Julia Grimes

Pre Class Exercises to help understanding

Physics 492R Capstone Project Report

4/22/16

Dr. Robert Davis

Abstract:

For this project we not only wanted to create pre-class exercises that would help introductory level physics students learn basic physics principles before coming to class, but we also wanted to get feedback from the students so that we knew how to make the exercises more useful for their learning. We conducted interviews with students from the Physics 121 and Physics 140 classes and gave pre and post interview surveys to all who were willing to take them. Based on the feedback that we got from the students who were interviewed, the students felt like the idea behind the exercises was great. Even if they found the exercises to be frustrating, they still thought that idea and purpose for making them was very useful and hoped that we would continue to improve them to make them even better for students in the future. The data and feedback we collected gave us an overwhelming response that the students want more explanations and feedback when they are taking the exercises. We also had a majority of students who said that the most useful part of the exercises for them were the videos that gave explanations to the problems that they needed to solve. Along with this feedback, we were able to come up with a list of other helpful aspects students saw, issues they came up against, and changes that they saw we could make to help improve the exercises. This is discussed and presented in the paper.

Introduction:

A big topic in the Education field right now is that of having a "Flipped Classroom." In a flipped classroom, students are assigned to complete a variety of short assignments that cover material they have not yet discussed in class. Then, when they come to class, they have already been exposed to and are somewhat familiar with the topics that they will be studying. _____ and _____ have found this flipped classroom method to be successful. By having the students learn the basic definitions and concepts before coming to class, the teacher can use class time to go over harder and more difficult concepts. Through this method, _____and _____ have seen bigger gains in how much students learn.

https://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom/

Very similar to this flipped classroom style of teaching, the inverted classroom approach focuses on presenting material before students come to class using a variety of different learning styles. Like in the flipped classroom setting, students are again assigned a variety of learning activities and assessments before they come to class that so that when they are in class, they are ready to move beyond the basics and focus on applying the material.

At Brigham Young University there is a wide variety of students taking the introductory Physics courses. From Physics 105 and 121 to the Introductory Physics Lab, Physics 140, the students in these classes have a very different level of preparation and experience coming in. Some of the students in these classes are just out of high school and have never taken Physics before. Others have recently began college again after a two year deferment to serve an LDS

mission and are trying to remember what they knew 2 years ago. Still others are college seniors in their last year of their Pre-Med programs. This wide variety of backgrounds knowledge leads to a wide range in student needs. It is therefore extremely difficult for a professor to try to address all of their student's smaller basic questions and then still have time to address the more complex questions in the short amount of class time that they have. Some students may feel ready to go straight into hard problems when they get to class, but others may still need to learn the definition on velocity for example. How does the professor decide what to spend time on?

In an effort to decrease this wide gap in the student's level of understanding, we wanted to help all the students to at least become proficient on certain basic concepts when they got to class. By using the ideas presented in the "Flipped classroom" and "Inverted classroom" methods, we create pre-class exercises that students were required to take before coming to class to help them get to that basic level of understanding. In these exercises, we check to see if they know the concepts at a basic level by having them answer questions on topics that will be covered in class. Having already spent time covering the basics, more of class time could then be spent on learning about and applying more advanced material. That way, students get a better and more in depth understating of the concepts they need to know.

For several semesters we had students in Physics 105 and 140 use the pre-class exercises to see if this helped them learn physics more efficiently and more fully. To determine if the exercises were helping we had each student take the nationally recognized Force Concept Inventory (FCI) Physics test at the beginning and ending of each semester and then compared their scores to look at the gains.

As an extension of this work and in an effort to make these exercise more helpful for the students learning, we surveyed and interviewed students from the Physics 121 and 140 classes to get their feedback and opinions on the exercises. With this information we hope to be able to make the appropriate changes or additions to the exercises so that they are even more helpful at teaching the basic concepts before the students come to class.

This paper will present to you the feedback and remarks from the interviews we conducted as well as with the data we collected in the pre and post interview surveys. We will also offer our conclusions and interpretations of the information we collected with the hope that this information will help us to improve the exercises and achieve our goals for the purpose of using them.

METHODS

To collect the feedback and data that we wanted, we decided to have students take both a pre-interview survey and post-interview survey in addition to coming in for a 10-15 minute interview. Students could sign up to come in for an interview by taking the pre-interview survey. After signing up for and coming in for an interview, we would have them quickly answer the questions for the post-interview survey.

The Three Components of the Interview Process

Pre-Interview Survey

In the pre-interview survey, students were asked questions about the general functionality of the exercises. The survey was designed to give us feedback so that we could fix any of the problems the students were having with non-content related problems. These problems include things like technical issues, loading issues, problems with writing or pictures being covered up or not visible on the screen, etc.

The list of questions that students were asked in the pre-interview survey are given below.

Pre-Class Survey for Physics 121 Students:

Please enter your email address in the space provided if you would be willing to participate in an interview.

Free response: Type your answer here

1. Did you work through or use any of the new pre-class exercises?
   - Yes, I used all of them
   - Yes, I used most of them
   - Yes, I used about half of them
   - Yes, but I only used a few of them
   - No, I studied in other ways

2. In what other ways did you study? For example, maybe studied by reading the book, going to class, or just by doing the homework. Please write down any other ways you typically studied.

Free response: Type your answer here

3. When you worked through the exercises, did you take them before the material was discussed in class?
   - Yes, all of the time.
   - Yes most of the time.
   - No, most of the time I worked through them later.

4. Did the exercises ever load too slowly for you?
   - No, they loaded fine
   - They were a little slow but not too much to be a problem

- Yes, they took too long to load

5. Did the exercises ever crash or not let you complete them correctly?
   - No, they worked well
   - I occasionally had problems, but not too many
   - Yes, I was always having problems running the exercises
6. Were the words or images ever covered or hard to see or read?
   - No, things were visible and easy to read.
   - There were problems occasionally, but nothing that made them too difficult to use.
   - I frequently had problems reading and seeing parts of the exercises.
7. How did you feel about the length of the exercises?
   - They were shorter than I would have liked.
   - They were only sometimes too short.
   - They were a good length, and kept my attention.
   - They were sometimes too long.
   - They were usually longer than I would have liked.
8. Did you feel the exercises were a valuable use of your time?
   - No, they were not valuable or useful to me.
   - Sometimes they were valuable, but not very often.
   - Yes, most of the time they were valuable.
   - Yes, they were great and they were very valuable.
9. How effective do you feel the exercises were at helping you learn?
   - They were not very helpful.
   - Sometimes they were helpful, but not very often.
   - Most of the time they helped.
   - They were great and they helped me a lot.
10. How effective were the exercises in helping you to use and apply new concepts before you came to class?
   - They were not very helpful.
   - Sometimes they were helpful.
   - Most of the time they were helpful.
   - They were great and they helped me a lot.
   - I usually took the exercises after the material was discussed in class so they didn't help when I was in class at all.
11. What was your overall opinion on the exercises?
   - I didn't like using them, they were a waste of time.
   - They were good, but I don't feel like they actually helped me in the course
   - They were good, I feel like they helped.
   - I thought they were great!

Pre-Class Survey for Physics 140 Students:

1. Please enter your email address in the space provided if you would be willing to participate in an interview.

Free response: Type your answer here

2. Did you work through or use any of the new pre-class exercises? *

- Yes, I used all of them
- Yes, I used most of them
- Yes, I used about half of them
- Yes, but I only used a few of them
- No, I studied in other ways

3. In what other ways did you study? For example, maybe studied by reading the book, going to class, or just by doing the homework. Please write down any other ways you typically studied.

Free response: Type your answer here

4. When you worked through the exercises, did you take them before the material was discussed in class?

- Yes, all of the time.
- Yes most of the time.
- No, most of the time I worked through them later.

5. Did the exercises ever load too slowly for you?

- No, they loaded fine
- They were a little slow but not too much to be a problem
- Yes, they took too long to load

6. Did the exercises ever crash or not let you complete them correctly?

- No, they worked well
- I occasionally had problems, but not too many
- Yes, I was always having problems running the exercises

7. Were the words or images ever covered or hard to see or read?

- No, things were visible and easy to read.
- There were problems occasionally, but nothing that made them too difficult to use.
- I frequently had problems reading and seeing parts of the exercises.

8. Did you feel the exercises were a valuable use of your time?

- No, they were not valuable or useful to me.
- Sometimes they were valuable, but not very often.
- Yes, most of the time they were valuable.
- Yes, they were great and they were very valuable.

9. How effective do you feel the exercises were at helping you learn?

- They were not very helpful.
- Sometimes they were helpful, but not very often.
- Most of the time they helped.
- They were great and they helped me a lot.

10. How effective were the exercises in helping you to use and apply new concepts before you came to class?

- They were not very helpful.
- Sometimes they were helpful.
- Most of the time they were helpful.
- They were great and they helped me a lot.

- I usually took the exercises after the material was discussed in class so they didn't help when I was in class at all.

11. What was your overall opinion on the exercises?
    - I didn't like using them, they were a waste of time.
    - They were good, but I don't feel like they actually helped me in the course
    - They were good, I feel like they helped.
    - I thought they were great!

Interviews

The interviews were designed to gather information about the content that was provided in the exercises. We wanted to get the student's feedback on aspects such as the explanations we were using, the definitions and videos we had, and the types of questions that were provided. We also wanted to get feedback on things that we could change to make the exercises more helpful.

The interviews were conducted in an office in the Eyring Science Center and a laptop was used to record the student's response as we asked them questions. The interviews lasted 10-15 minutes and students were paid $5 for taking them.

Lastly, the student assistant who conducted the interview was familiar with the format of the exercises, but did not personally create the exercises that the students were asked to give feedback on. Students were informed of this at the beginning of the interview so that they felt free to give any feedback that they wanted to give without fear of offending the interviewer.

The list of questions used when conducting the interview are listed below.

Interview Questions:
What is your overall opinion on the exercises?
How do you use them?
Do you feel like the exercises help you learn and come more prepared for class?
In what ways do you think the exercises helped you to learn?
What parts of the exercises were valuable to your learning?
What parts of the exercises did you consider to be least valuable to your learning?
What did you like about the exercises?
What didn't you like about the exercises?
What do you think would make the exercises more effective?
What changes would you make to the exercises?
Did you feel like you had the opportunity to use the equations and apply things before you got to class?

In the exercises would you rather have a written explanation or a video explanation after missing a question?

Post-Interview Survey

In the post-interview survey students were asked questions that helped us collect information about the class dynamics. We collected data in many areas such as the student's age, major, year in school, prior experience with physics, etc.

The list of questions that students were asked in the post-interview survey are given below.

