J. C. Wheeler, J. Vinko, A. Nagy, B. K. Wiggins, W. P. Even, 2016, Astrophysical Journal, 829, 94

Presentations at External Research Conferences

Neutron Star Mergers Throughout the Evolving Universe (worldwide conference)
8th Huntsville Gamma Ray-Burst Symposium, Huntsville AL, Oct 28, 2016

Smoothed Particle Hydrodynamics Simulations of Double White Dwarf Mergers (regional conference)
Conference of the Utah Academy, Orem UT, April 7, 2017

Papers in Review

The Role of Dredge Up in Double White Dwarf Mergers
J. Staff, B. K. Wiggins et al. 2017, Astrophysical Journal (in review)

Smoothed Particle Hydrodynamics Simulations of Protoplanetary Mergers B. K. Wiggins, Morgan Taylor 2017, Journal of the Utah Academy (in review)

Papers in Preparation

Binary Neutrons Stars Throughout the Evolving Cosmos: Location, Location, Location
Brandon K. Wiggins, Chris L. Fryer, Joseph M. Smidt, Dieter Hartmann et al. 2017

The First Water in the Universe: Molecular Chemistry in Cosmological Simulations of Metal-Poor Halos
Joseph M. Smidt, B. K. Wiggins, Morgan Taylor et al. 2017

Student Mentoring

Students Mentored At Los Alamos National Laboratory in Summer 2017

- **Morgan Taylor**, **Southern Utah University**, mentored during summer 2017 at Los Alamos National Laboratory in astrochemical modeling in cosmological simulations

  Computational Physics Summer workshop poster: Alex Gigliano, Morgan Taylor, Joseph Smidt, B. K. Wiggins, 2017, The Cosmological Origins of Water, Aug 11, 2017
  Paper in preparation: **The First Water in the Universe: Molecular Chemistry in Cosmological Simulations of Metal-Poor Halos**

- **Mark Keltenberg**, George Washington University, mentored during summer 2017 at Los Alamos National Laboratory in setups of particle hydrodynamics simulations of binary white dwarf mergers.

  Co-mentor: Wesley P. Even

- **Alex Gigliano**, Virginia Tech University, mentored during summer 2017 at Los Alamos National Laboratory in astrochemical modeling in cosmological simulations

  Computational Physics Summer workshop poster: Alex Gigliano, Morgan Taylor, Joseph Smidt, B. K. Wiggins, 2017, The Cosmological Origins of Water, Aug 11, 2017
  Paper in preparation: **The First Water in the Universe: Molecular Chemistry in Cosmological Simulations of Metal-Poor Halos**

- **William Black**, Brigham Young University, mentored during summer 2017 at Los Alamos National Laboratory in astrochemical modeling in cosmological simulations

  Paper in preparation: **The First Water in the Universe: Molecular Chemistry in Cosmological Simulations of Metal-Poor Halos**

SUU Students Mentored During 2016 - 2017 Academic Year

- **Morgan Taylor**, carried out simulations of protoplanetary mergers in the early solar system with smoothed particle hydrodynamics. Used turquoise HPC clusters at Los Alamos National Laboratory.

  Talks given: *Protoplanetary Collisions in the Early Solar System*
  Morgan Taylor, B. K. Wiggins, Conference of the Utah Academy, April 7, 2017

  Papers submitted: *Smoothed Particle Hydrodynamics Simulations of Protoplanetary Mergers*
  B. K. Wiggins, Morgan Taylor, Journal of the Utah Academy (in review)

- **Agueda Rodriguez**, carried out fluid dynamics simulations of turbulence in blood flow.

  Festival of Excellence Talk: *Turbulence: An Analytical Depiction of Blood Flow in Atherosclerosis*, April 4, 2017

- **Skyler Porcaro**, carried out particle fluid dynamics simulations of asteroid deterrence.

  Festival of Excellence Talk: *Massively Parallel Smoothed Particle Hydrodynamic Calculations of Asteroid Deterrence*, April 4, 2017

- **Payton Christensen & Kyle Christiansen**, simulations of self-gravitating accretion disks around massive black holes.

  Festival of Excellence Poster: *Accretion Disk Morphology and Massive Black Hole Growth*, April 4, 2017

Affiliations and Memberships

- **LANL researching faculty guest scientist/consulting scientist**, CCS-2/XTD-IDA, Los Alamos National Laboratory. Maintains current security clearance.
- **Astrophysical Journal Referee**, tier 1 astrophysics journal, 1 paper reviewed during 2016-2017 academic year
- **Journal of the Utah Academy Referee**, local journal, 1 paper reviewed
- **Member:** American Astronomical Society, Utah Academy of Sciences, Arts and Letters, Center for Theoretical Astrophysics, LANL.

