Southern New Hampshire University

PHY-150 8-1 Project: Perception of Physics

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1 Introduction

Physics is one of those scientific subjects that I have made into a passionate side hobby. While my main interest is computer science, mathematics and statistics, physics does manage to find itself as being one of those things that I muse about—even if it is to a somewhat lesser extent. While I do find fields like chemistry, biology and neuroscience interesting, they are nonetheless harder for myself to understand.

It took me a while to figure out why I liked physics over other natural sciences, but science writer Rhett Allain helped me to articulate my feelings when he discussed his passion for physics:

> "Why physics? Well, physics does something different than, say, chemistry. In chemistry, there are a whole bunch of models with a whole bunch of exceptions to the model. In physics, there are just a couple of key fundamental ideas that you can use to do a whole bunch of cool stuff. At least that is how I see it."—Allain (2011)

I think that I like physics, along with computer science and maths, because these science subjects manage to keep things simple. Physics is founded on simple things like *Newton's three laws of motion* or the *Principle of Least Action*. With these simple things at hand, the material world can be clarified in great detail.[1]

2 Prior to this course

When I was in grade school, I did not perform well in science class because schoolteachers would teach science with a rote-memorisation approach. One rather humourous memory that I have of grade school science was when the lecturer was going on about the different kinds of energy (s.a. mechanical, potential, thermal, et cetera) and tried to explain nuclear energy by using an example from the classic animated sitcom *The Simpsons* which involved Homer Simpson, one of the main characters, working in a nuclear power plant. While *The Simpsons* is certainly a well made piece of fiction, I would not use it as a tool to explain things that are founded on fact, and I felt that such grade school explainations are more confusing than clarifying.

Later when I was a teenager, I tried to teach myself physics. I read physics articles on the *Stanford Encyclopedia of Philosophy* and tried to do algebra based physics from those *For Dummies* textbooks, but did not get too far. But in the year 2017 when I was around twenty-one years old, I bought a book called the *No bullshit guide to math & physics* (Savov, 2014) which introduced physics in a way that I felt made sense. The author introduced a formulation of physics that made everything "click"

$$m^{-1}\Big(\sum \vec{F} \equiv F_{\text{net}}\Big) = \vec{a}(t) = \frac{d\vec{v}}{dt} = \frac{d^2\vec{r}}{dt^2}$$

After Savov (2014)

A couple of years prior to this, I was trying to teach myself calculus-based statistics. When I first read this book, the calculus at a conceptual level resonated with me, and it drove me to learn more calculus with physics being the prime motivator that guided my learning of the subject through the Newton-Leibniz formulation of the derivative and integral.[2] Around the

[1] As long as the world doesn't get "too big" or "too small."

[2] At the time of this writing, Cauchy's formulation of the limit still confuses me. I can work with limits, but it is admittedly hard for me to make sense of limits at infinity and limits applied to "special" functions.

same time, I followed the science blogger Rhett Allain to read up on all the quirky and charming ways that he would make use of physics— like his application of the scientific method to deriving the “laws of motion” in Super Mario world (Allain, 2016).

From Allain’s advice, I bought a textbook called *Matter and Interactions* (Chabay and Sherwood, 2015)— which was just a wonderful thing for people like myself. It combined physics education with computer science, and is one of the few introduction to physics textbooks that takes computer programming seriously.

I only got through a couple of chapters and did the first few problems in the first chapter, but did not accomplish much because of other things going on in my life. I did do one of the programming problems though; the following is a snippet of my solutions to said problem:

```
## Matter & Interactions (Fourth Edition)
## Chapter 1, Problem 68
## By: A. S. "Aleksey" Ahmann <hackermaneia@riseup.net>

 [... snip ...]

from visual import *

def render_this(v_pos, v_aaxis, thing_name):
    print("[*] Rendering the", thing_name, "Thing...")
    sphere(pos=v_pos, radius=0.5, color=color.green)
    arrow(pos=v_pos, axis=v_aaxis, color=color.red)

parameters = [
    [vector(0, 0, 0), vector(0, -1, 0), "Middle-Centre"],
    [vector(+2, +1, 0), vector(-1, 0, 0), "Top-Right"],
    [vector(+2, -1, 0),vector(+1, +1, 0),"Bottom-Right"]
]

for n, k in enumerate(parameters):
    render_this(k[0], k[1], k[2])
```

This was the last “significant milestone” before I took the physics class.