Post-Interview Survey:

1. Do you usually do the reading?
   - Yes always
   - Not always but more than ¾ of the time
   - Not always but more than ½ the time
   - Less than half the time

2. When you do the reading, how well do you feel you understand what is being taught and explained?
   - I don't understand anything
   - I understand some things, but I don't understand them very well
   - I understand some things somewhat well
   - I understand most things very well
   - I understand the whole reading very well

3. How long do the readings take you?

4. What year did you graduate from high school?

5. How many semesters of college have you taken?
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7 or more

6. Are you a Physics, Applied Physics, Physics and Astronomy, or Physics Teaching Major?

- Yes
- No

7. If not, what is your major?

8. Why are you taking this class?
   - It is required for my major
   - To fulfill one of my general ed. Requirements
   - I am just taking it for fun, not for any major or general ed. Requirements

9. Before taking this class what were your feelings about physics?
   - Very Positive
   - Positive
   - Neither Positive nor Negative
   - Negative
   - Very negative

10. Have your feeling changed?
    - No
    - Yes, they are now more positive towards physics
    - No, they are now more negative towards physics

11. How long ago did you take your last physics class?

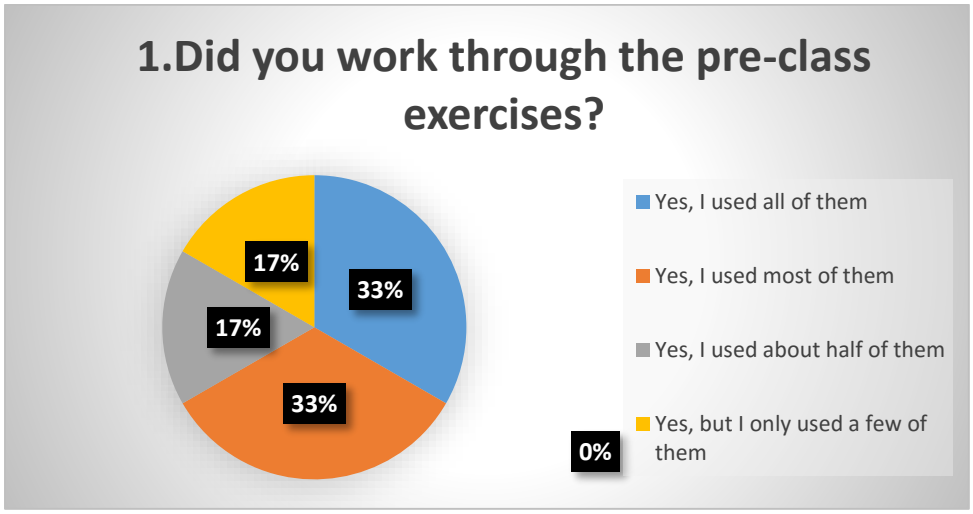
12. How much time did you spend on the exercises before each class?

    - None
    - 5 minutes
    - 10 min
    - 20 min
    - 30 min
    - 40 min or more

Results and Discussion

Below are the responses we received from the pre-interview surveys. We gave a slightly different survey to the Physics 121 and Physics 140 classes and so both of them are included below.

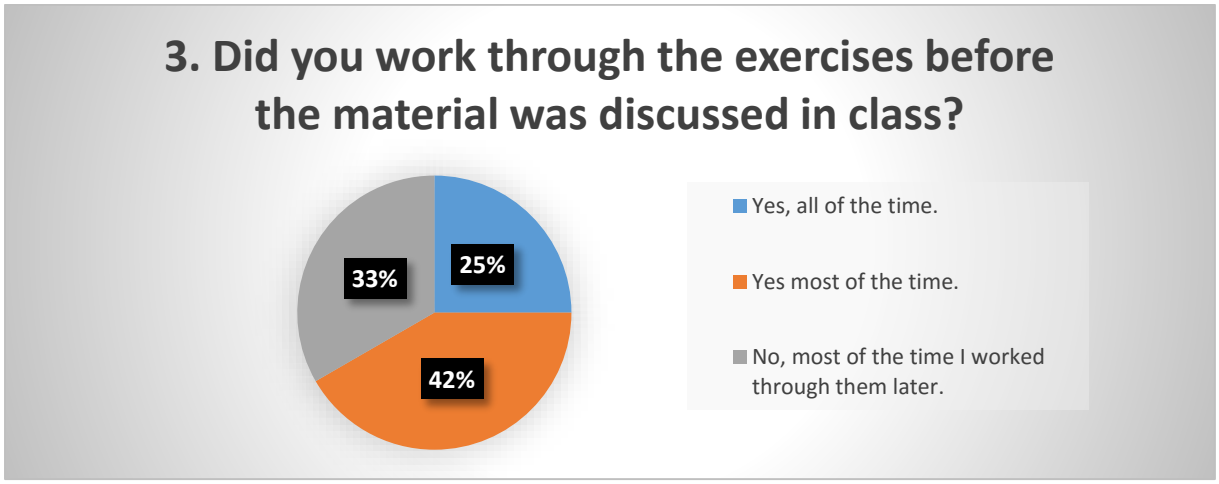
Pre-Interview Survey Results: Physics 121

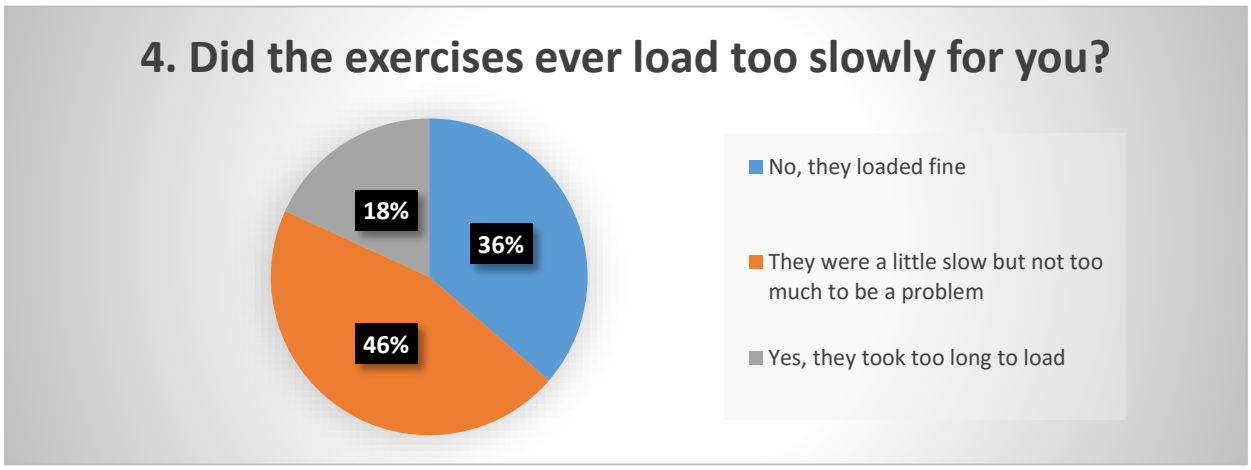


2. In what other ways did you study? For example, maybe studied by reading the book, going to class, or just by doing the homework. Please write down any other ways you typically studied.

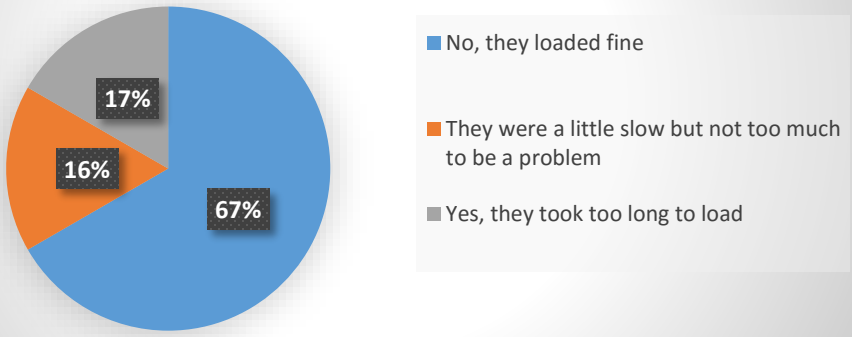
Reading the book then testing my knowledge with the reading quizzes. Doing the homework and if I didn't understand that going back and reading through the chapter summaries.
I read over the chapter summaries provided and I try to memorize equations on the memorization sheet.
I mostly just did the homework, and spent time recalling my physics class from three years ago, Seems to work pretty will
Reading, homework, flashcards
Practice questions at the end of each chapter primarily.
All of the above
Reading the book, going to the physics TA lab often.
Reading, homework, and class. Last chapter I also got a tutor.
Doing previous test, re-doing homework, online tutorials on Learning suite, and TAs
I redo the homework and work through all the practice tests. I also enjoy the review class session we have before tests
I made flash cards, got a tutor, did all the homework in open lab, and read all the assigned readings.

I read the chapter summaries, then if I didn't understand I would read the textbook. I almost always went to the TA lab, and to prep for the test I would do the practice tests and the practice problems in the chapter summaries.

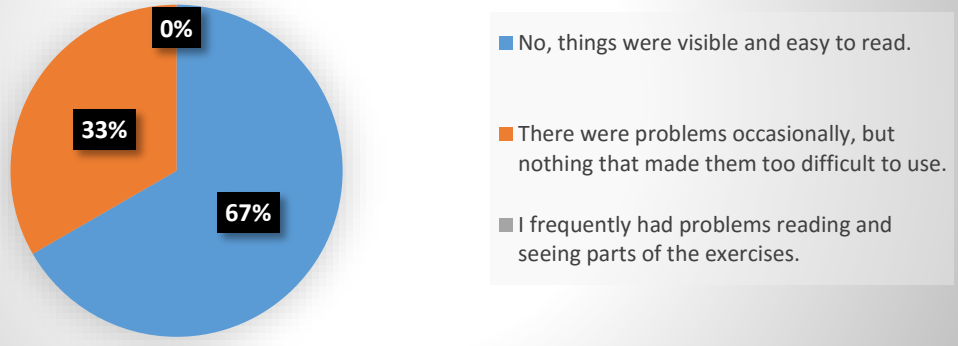




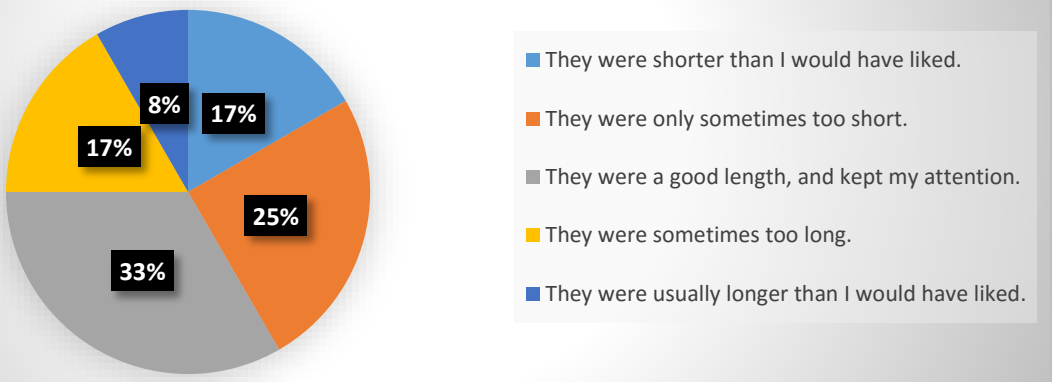
5. Did the exercises ever crash or not let you complete them correctly?