Faculty Consulting Scientist at Los Alamos National Laboratory

I maintain active affiliation with the national laboratory. This includes maintaining a security clearance and periodic visits to Los Alamos no more than 90 days apart. This connection has proven valuable. Several student research projects have been carried out with LANL computing clusters. I have secured a high-profile internship for Morgan Taylor at Los Alamos during summer 2017. Visits to Los Alamos provide research retreats which allow me to participate in larger projects in computational physics. During this past summer, I was privileged to be on site at Los Alamos through funds available through their contract with SUU. I used the time to work on papers and mentor students, including Morgan. My letters of recommendation are usually prepared on LANL letterhead which diversifies student applications and I comment on the merit of SUU students in the context of the wealth of students

I have and continue to mentor at Los Alamos. I have consulted several initiatives at Los Alamos in an official and unofficial capacity.

I have found that students value the expertise of an active expert.

External Proposals

Radio Astronomy Observing Proposal: The Water Megamaser in II Zw 96, Co-I, submitted to the VLA, Feb 2017, VLA/17B-047.

LANL Grant - Work Proposal

For the information of the committee, I include my grant proposal to LANL to receive funds at SUU from an internal proposal for which I was a Co-I last year. This document summarizes some of my research thrusts and goals with this generous funding from the national laboratory.

Background of Research

Last year, the Laboratory Directed Research and Development (LDRD) program at Los Alamos National Laboratory funded an exploratory research campaign to investigate the growth of massive black holes in the early universe on multiple spatial scales. I was a Co-I on this proposal and will be returning to the Laboratory this summer to assist this effort. I will contribute my expertise in Monte-Carlo radiation transfer and meshfree particle methods.

The formation and growth of massive black holes in the early universe remains a troubling cosmological question. The de facto model of a black hole created from core collapse of a massive star in the early universe which subsequently grows to supermassive status by the present era has been challenged by the observations of the Mortlock (Mortlock et al. 2012) and Wu (Wu et al. 2015) quasars which host black holes 109 solar masses at less than 1 Gyr after the Big Bang. Analytic calculations project that stellar size black holes could not have grown to supermassive status by 1 Gyr as their accretion rates are limited by radiative feedback: larger black holes can eat faster than smaller ones. Thus massive black holes must have either formed larger or grow at rates which exceed predictions of spherically symmetric accretion.

Several pathways to massive black holes have been proposed in the literature. These include direct collapse of an atomically cooled halo in the early universe, the collapse of the core of a supermassive (105 solar mass) star among some speculative ideas like hierarchal merging of stellar-sized black holes. While the former two pathways have been investigated thoroughly in the literature, no fully self-consistent multi-scale model with radiative feedback of the accretion and formation of a supermassive star has ever been carried out. This study would inform our understanding of the connection between accretion on cosmological and stellar scales and elucidate constraints on the growth of massive black holes through cosmic time.

To validate models of accretion, a means of constraining the resulting emission which would be visible to telescopes is needed.

Proposed Research

My research contribution will be part of a broader thrust at Los Alamos National Laboratory to study the growth and emission of massive black holes in the early universe. My work will be include the following efforts:

1. Calculate emission from black holes in the early universe via Monte-Carlo radiative transport

2. Constrain the growth of supermassive stars and massive black holes by modeling accretion flows with particle hydrodynamics

We discuss these points in detail below. Note that, as appropriate, I will be working marginally on related astrophysics-based projects and associated code development. This summer work will culminate in the submission of a publication for peer review in a first tier astrophysics journal on behalf of this LANL-based research effort.

I will also be mentoring a summer student this summer. This undergraduate may assist in the development or testing of radiation transfer methods for calculating black hole emission or in setting up, running or analyzing supermassive star/black hole paricle hydro accretion disk calculations. I may also assist in mentoring other students involved to this broader research campaign as deemed appropriate by my supervisor Joseph Smidt.

Calculating Emission from Massive Black Holes in the Early Universe

I will be part of the effort to help LANL develop capability to predict electromagnetic signatures of young massive black holes (i.e. quasars) whose pathway to supermassive black holes is predicted by cosmological simulations. Part of this work will involve helping develop software to post-process data dumps from large parallel simulations carried out on LANL platforms to determine how black hole emission will appear to current and future telescopes.

I have already written a parallel Monte-Carlo code for radiative transfer of Lyman-alpha photons on grid-domains, but I will be expanding the capabilities of this code to calculate additional types of radiation. This might include non-LTE radiation processes such as x-ray and radio synchrotron emission, maser emission or incorporating LANL opacities into our emission pipeline.

Modeling Accretion Flows with Particle Hydrodynamics

In addition to my work in radiative transfer, I will be using Chris Fryer's particle hydro code SNSPH (Fryer et al. 2006) to study the accretion of gas onto large stars and massive black holes in the early universe. I have experience with this code and will be assisting in adapting it for accretion disk dynamics with radiative feedback. Part of this might include a broader study of the sensitivity of simulation results to choice of particle hydro prescription and addressing the problem with modern particle hydro schemes. This work will also include the development of some setup tools and a robust visualization pipeline (which does not yet exist) which can be used by collaborators at LANL after this summer. This will constitute a deliverable for this summer in addition to the academic contribution mentioned above.