3 (Auto)didactic science: the classroom and beyond

I will be honest, this class was hard. But at the same time, it was really fun and a pleasure to do. There were a lot of challenging things, but those things definitely "grew" my approach to scientific inquiry.

One thing that this class has helped me learn was communicating my ideas in simple and condenced ways. Unfortunately due to political forces beyond any individual's control, college teachers are overworked and have to work with dozens— or even hundereds— of students (Clay, 2008; Kevin Bird, personal communications). This forced me to find a balance between the precision that I am used to and "keeping it simple" in regard to technical writing as to not overwhelm my teacher.

Related to the first useful thing, another useful thing that I developed whilst taking this class is social skills, albeit in an indirect manner. I had to answer discussion board questions and communicate my ideas in a casual manner— whilst maintaining some degree of scientific formalisms. I lack good social skills, but I feel that this experience can contribute to me working in both remote and in-person research environments.

Another third useful thing that this class helped me develop was doing experiments. Experimentation is arguably the most important part of basic science and whilst many do not find replication experiments to be "interesting," they are what nonetheless what keeps the scientific community "alive" in challenging the status of scientific models. The world of psychology has been "shaken" by a replication crisis (Wiggins & Christopherson, 2019) and this class has definately contributed to the development of my ability to do hands-on, controlled experiments that can be transfered to other sciences that involves quantitative research and experimentation.

In regards to concepts that I have learned, I think that I finally got a "kick start" on the notion of energy and the law of conservation of momentum. Prior to this class, I struggled a bit to understand these concepts and the purpose of them. But the problems in this class definitely showed me ways that energy transfers and the law of conservation of energy could be used to predict the behaviour of systems when a force is unknown, or if mechanical force is not the appropriate means to work out a physical body's velocity.

This course definately improved on how I looked at the world. Before taking this course, I was aware of using testable and falsifiable models to explain and predict how the world works (and how these models have severe limitations). What made this class special is that it forced me to do an entire introduction to physics in a sequence that made sense and could improve upon my previous understanding.

The most significant concept is, in my opinion, Newton's laws of motion. With these basic assumptions of how objects move coupled with Newton's formulation of gravitation, an entire framework of explaining the universe is at our grasp. All the other forces, such as friction, are a consequence of applying Newton's laws to a physical system.

3.1 ... the "beyond" part

Another thing that this class helped to reenforce was the idea that it takes many, many hours of practice to get good at something— especially if that something belongs to the natural sciences. I will admit that I struggled to turn word problems into a formal maths problem.

While I will not go into the specifics of my learning abilities for the sake of keeping this paper as succicint as possible, I do have a learning disability that makes it difficult for me to read (fiction in particular, but anything that forces me to visualise something just from words). The tricky part is to make sense of words and make it into a formal problem. After that is accomplished, the solution can be easily worked out with "just maths."

My major is computer science, and I think that I can go on a semi-autodidact journey into learning physics "on the side" as to add more "tools" that can be used in my proverbial critical thinking toolbox. I intend to learn more physics by doing more of the problems in those physics textbooks that I have lying around, do those *massive open online courses* with physics as the focal point, join communities of both formally trained and amateur physicists, and maybe start an online science community *a la* LessWrong[3] or Physics Forums.[4]

4 Summary

This was definately an interesting class. It was a pleasure having such a patient teacher, students with diverse perspectives on applied physics, and the grind of doing hard, but meaningful, work. The heaps of *Red Bull* energy drinks and staying up late to get my work done were definately worth it!

[3]Their website: https://www.lesswrong.com/

[4]Their website: https://www.physicsforums.com/

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