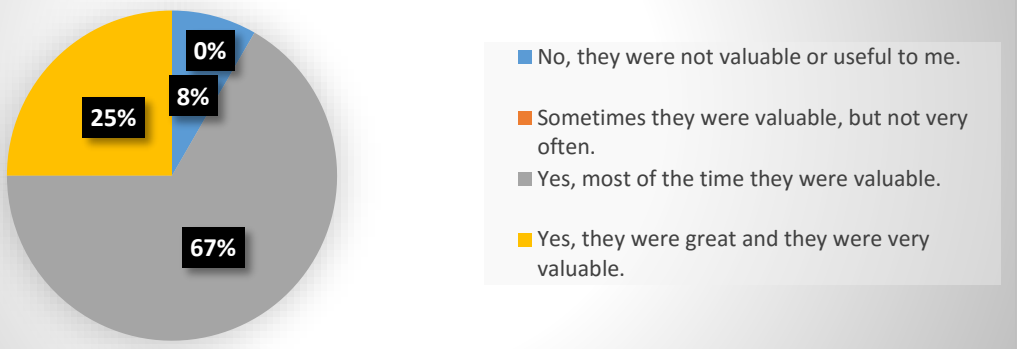
6. Were the words or images ever covered or hard to see or read?



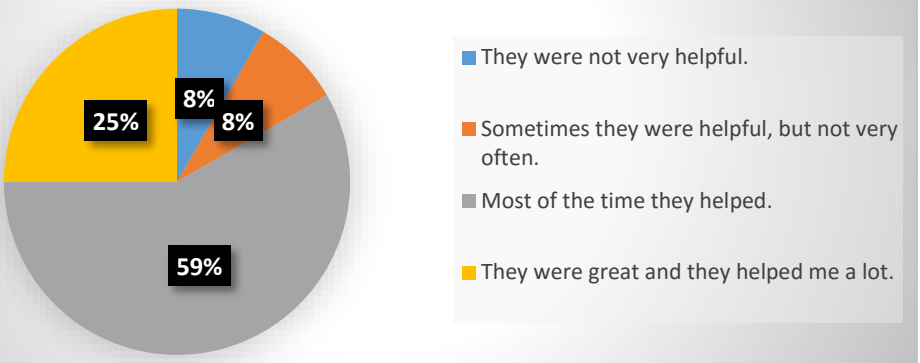
7. How did you feel about the length of the exercises?



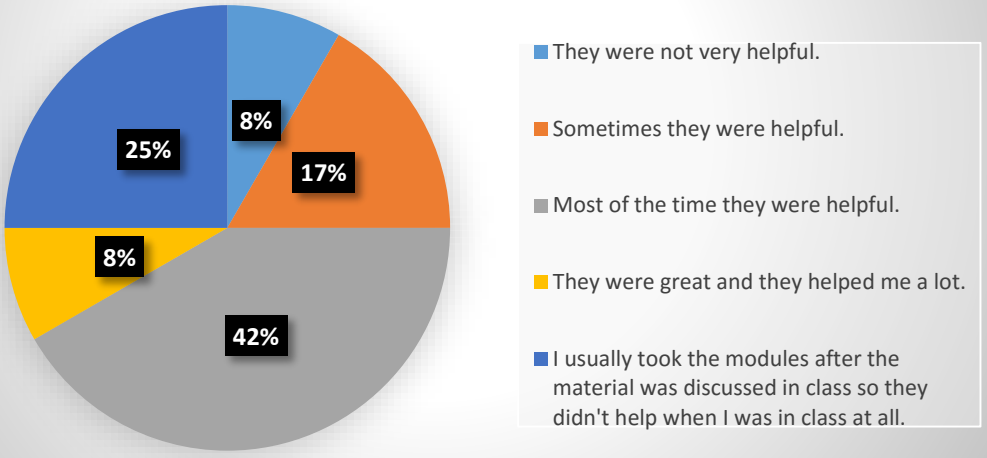
8. Did you feel the exercises were a valuable use of your time?



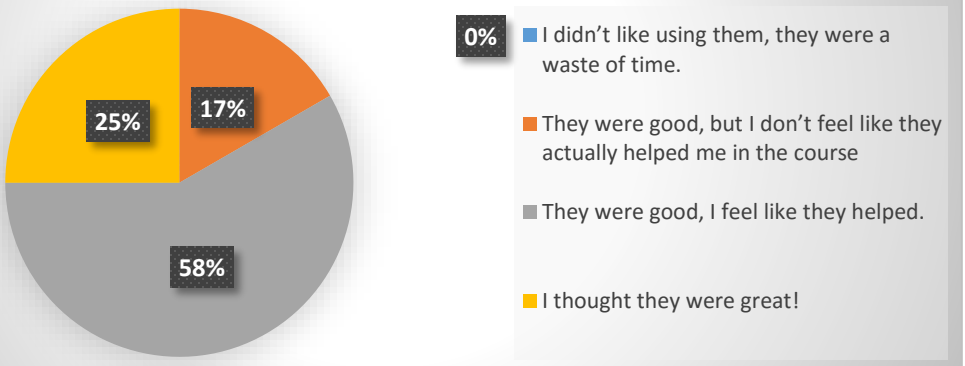
9. How effective do you feel the exercises were at helping you learn?



10. How effective were the exercises in helping you to use and apply new concepts before you came to class?

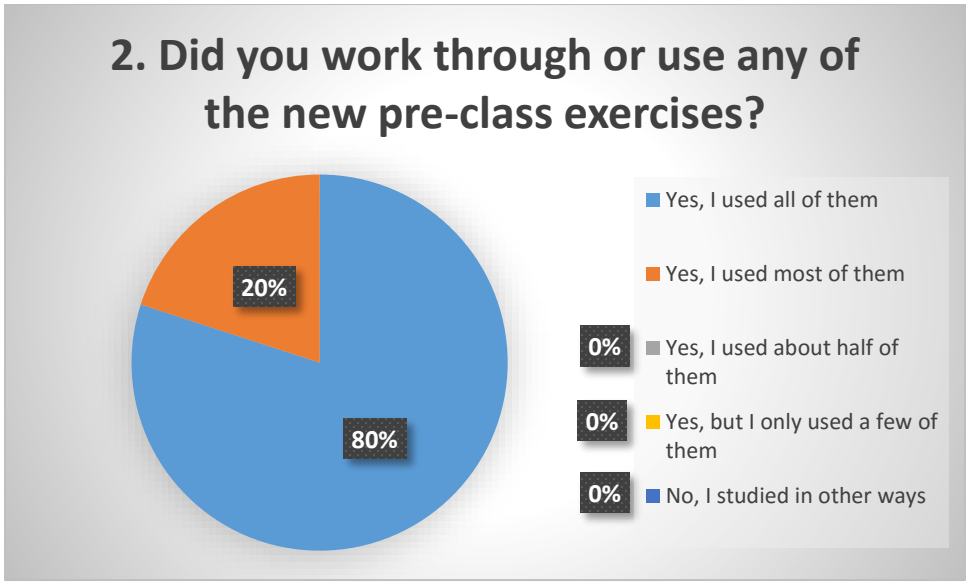


11. What was your overall opinion on the exercises?



Pre-Interview Survey Results: Physics 140

Question one asked students for their email.



3. In what other ways did you study? For example, maybe studied by reading the book, going to class, or just by doing the homework. Please write down any other ways you typically studied.

Reading the book
I usually read over the chapter, sometimes not completely, before starting the module and class.
Asked for help from more experienced students
Read book, go to class, do labs, research material on internet
Going to class, reading the book, doing the pre-class exercises and the homework
I took notes in class, read through the pre-class readings, as well as went over labs we had done to study.
I studied by doing the reading before class every Tuesday and by doing the pre-class modules.
Google
Read the book
Going to class, occasional study groups, skimming the reading
Reading the manual and going to class!
Doing the pre-class and prelab readings, went to class
Going to class.
Practice problems off other universities websites
I read through the assigned readings and review in-class activities that I do not get correct.
Reading the lab manual, going to class, other online resources and texts.
Reading the book and doing homework

Going to class, doing the labs

Going to class and lab

I studied by reading the book various times until I got the gist of it, otherwise it was all learned in class, I just wish there had been some feedback to say which part I had gotten wrong-that way I would know what I did not understand yet.

I read the topic that's covered in the lab packet and I attend the Tuesday lecture.

Mostly going to class or reviewing out of the packet

Class and homework

Going to class, reading the manual, and doing the labs

Going to class, reading the manual, going to lab

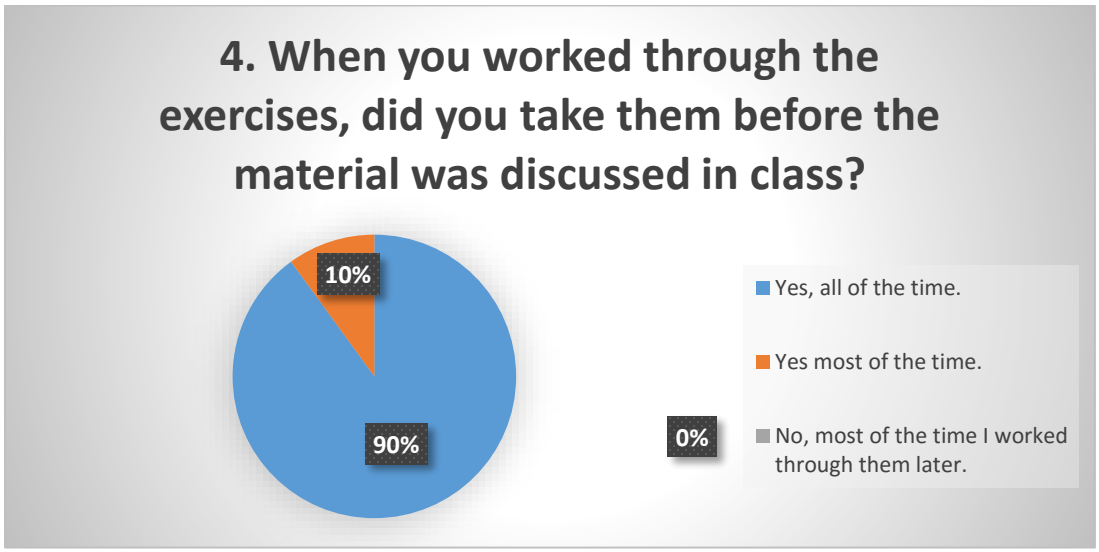
I used a circuit simulator to help visualize concepts; I looked up topics online.