Impact of Research

The appearance of supermassive black holes in the modern and ancient cosmos pose a formidable challenge to standing theories of large scale structure formation in the universe. Understanding the origin of these objects will shed needed light on the character of the primordial universe the events taking place in this era which impact the present state of the universe. But black hole formation is not merely interesting on its own merits. The growth of large black holes appears to be intertwined with the evolution of galaxies. In particular, black hole masses are correlated with stellar velocity dispersions in galaxies, suggesting that the galaxy and its central black have long shared histories. Understanding the origin of massive black holes is thus critical to understanding the processes involved in assembling the largest structures in the cosmos in general.

We again point out that this research is in conjunction with a broader research thrust to study black hole accretion on all relevant scales, from cosmological flows down to the accretion disk itself. No such multi-scale model, complete with all relevant physics and feedback between scales has yet been attempted but is crucial in evaluating the merits of current theories of massive black hole formation.

Our research will further contribute to LANL's capability to estimate emission via post-process of black hole environments. The ability of post-process high-fidelity data dumps via Monte-Carlo transfer will contribute to LANL's

substantial technical lead in this field and may be applied to other high-energy astrophysics problems of LANL interest.

SECTION

3

SERVICE TO THE COMMUNITY

Scholarly Services

- Physical chemistry tenure-track position search committee member, 2016
- Session chair, Conference of the Utah Academy, April 2017
- Astrophysical Journal (tier 1 in astrophysics) Referee, 1 article
- Journal of the Utah Academy Referee, 1 article
- Los Alamos National Laboratory consulting scientist, CCS-2, XTD-IDA. Various projects.

Science Outreach

- **Mentored Joy Coates** at Cedar High School in physics educations, including curriculum development, 2016-2017 academic year
- **Homecoming float entry**, chemistry + physics clubs, 3rd place (probably because chemistry joined us), Sep 24, 2016
- **Supermoon science outreach night**, Ashcroft Observatory, Nov 14, 2016
- **STEM Night**, science presenter, Gateway Preparatory Academy, Fall 2016
- **Physics of Halloween** Demonstration Shows at Cedar High School, Nov 11, 2016 (3 shows)
- **String Theory Seminar**, Math Department, 6 lectures, Fall 2016
- Regional Science Olympiad **Event Officiator**, Mission Impossible, Mar 16, 2017
- **Judge**, SUU Science and Engineering Fair, Mar 31, 2017
- Southern Utah University "Honors You" **Science presenter**, Dec 3, 2016

- Iron Springs Elementary STEM Night **Presenter**, April 6, 2017
- STEM endorsement **presenter/trainer**, northern and southern cohorts: Jan 21, 26, 2017
- Orchestra of Southern Utah Children's Jubilee **presenter/guest scientist**, Feb 11, 2017
- Orchestra of Southern Utah Legacy **Guest Scientist presenter**, Feb 23, 2017
- **Physics of Electromagnetism** at Cedar High School, April 26, 2017 (3 shows)
- **Big Bang Night of Science**, co-organizer, presenter, April 14, 2017
- STEM K-12 Infrared Camera Training at SUU, **presenter,** May 2017.

SECTION

4

COLLEGIALITY

I have attempted to maintain positive relationships with faculty and students by offering optimism and attempting to serve as a confidential listening ear for colleagues wishing to vent occasional frustrations. I do believe in voicing objections but doing so in a civll/constructive manner which doesn't breed animosity. In addition, I am eager to collaborate with colleagues across campus and to maintain my connections beyond SUU.

Collegiality With Colleagues

- Substituted Rhett Zollinger's PHYS 2220 class for 2 days while he was on travel
- Delivered 6 lectures on string theory to the SUU Math Department during Fall 2016
- Consulted Jim Brandt (SUU Math Dept. Chair) on the proposal of an Applied Mathematics major
- Attended CETL new faculty orientation (11 weeks)
- Gave in-class physics demonstrations in PHYS 1010 (Prof. Cameron Pace) and PHYS 2210 (Prof. Rhett Zollinger) who are presumably afraid of fire
- Agreed to teach at 7:00 a.m. in Fall 2017 though I was also scheduled to teach at 4:00 p.m.

Collegiality To Students

1. Punctual to all class meetings
2. Observed office hours
3. Implemented **tutor-center office hour** during spring 2017 semester. This allows me to meet many more students at a time and facilitate/train students on group study. Some students are intimidated by one-on-one office hours and this breaks down that inhibition by assuring a larger group will be meeting together with the course instructor.

4. Rearranged office furnishings to host 3 additional students (total of about 5 now fit comfortably in my office). Purchased some additional seating/furnishings for my office to this end.
5. Made and met multiple non-office hour appointments including evening appointments
6. Posted grades on Canvas at student request
7. *All* exams graded within 24 hours of me receiving them from the Testing Center.
8. I make it a point to greet students when I see them across campus and inquire how life and coursework are going
9. I have prepared some 12 letters of recommendation for students

Collaborations Beyond SUU

- Center for Theoretical Astrophysics at Los Alamos National Laboratory
  Collaboration has yielded 1 student internship (Morgan Taylor) and access to high performance computing (supercomputing) clusters.