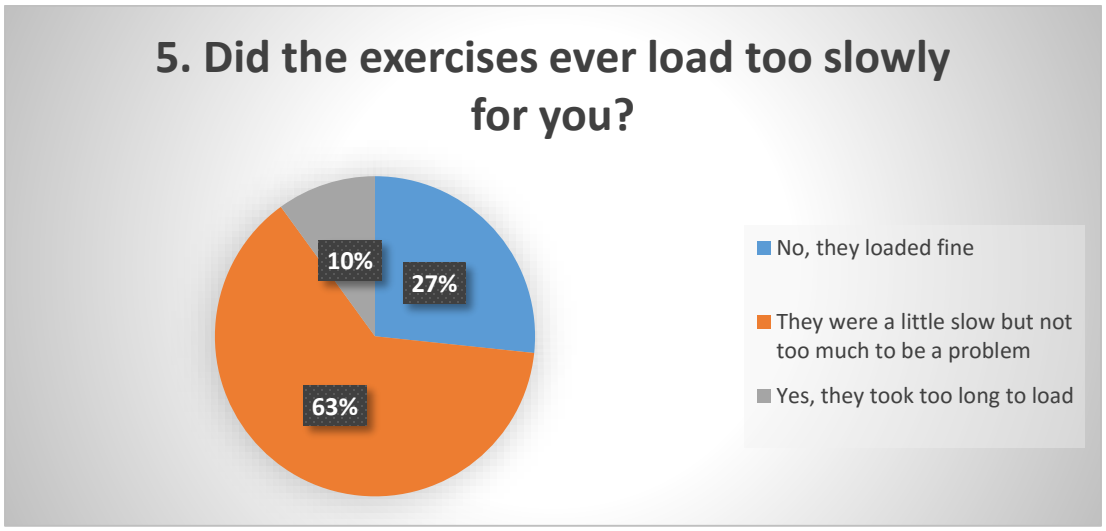
I also did the readings in the lab handbook and looked concepts up online that I didn't understand.

Went to class, did homework, did labs.

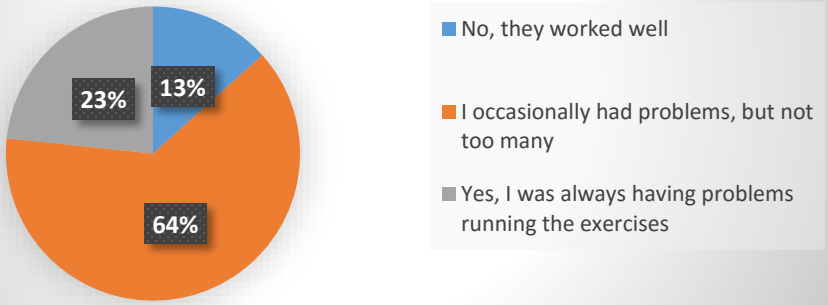
Doing the homework and going to class

I went to class and worked on the labs

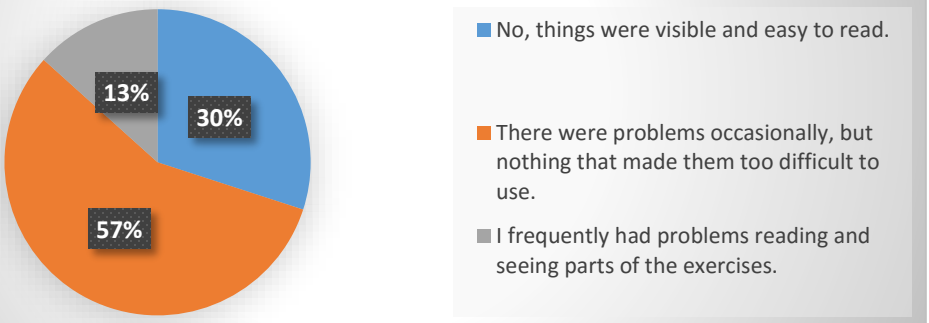




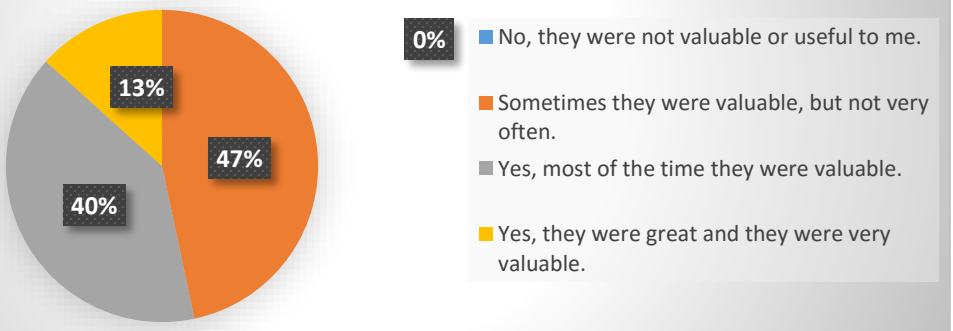
6. Did the exercises ever crash or not let you complete them correctly?



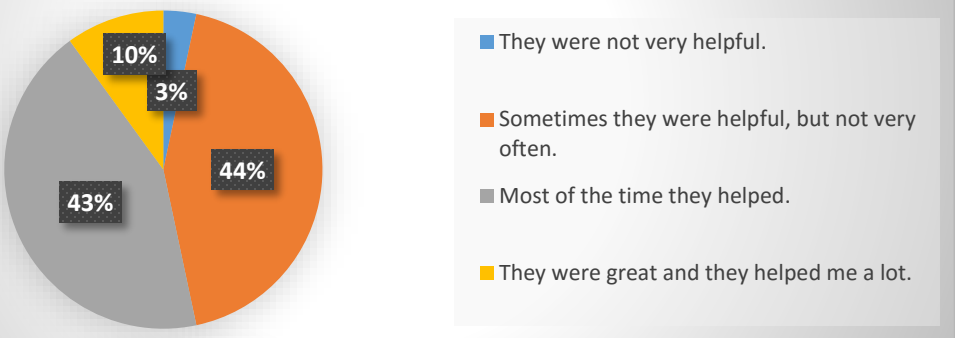
7. Were the words or images ever covered or hard to see or read?



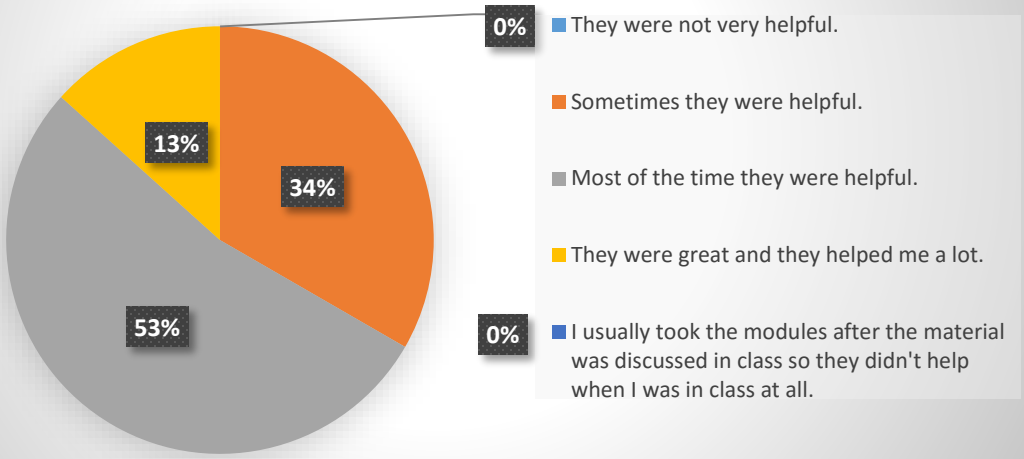
8. Did you feel the exercises were a valuable use of your time?



9. How effective do you feel the exercises were at helping you learn?



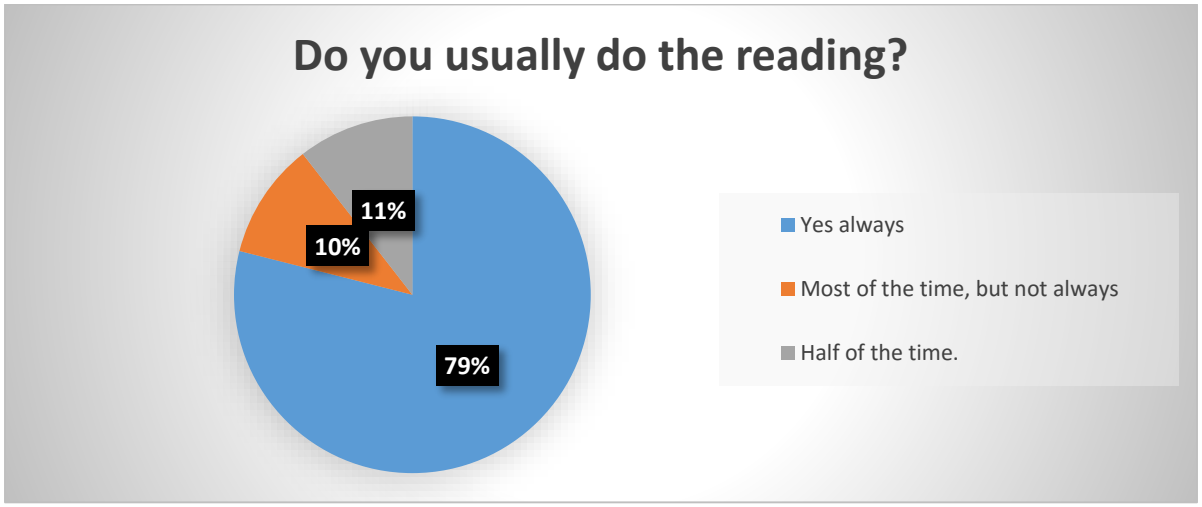
10. How effective were the exercises in helping you to use and apply new concepts before you came to class?

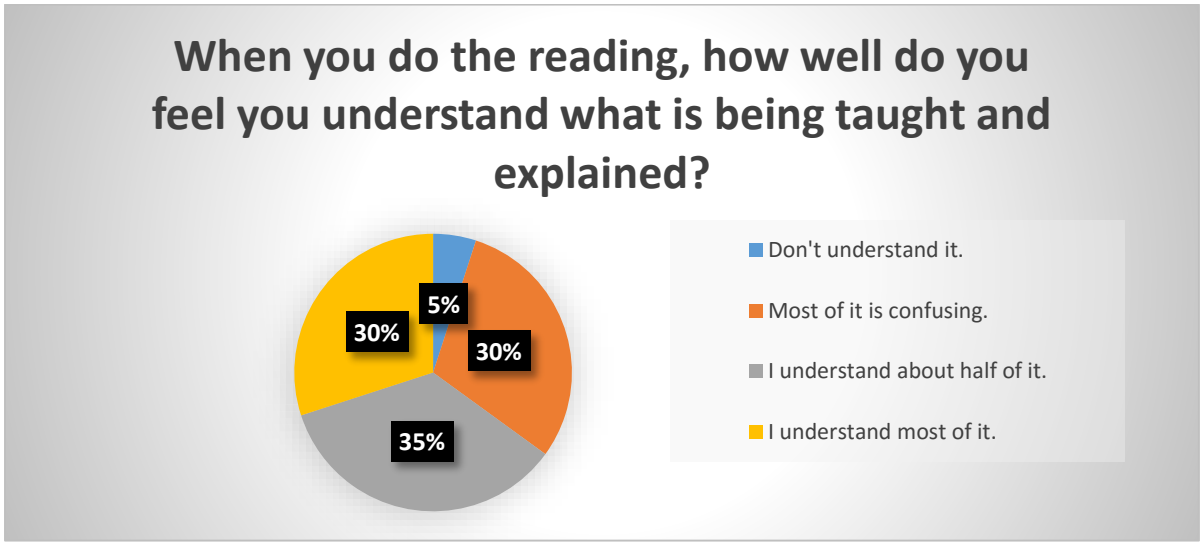


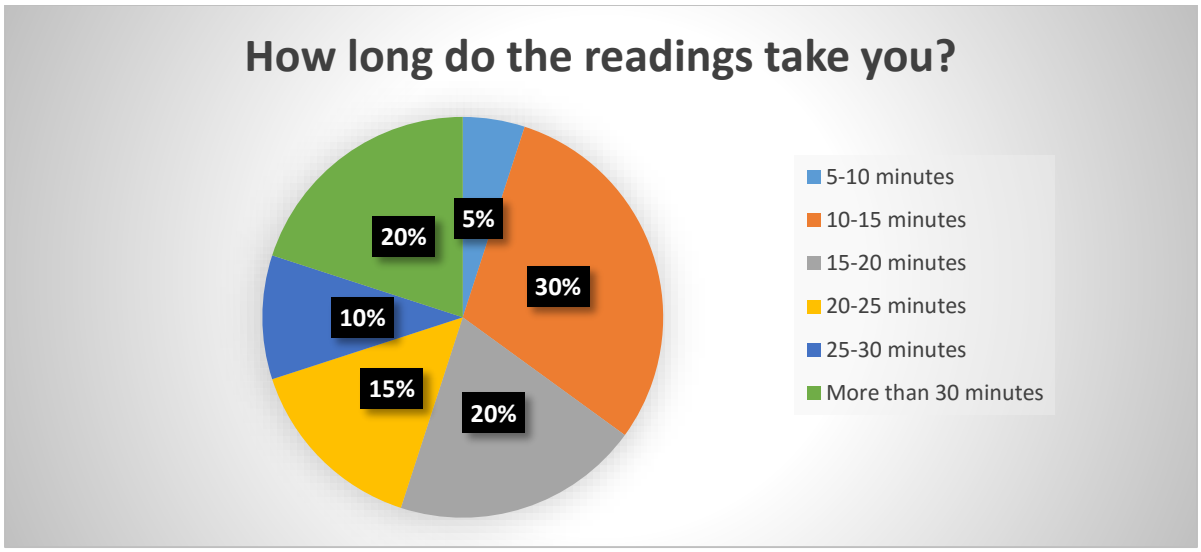
11. What was your overall opinion on the exercises?

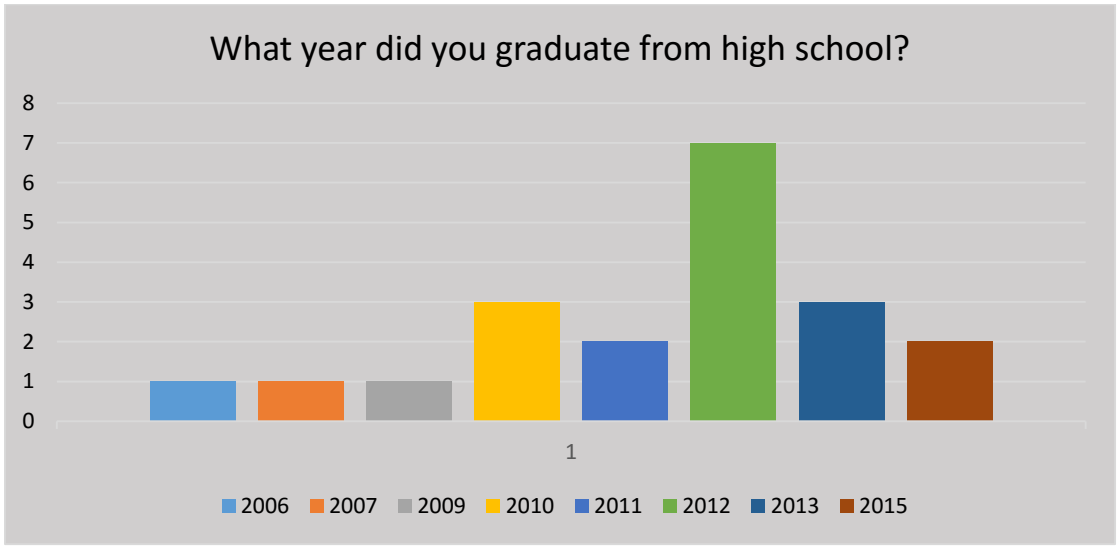
Post Interview Survey Results:

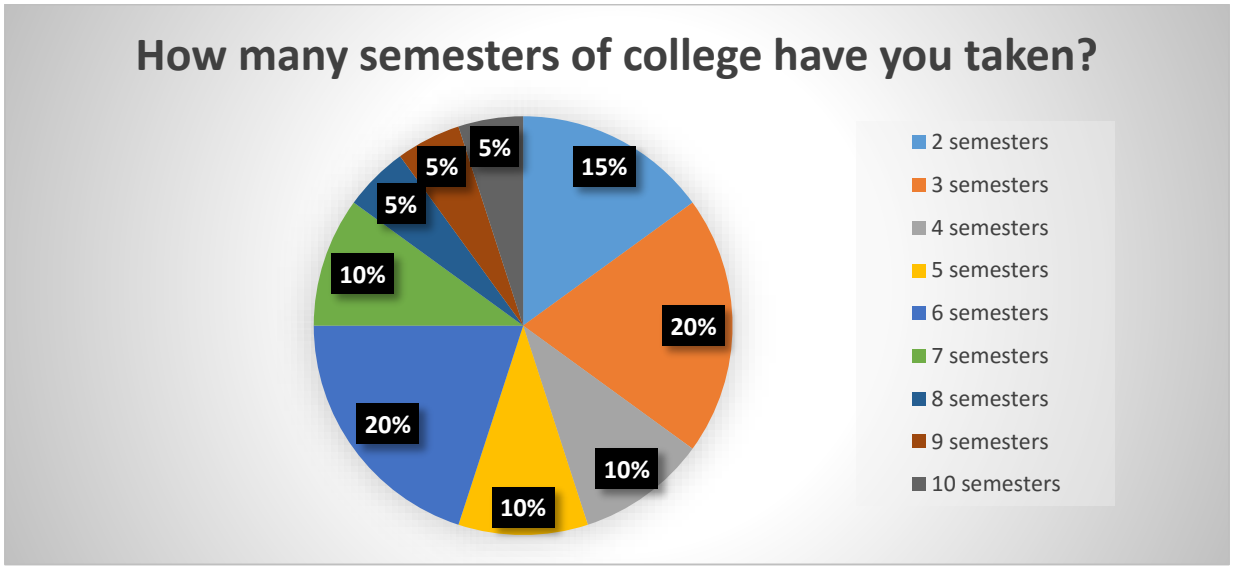
The Post Interview Survey was given to the students at the end of the interview. The results we collected form this survey are posted below.

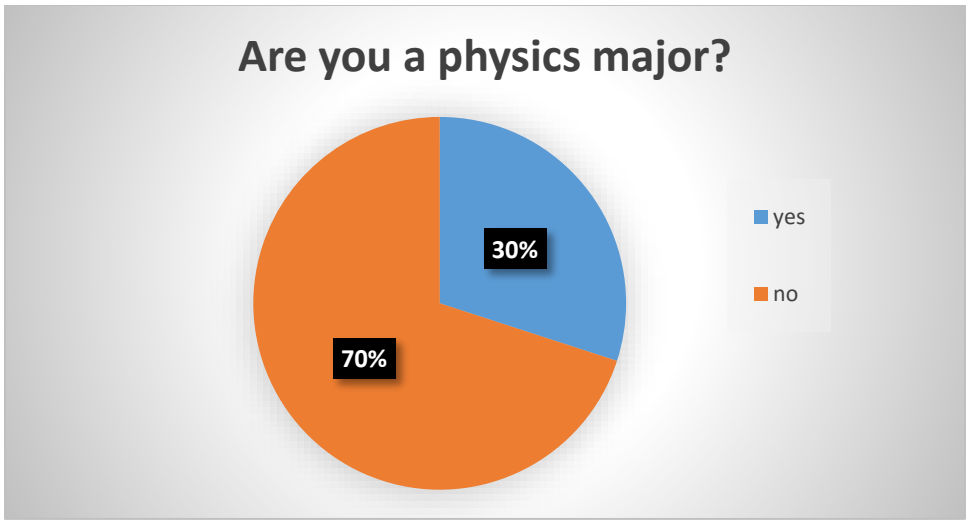


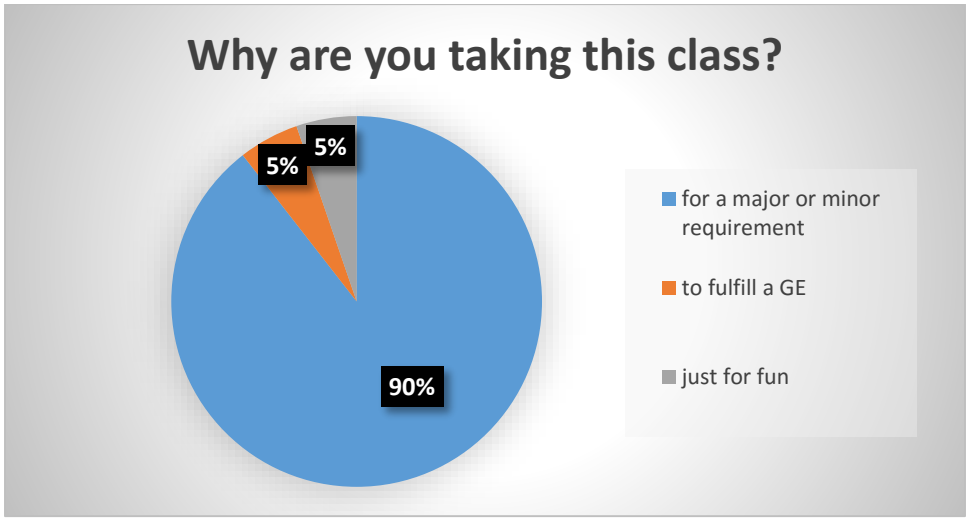


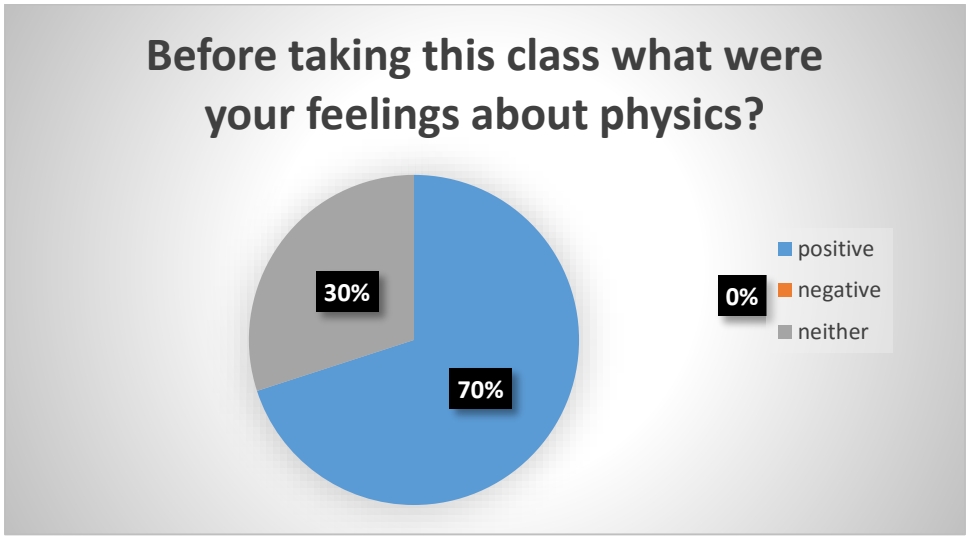

How long do the readings take you?
5%
30%
20%
15%
10%
20%
5-10 minutes
10-15 minutes
15-20 minutes
20-25 minutes
25-30 minutes
More than 30 minutes

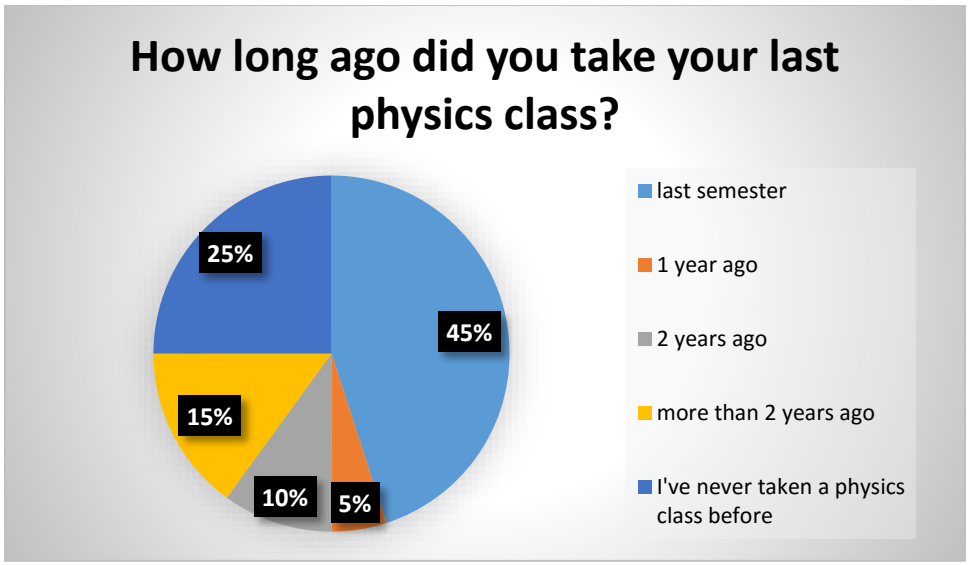

What year did you graduate from high school?
8
7
6
5
4
3
2
1
0
1
2006
2007
2009
2010
2011
2012
2013
2015

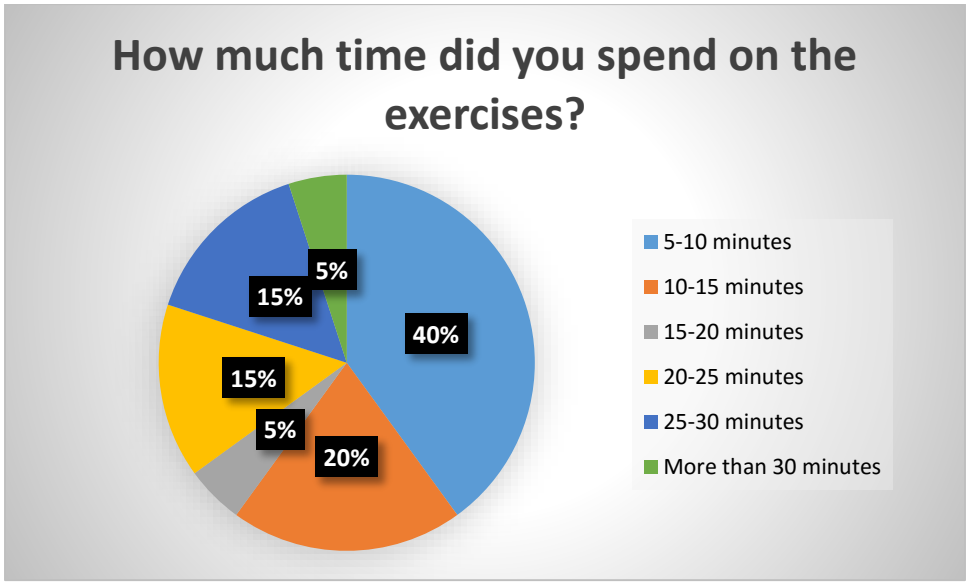

How many semesters of college have you taken?
15%
20%
10%
10%
20%
10%
5%
5%
5%
2 semesters
3 semesters
4 semesters
5 semesters
6 semesters
7 semesters
8 semesters
9 semesters
10 semesters


Are you a physics major?
30%
70%
yes
no


Why are you taking this class?
5%
5%
90%
for a major or minor requirement
to fulfill a GE
just for fun


Before taking this class what were your feelings about physics?
30%
70%
0%
positive
negative
neither


How long ago did you take your last physics class?
25%
45%
15%
10%
5%
last semester
1 year ago
2 years ago
more than 2 years ago
I've never taken a physics class before


How much time did you spend on the exercises?
5%
15%
40%
15%
5%
20%
5-10 minutes
10-15 minutes
15-20 minutes
20-25 minutes
25-30 minutes
More than 30 minutes

Student Interviews - Physics 140 modules

Overall Opinion

The modules really helped me learn.

- The first few modules were really good. They really helped me because I didn't really know anything about physics.
- I think it's a great idea and it's worth it. I feel like it's well on its way to being optimal. It's worth it.
- I liked them because if you understood the topic then you could get through them really fast, but then if you didn't quite understand the topic you could take it again and again.
- I like the modules a lot. I use them by taking them after the reading before class, and also by using them to review for the test before we took our first midterm.
- I feel like these modules have really helped me learn by providing a good refresher. I'm a junior so I've heard of most of these topics already. I feel like it gave me a good review of the basics.
- I like the length of them, I don't feel like they are busy work and I don't think they are a waste of my time.

The modules didn't really help me learn.

- The modules were usually pretty frustrating because it was hard to see a connection between the reading that we did and how to do the problem.
- The modules just overall seem too unrelated.
- The modules are somewhat aggravating because I feel like the things we learn in the module are the pinnacle of what we are trying to learn in class. We have an hour long lecture and sometimes after an hour long class we just get to the point where we re-due the quiz. It's frustrating that they put it all back on me to learn the module before we come to class when understanding the module is where they want us to get to by the end of class anyway. That puts us out of class trying to figure out what we are going to learn in class all by ourselves and we are graded on it.
- **I really like the idea of the pre class modules however I think the way they are done is really poorly.**
- I think they are really good in theory, but there are a lot of technical errors. These types of errors make you question your understanding of the subject and make things frustrating.
- They are pretty frustrating and a lot of times they don't work. That is pretty frustrating because a lot of times I'll sit down with plenty of time to complete the module but they take longer because there are so many glitches.
- I feel like the modules are a good idea but there are better way to implement them.

The modules focus too much on math and equations.

- Many times I don't feel like it's geared towards the understanding part of things, it's more focused on the mathematical sort of things.
- I feel like the way its set up it's more heavily focused on the equations.
- It's easy when there is an equation in the reading where it's obvious that we just need to use the equation and plug numbers in, but when there is no equation, then it's hard and unclear to know where to go.

The modules make you do the reading. They help you know if you understood the reading.

- I don't feel like the modules really helped, they just let me know if I understood the reading.
- I like the modules and I like the idea of them. I feel the questions are good when they follow along with what we are reading.
- I feel like the modules help us to know what the important things form the readings are that we need to know for class.
- Overall they are helpful to apply the readings so it's great that we get a look at the stuff from the readings before we get to class.
- Overall I think they're a good idea and they are a good way to make sure you come to class with questions and with the book read.
- The modules were a really good gauge as to whether I understood the reading or not.

One student commented that the exercises are a good preparation for class, because it gives you exposure to the material before you get to class.

- It is a good prep for class because it gives you good exposure to the stuff you are going to need for class before you get there. You get there and you have already heard the words and seen the equations you'll be getting in class.

Things that the students found to be useful:

The students really like it when they get feedback.

- I love, when it really goes step by step, when they have a videos in between the questions, or when it says, now that you know this you can effectively look for this or do this. I find those types of explanations to be extremely helpful. They are effective because it is explaining equations.
- I really like them if they can give that instant feedback.
- When it does go into an explanation that's super helpful. Those parts are great.
- I also use them to prepare for the midterm. They are a really good review and can give instant feedback.

They really like the videos. The explanations that the videos gave were usually what students thought was most helpful.

- I really like the videos. They really teach the principles well.
- Going through the videos a couple of times solidified the material for me especially in the op amp one.
- If I don't get something right and I'm stuck, the videos are what helps me the most. Getting to go through those is always good.
- I really do like the videos because I think Dr. Davis is really good at explain them and it's really good to give you a visual and an audio representation of it.
- I really like the videos because often, I'm not positive what they are looking for in an answer or how to interpret the question. Usually even going right into the module I'm still pretty confused about what exactly is going on and so the videos are really helpful in helping us know what's going on.
- The videos are definitely the most important part I feel to my learning.
- I like that if you get the question wrong then you get a video that explains them.

One student commented that they liked the circuit analysis questions.

- My favorite parts of the modules, and the parts that I find most helpful are the circuit analysis questions where it shows you the circuit and it asks you what is happening in a certain part of the circuit. Those types of questions really helped me to know what I was doing.

A few students said that they use the exercises for test review.

- I use them to review before coming to class and I have worked through them for test review.
- They're not too long, and because of that they are a good test review. If they were super long I probably wouldn't go back and use them, but because I can get through lots of them in 30 minutes I go back and use them to review for the test.

A few students commented that the modules were a good chance to get first time exposure to the material before coming to class after they did the reading.

- I thought the unit questions were good. I think the lead up questions help prepare for it. I felt like the tutorial did a really good job at leading you up to the unit question.
- I appreciate being able to take what I read and apply it. The modules allow me to take the information and put them in a real situation.
- Seeing how the numbers fit in really helps. I do the reading and when I read about it, it is still unclear how all these numbers fit together. Doing the modules helps me see how things fit in together and work.

Issues students had with the modules:

Most of the students interviewed felt like there was not enough feedback.

They felt like there were not enough definitions, and explanations.

- When I didn't know the answer, the steps didn't really seem to help me. They didn't help me figure out what little math things I was getting wrong, like peak to peak or like the wrong unit of measure.
- Many times they have been more frustrating than helpful. I feel like when I don't know how to do a problem, there will be no help or video explanation explaining what to do.
- Many times when you get a question wrong, after they explain the circuit they will then have you answer the same question again, but with a different circuit. Still, many times there is no explanation. When the next question comes up, I'd look at it and because I didn't know how to do it the first time, I was still a little lost as to how to do it the second time since there wasn't enough explanations.
- When there are five different questions to answer on one slide then we don't know what we got wrong when we miss it. For example, there is no feedback telling us if we got them all wrong or just one of them wrong.
- If you do the modules and get the challenge question wrong then you are supposed to have an explanation that helps you know what you got wrong, where you got it wrong, and then help you to understand how to get it right before you move on. My experience has been that they rarely give you and explanation as to why you got it wrong. It mostly just goes right into the next question.
- Sometimes it was confusing and frustrating just trying to figure out either what the question was asking or how they wanted it to be answered especially when they were free response.
- On op amps, I missed the challenge question, then they asked two follow up questions. I got those right so they didn't show me the video or give any extra explanations, but I still missed the overarching theme of it. It wasn't sufficiently covered in the two questions so when I got to the unit question, I still got it wrong and I lost points for it.

A good number of students felt like the jumps that were made were too big.

- Many times I'll be working through the module and when I get to the end the quiz question will be way out there. The little questions are supposed to lead you step by step, but then sometimes when I get to the unit question it feels like they took a huge leap.
- Sometimes I'll go through all the little questions and I'll get them all right, but then I'll get to the unit question and I'll have no idea.
- I think one problem is that I do the readings and I think these concepts are easy to understand, but then when I get into the module, there are always a few more steps to infer than I was prepared for. Therefore, the questions and steps at the beginning of the module are usually a little out of my range of application for how I understand it at that point. By the time I get to the end of them, then I feel like it was really easy, but in the beginning I'm not quite ready to see that.
- The questions seem justified, and well put together after I finally get around to understanding what they are getting at or asking for. I think it is just hard to get up to that level of understanding from the module.

- In the teaching, when the module is trying to walk you through the steps I feel like there are gaps where things are assumed and in the end I fail to see the connection between the step by step activity and the last question.

Many students had a hard time seeing how the readings, modules, classes and labs were all connected.

- A lot of times when I get to the lab there's just this huge disconnect. I don't see how they are related.
- If there was more of a connection between the readings, the modules, and then what we do in the class, then I'd get more out of it. By the time I get to the lab, I'd go from not knowing what an op amp is to, to knowing what it is and to being able to work with it and put it into a circuit.
- I feel like there is a little bit of a disconnect between the readings, modules, class, and the lab.
- It's hard to see the application from just the reading. There seems to be a gap from the information that we are given in the book and then being able to turn that into functional knowledge.

TECH ISSUES

Most Students reported having to work around technical issues in one way or another, but in the pre-interview survey, most said that these issues didn't prevent them from completing the modules.

It did however make them frustrated and occasionally made it harder to learn.

Students also had the best results when they used Chrome on an HP as opposed to Safari on a Mac.

- The things that caught me up, weren't often the concepts or content. It was usually the technical problems.
- Formatting problems and technical problems were a big put off for me. I really didn't like the modules that had them and I had a hard time staying invested when that would happen.
- Technical problems like in the transistors module make me really confused and frustrated.
- When I got the right answer and things just weren't working then it was really, really frustrating.
- When using a 15" Mac, I had to use a bigger screen. It wasn't big enough for me to see the module.
- I use a mac and sometimes the words at the top are cut off.
- Safari on a mac doesn't show the videos.
- Usually the tops of the videos were cut off.

- **The blue bar at the top of the module cuts off the video.**
- There are blue lines at the top that cut off the top of the video.
- The headers are cut off on a few problems.
- I also found them frustrating when they didn't post to learning suite. If I don't close the browser right away then it doesn't post.
- Most of the time they don't post on learning suite.
- **For example the transistors when you couldn't submit it was frustrating.**
- There are some functionality errors. There have been a few times when after the third time going through the module I feel like I finally understand it and can fill it out but I'll get to a question and the question is there, but the questions were blacked out over the questions and then no matter how many times I went through them I could never see that one specific question. It is always blacked out.
- There was a module were you had to get the second question wrong to get them to accept the third questions answer.
- At the end of the module they always say to close the browser to post the score. I think I always forget to close the browser or I don't do it right because it doesn't post my score very much. I can't just close the tab I have to actually like close the entire browse to get it to work.

Students felt like they didn't get very much conceptual understanding. They felt like they only understood how to manipulate equations and they want to be able to understand the concepts.

- It's really easy to get through the modules without learning anything. You can see what they are asking for and look through the book and find an equation and then just match it without knowing what's going on. The only thing that it's measuring is which equation to use and do you know which equation to use?
- **I don't understand the concepts that we cover on the modules and in the class that well. I feel like the module and class period are very disconnected with the actual lab. I'm doing really well in the lab, and I'm doing well in class and on the modules. I can understand it enough to take a test and do well on it, but I don't really understand a lot about how it works.**
- My strategy is to simply look for equations that match the questions. I don't get much conceptual out of it. When I use the equation I don't know how it works or what is does.
- Anyone can pick out numbers, but I don't understand the concepts. When they explain the equations and give you more of a conceptual understanding then it is better.

A few students thought the modules were too basic. They wished it would have taken the concepts a little further.

- I think the modules are good but they only get a really, really basic and shallow testing of our understanding. They are good in forcing us to do the reading and in kind of getting us to at least know something before we get to class, but it only a basic shallow understanding.

- I thought some were too basic and I feel like they could have been a little longer. They'd maybe only go over one thing that we covered in class and then there were several other things that we would cover in class that the modules didn't go over. If the modules are supposed to prepare you for class we need to cover those things.

Students didn't like when the modules asked more than 2 questions in a row without giving feedback.

- I feel like the most effective modules are the ones that ask one questions as a time. It's frustrating when you have ten questions at once and you forget a minus sign on one then have to go back and do the whole module over again. Also it's good with just the one because then it can give you immediate feedback on one specific part of a problem at a time.
- **Sometimes when you're doing the module you'd put in your answer and you'd pretty much have the right idea, but you'd get it a little wrong, so you go on answering more questions without any instruction. Then, it was only when you'd get it wrong several times in a row that you'd finally have a video that would start explaining what is going on. I wish they'd give feedback right away.**
- The frustrating ones are the ones that have us calculating 4 different numbers at once for one question. Then if I miss one, I don't know which one I got wrong.

Changes the students would like to see:

Don't have us do the challenge question, just have us do the module and answer the unit question at the end. We get more out of it that way.

- **I think that the challenge questions are a bad idea, because I would read the challenge question before I did the reading so then when I took the module I could answer the question right, but then that was the end of the module and I felt like I didn't really learn anything.**
- I don't like that we have to skip the whole module when we get the challenge question right. I wish there was some way to still watch the video or see the explanations even if we got the challenge question right.
-
- **I think it would be a good idea to start the module with a video explaining what is going on and giving you a few examples. Then after that the module could continue on giving you the problems to work on afterwards. Because if you do get the challenge question right and don't go through the module then you miss some stuff that is in the module that isn't brought up or covered in the challenge question.**

- **When I've missed the challenge question and had to go through the module then I've learned things that weren't brought up that I thought were really important but that I never would have learned without taking the module. It takes less than 10 minutes so why not take the whole thing.**
- **They don't have the option to go straight to the module.**
- I wouldn't mind having to go through the whole module. Sometimes when you get the first question right it is actually an easier question, so when you get it right and you don't go through the module you miss things you would have learned. I know it might just take more time, but I wish we would rather have to just go through the whole module.
- It is more helpful when I miss the challenge question because then I get to go through a better review of the material.
- When I miss the challenge question and get to watch the videos I actually see why and how it works instead of just an equation.
- Some did a better job than others at testing our understanding. On the ones I didn't get right and when I had to go through the module I feel like my understanding was always way better on those than on the others.

Most of the students want the modules to change to give them more feedback when they get things wrong.

They also want the modules to give them more definitions, and explanations.

- If I could change something about it, I would put most of the instruction directly following the challenge question. I would talk about the concepts and why the concepts work the way they do. Then I would show how this makes the equations into what they are.
- I think it would be useful to put an explanation in the module that explained the point of the simpler problems so that see how it relates to the harder problems.
- The frustrating ones are the ones that have us calculating 4 different numbers at once for one question. It would be helpful if those were split up into giving one answer at a time, or if it would just tell me which one was wrong. I wish there was a little more feedback, not four questions and then some feedback at the end.
- The videos did a great job at explaining what was going on in the question before, but then questions after the videos didn't have anything to do with what we learned in the video. After the video I'd like it if they gave us the same question with just different values so I know if I got it.
- **I want more explanations, even in class. I get that there is learning going on when you are struggling to understand a concept, but if there is no explanation to begin with, we are just left guessing and making bad assumptions.**
- More feedback when I get answers wrong!!!
- In the videos if they said, when I have to do this, the first thing I do is, the second thing I do is, … then that would be helpful.
- If I could change the modules I'd have an example problem or two before I get into the module because I expect to spend 30 minutes on the modules but it often takes more than

that to find out what the problem is asking me or to figure out how to go about the math. Having one example to help me know what is going on would be great!

- **It's still not conceptually there. I think if you get it wrong once, it should bring up the video. Most of the time you really just don't know how to do it. I'd like more feedback on what's going on.**
- **Then the video will come up and I understand how to do the calculations, but I don't really understand why I'm doing the calculations so the conceptual part is totally not even there.**
- At the beginning of the module, it would be nice to have a slide that tells you what the big picture for the module is. If they tell you what they want you to get out of the module and what the first and second step to the problem solving is then that would be extremely helpful. The modules go straight to the questions.
- For things that require a shorter explanation, instead of the videos I feel like it would be more useful to just have a written explanation. I really like the drawings also they are really good, but the videos just take so long.
- Instead of the having a video, I would be fine with having a sample problem that shows all the steps and equations we need to use to get a problem right. We'd still know what we'd need to do so that we could get the problem right.

Some students want the option to have an extra try on a question just before they are given feedback. We could have a button that allows them to choose to go straight to an explanation or to try again.

- I wish they'd give us more second chances so that if you miss the question for the signs it would say "watch your signs" and then let you try that question again before just marking you wrong.
- More opportunities for a second try, with some small feedback would be nice.
- On some of the tutorials I wish they gave you an extra try. Sometimes it seems like I know it's either one answer or another but I'm not quite sure which one is right and so I guess, knowing the principle is applied either one way or another. When I get it wrong it leads me straight into a video. I want to watch the video, but I want to test my other theories first. I feel like more often than not it goes straight the video.

Most of the students wanted more functionality on the videos.

- I wish there was a way to fast forward or pause the videos. If we could pause it then we could actually stop and try it out right then and there.
- If you got the question right, or quickly understood what you were missing, then I wish there was a way for you to fast forward or get by the video.
- The videos are probably the most helpful part, but you can't re-watch the part you still have questions about, you have to watch the whole thing. I wish you could.

- If I could change the videos I would make them faster. The videos can be frustrating because if you get the answer to the previous question wrong, and you still have to go through the video, it takes a long time.
- I like the videos in the sense that they show you where the numbers go, but I wish that there was an option to skip the videos if you have already watched them before or if you already understand it.
- Sometimes if you already know what you're doing, but then miss the question because of a typo error and then you still have to watch the movie it's annoying. I wish you could skip or fast forward it.

Several students would like the chance to at least get partial credit if they were really stuck on one thing and couldn't get the last question right.

- I wish there was partial credit. Sometimes I have spent 30 minutes to an hour on the modules because I'm getting everything except for one concept and so to get 0/10 for that is frustrating.
- When you just can't figure it out after you spend all that time on a module, then it is a letdown to get no points whatsoever.
- When you go to the lecture you can get up to speed on the concepts you may have missed before. It is frustrating that you get no points for it since you were tested on it even before you were even taught about it.
- I feel like the ideas in the modules are where we need to be at the end of class. They are a great way to get us exposed to the material before we come to class, but then I wish we wouldn't get penalized for not being able to learn as well on our own. I wish as students we could have a little more of a crutch as we work through the module for the first time.
- I would like partial credit. Sometimes you just have to give up, but it's really hard to give up when it's all or nothing.
- I wish we had partial credit.

Other Ideas for changes that can be made.

Having different response types would be helpful

- Different response types would be good.

More Circuits

- Can the modules be written with a more hands on circuit? That would be nice.

Ask definition questions or questions on rules to help us with conceptual understanding.

I like the variety in the types of questions, but I wish there were multiple choice questions that just simply ask for you to define the two rules of op amps or questions that ask for your understanding of a concept instead of just math.

Post class

- I'd really like a post class module as well. After the lab, I'd realize that there were things I had learned about transistors or transformers that I hadn't realized before the lab. If there was a post class that would cover all the things that we were hoping to finally get out of the lab after doing it, that would be nice.

Combine the questions to the readings so that they directly match up

- If there was a way to combine the readings with the questions on the modules so that they matched up more with them, that would be great. Maybe the questions could go section by section so we could see if we are understanding the reading as we go.

Accommodate for color blindness when using resistors

- On the resistors lab, it would be helpful for people with color blindness to put the name of the color next to the resistor just so we know we are getting the color right.

The Modules could be longer if you wanted them to be

- **I feel like you could even make the modules longer. I've had modules that have only taken me three minutes to do. I did well on the test, but I know there are some people who struggled on the test just because we don't have a lot of experience using the concepts and doing the problems.**

Show us the answers so we know what we got wrong

- I wish that once you get it wrong then you could see the right answer and then a different question was given so you could try again. That would help to get rid of simple formatting errors. If you got the idea right and just inputted your answer in wrong then there wouldn't be so many hang ups and frustrations with issues like that.

Closed Captioning Videos

- I have needed the videos and I haven't had any headphones when I'm in the library or something. If there was any way to have some kind of close captioning or something that would be really nice.

Flexible Input Methods

- If they would be a little more flexible in the way that the answers are entered in that would be better.

Accessibility

- I wish the modules and more of the things in class were in a centralized place. They are hard to access for me.

Student Interviews - Physics 121 modules

Overall

The modules were very helpful.

- I really like them and I hope they post more.
- They were helpful. I used them when I needed to know a certain subject.
- They have helped me learn by helping me to realize what the heart of the chapter is trying to teach us. There is so much in the reading that it's hard sometimes to know what they are getting at.
- It's an awesome project.

They helped me prepare for class.

- Having to go through the modules helped me to know what was coming up and it helped me to know what I should know how to do when I got to class.

They were helpful because it was a guided practice and guided learning.

- Thought they were really helpful and provided a nice little guided practice.

They were really basic. Some students liked that, others would like them to go a bit further.

- The modules were pretty helpful. It was so basic you couldn't help but understand it. It simplified what the book was trying to teach in a more straightforward way.
- Thought they were basic enough for me to understand, I really liked using them.
- They were really helpful and basic.
- I didn't really mind that they were more basic they were fine.
- I felt like they were basic, I wouldn't have minded a little more, but I felt like they were sufficient. They seemed cover what was needed.

They helped me even after class when I needed to review or relearn.

- I used them because I was struggling and so someone mentioned that they would help and so I used them and they helped a lot to make sure that I understood the concepts before I went through the exam.
- I feel like they are really useful and I feel like I need them. Physics is hard and a lot of times when I didn't quite understand something that was being taught in class I can go back and understand the basic concepts of what was taught after class.
- I use them after class to relearn them.

They helped students to find their mistakes so they knew if they were really understanding the material.

- When I didn't get the challenge question right the module helped me to figure out what I had missed. It was usually something small that I wasn't getting or understanding so the modules helped me to find those small misconceptions and mistakes.
- I felt like if I didn't know what the answer to the challenge question was, then by the time I got to the unit question I think like 3/5 times I knew how to answer the unit question. Most of the time I felt like I understood it, but then sometimes I still didn't understand it. It was a good evaluation helping me to pick up on stuff that I had missed before.

Good

They liked having a feedback right after getting a wrong answer.

- I liked the general format. I liked the tutorial right after any wrong answer

They liked having different types of questions, especially the select all that apply questions.

- Liked all the different types of options for the challenge questions. My favorite were the click all that apply. They really helped me to understand things well.
- The challenge questions that were the select all of the following were more challenging but also way more effective in the sense that they made you actually understand the material.

They liked that the modules were basic.

- The definition were really useful for me just because of how basic they were for me. I really liked just how basic they were, the definitions were good and simple.

They liked the videos.

- I really liked the videos. I really liked how you could just keep watching them again and again. That way you could make sure you understood everything. Even if you got it right you may not have understood everything.

They like the format of definitions followed by practice problems.

- What I find most useful are the short definitions followed by practice questions and the videos.
- If it gave a good definition and then if I got to practice it that was always helpful. When the practice problems were followed by good feedback, those were the modules that were most helpful.

Issues

They felt like there wasn't enough conceptual knowledge taught and emphasized.

- Instead of conceptual, they look at all these things that you can do with an integral. It was this is how we will be calculating the force.
- I feel they just taught math instead of conceptual math.
- It focuses too much on just the math. I want more of this is how this concept works, this is why it works, and this is how you apply it. I felt like we got was, here is the equation, now apply it. I was left feeling like I still didn't know how to apply it? I'd really like more conceptual!!

They'd still like more immediate feedback then they are getting right now.

- I wish they would give more feedback. Sometimes when I'm doing them and get something wrong, I wish it would tell me what I did wrong.
- Every time I get something wrong, then having a "this is what you should be doing" statement would be great.

They like shorter definitions. If they are too long they will just skip it.

- If they just give me a ton of information I usually just skip it and go straight to trying to answer the questions. Then if I get the answer wrong I'll go back to the information and try to figure out what I got wrong.
- When there is too much on the slide, I want it to be split up onto more than one slide.
- Whenever it starts to be more than one idea, especially at the beginning it's too much.

One student didn't really like the challenge and unit questions.

- Many times I don't even see how the challenge questions and the unit questions are useful.

There are still some formatting and technical issues, but not very many.

- I wish I could change some of the technical issues and formatting issues.

Change

Spend more time on teaching us concepts.

- Spend more time on the conceptual part of it. Make sure we understand the concepts before we get into the practical application.
- I would have been fine if there had been two challenge questions with two different tutorials to get more of the different aspects of the things. We could get the other concepts too not just one concept from the chapter.

Have more than one definition for those of us who understand things differently.

- Have more than one explanation for definitions. Not everyone gets it from the same explanation. Maybe if they have to try again, offer a second or alternate explanation.

Provide more functionality on the videos.

- I wish I had the option to skip the videos or pause it or fast forward.

They just want to do the module whether or not they get the challenge question right.

- Sometimes I would get it right, but I wish there was an option to skip the question and go back and review it. I would usually go back and do it again and purposely miss the challenge question.
- I wish there was an option to just go to the video when you get the challenge question even if you did get it.
- I wanted to go right into the tutorial, even after answering the challenge question right.

They'd like more explanations, but they want them to be short.

- Short written explanations for easy explanations, video explanations for longer more involved explanations.
- I wish they would give more feedback. Sometimes when I doing them and get something wrong, I wish it would tell me what I did wrong. Every time I get something wrong, then having a "this is what you should be doing" would be very helpful.
- Instead of having all the information on one slide, having less on a slide is better. Some slides have something like, this is torque, this is the equation for torque, and then this is a situation in which you use torque and that is all on the same page. If I see a whole bunch of stuff to read then I don't want to go through it, but if each one of those elements was on a different page, the definition, then the equation, and then a small explanation talking about when you apply it or when it comes up, then I'd go through it all step by step.
- If they are simple enough to keep following them then I'd go through them. Especially when you have relevant practice problems directly following them then it's worth it.

Highlight key words or phrases.

- Maybe something that would have been more helpful would be to highlight the important words that we need to remember or know. That way when we are reading the questions or the definitions, we'll understand what the important parts are.

A second level of modules that went one step after the basics would be nice.

- I'd really like a second level of the modules. They are usually super basic so that none of this stuff is ever on the test. I'd like something like a level two or a level three. Just some way to bridge the gap maybe one more level.

Conclusion

All of the students interviewed felt like the exercises were a great idea. Most of the students said that the modules were helpful and useful. Even those who didn't find them to be very helpful as they were now, said that they thought the exercises were a great idea and that they would be much more helpful as we continued to improve them.

One aspect of the modules that they students thought could be better was the amount of help and feedback that was given as well as the type of feedback given. Based on the results of the surveys and the comments given in the interviews there was a huge response from students that they wanted more feedback. They felt like the most useful things for them were the definition, video and explanation slides and they wanted more of them. They also wanted their feedback to be more instantaneous. If they were working through questions and if they were getting them right then they didn't need as much. If, however, they got something wrong, they wanted to be told how to fix it right away instead of being asked to do another question or two first. Students would like to have the option to go straight to a tutorial to get instant feedback if they don't know what to do.

Another topic that was brought up in almost every interview was the use of videos in the exercises. The student's found the videos to be extremely helpful and really liked using them, but they wanted them to have more functionality. If the students could pause, fast forward, or rewind the videos then they would find them much more useful as they work through the exercises.

The last thing aspect that came up often was that students really wouldn't mind just taking the entire module each time. Many of them liked the idea of just doing away with the challenge question all together because they felt that if they went through the module they always learned a lot more about the topic. Even if they already knew enough to get the challenge question right in the first place, they often wish they had the option to still go through the module.

While there were a large number of technical and formatting issues that students talked about in the interviews, more than 75% of the students reported as not having so many problems that they effected their learning.

All in all the students feel like the exercises are a great idea and that they helped then to learn to some degree. They also felt like it was a useful and beneficial project that could be even better in the future as we continue to make improvements.