“Meaningful Learning”. “Real Learning”. Call it by any name you want, we all know what it is. When good, productive, challenging, satisfying,[1] learning is happening, student retention and institutional recognition are bound to follow.

Student success one year builds a base for an even larger success in following years. A positive exponential multiplier (compound interest) will operate during a student’s school carrier and professional carrier. Student retention and institutional recognition are bound to follow.

A climate of active and successful learning is infectious. A positive chain reaction will occur as students share their knowledge and excitement with their class mates. Student retention and institutional recognition are bound to follow.

The Goal of Education Denied by Superficial Learning.

During the years 1993 to 1996 students desiring to get an “A” grade in physics, were required to convince me, as their professor, that they had read the book *Zen and the Art of Motorcycle Maintenance*. In 1992, after fourteen years of physics teaching, I concluded that our present day educational milieu promoted exceedingly superficial modes of learning. Despite the fact that student learning & performance in my physics classes was at least equal in quality to that of other universities in the southeast, there was still a huge problem. Except for the pressure of future professional examinations, my students (on average) had the essential expectation that physics did not have, and would never have, any practical use in their personal or professional lives.[2] Because of this expectation, they were “learning” in such a manner that physics had marginal personal or scientific meaning. Despite my best efforts, even the good students were “learning” the material in a rote manner. Their study was primarily directed toward doing just what they were told and only what was necessary to “get a good grade”. Really understanding the concepts, identifying and resolving confusion, and applying course ideas to the surrounding world, were all but absent. They had, in essence, a plan to forget as soon as the course was completed. From my study of a wide range of Science Education Research, I have come to realize that this problem is equally serious in the other sciences at USCA and is prevalent in many institutions of higher learning. Howard Gardner in *The Unschooled Mind* (1991) accurately describes what I have seen and come to understand. He also proposes excellent solutions in the context of a reformed undergraduate liberal arts education.
USCA Physics Students Asked to Read the Book *Zen and the Art of Motorcycle Maintenance*.

I requested my students to read the “Zen Book”, as an attempt to improve their attitudes concerning why they are learning and how they should learn.[3] I was willing for the students to receive and understand the book at their own level and they could fulfill the requirement by reporting to me their reactions, learning break-troughs, and personal development. Students were given wide latitude as to how they could “convince me”. Students could choose: 1) Regular office & hallway discussion as their reading progressed. 2) An office appointment conversation after they had finished reading the book, usually at the end of the semester. 3) Regular writing of a brief synopsis of the student’s current Zen reading. This could be written as an appendix in their Physics Laboratory Notebooks (due weekly). 4) Writing a standard full-length paper (or book report) concerning what they had learned and what the book had meant to them. I endeavored to give the students much “one-on-one” feedback, support, and conversation concerning their Zen Book responses, but they were not directly given a grade on their efforts. Since at most only half of the class read the book, little class time was devoted to the Zen Book. In the Fall Semester 1995, several students requested regular Zen Book discussion sessions. Weekly Zen Book discussion meetings were conducted in the Fall Semesters of 1995 and 1996.

Student Written Response To the Book *Zen and the Art of Motorcycle Maintenance*.

My various conversations with students helped me confirm the positive merit of the Zen Book as a supplement to the physics class. However these conversations were too fleeting for me to adequately record what the students were saying and thinking. Moreover, my interpretation of what the students were saying would never be sufficiently factual.

By far the best view of how the Zen Book impacted students, in the context of a physics class, is contained in their own writing. The pages below present some of the more thoughtful student reports from my physics classes in years 1993 to 1996. During this time, approximately 114 students read over one half of the Zen Book out of a total class attendance of 197. I have omitted reports wherein the Zen Book has provided little change in the student’s thinking and/or showed a superficial reading of the book. The reports omitted would not contain a different over-all impression of what the students were saying nor reveal a general negative student sentiment. With the exception of the fact that three “A” students declined to read Zen,[4] negative reactions to the Zen book were not expressed directly to me. Certainly the general “ground swell” of student objection I have received on occasions of other projects the students really hated, was not evident in the case of the Zen book reading requirement.

I believe that the student’s own writing shows that reading the “Zen book”:

1) Propels the student, as reader, to think a great deal about their own life and why they are in school.
2) Helps students realize they must take charge of their own life, their own education, and set their own standards. The book provides students tools and motivation for doing this.

3) Brings the student to pay more attention to the processes of learning and problem solving, especially insight problem solving and attendant stuckness. Moves students to care about their study and thus take up the struggle and the risk of the unknown of problem solving which is the real juice of real problems.

4) Moves the student in the direction of more active, purposeful, and meaningful learning. Helps students want to learn.

5) Shows students that they must study for understanding as opposed to “good grades”. Knowledge motivation as opposed to grade motivation. Students come to realize that studying for “high grades”, but ignoring deeper understanding, is ultimately destructive of the educational enterprise.

6) Specific topics support and amplifies what students are learning in the physics class, their science classes, and indeed all their university classes.

7) Supplies the student with a large tool kit for better techniques in: a) productive learning, b) problem solving, and c) trouble-shooting.

8) Helps the student appreciate that art, science, math, literature, rhetoric, philosophy, and history, all must be learned together to achieved a coherent understanding of the world. Integrated inter-disciplinary learning is thus effectively and powerfully supported.[5]

The student’s own writings are below. I hope you, the reader, will see the significant and positive student progress as stated above. I believe this progress was achieved despite the ever present problems of superficial learning mention previously. The changes were at the level of individual personal motivation. This is a territory deep within each student. It is hard to call forth changes let alone know if anything has happened.

To discern the student’s progress toward more meaningful learning, you the reader must sift through their words and listen closely.[6] Shaded areas indicate writing where, in my judgment, the student achieved especially noteworthy learning progress or discovery. As is true in any educational setting, it is very hard to discern just what any human being “gains” from books or university course offerings. However the writings below show that significant student intellectual and emotional progress has taken place in the minds and hearts of these student authors. And for every student who has spoken, there are probably several other students in whom the same or similar seeds are planted.

Appendix.

General Procedures For Collecting and Editing the Student Writings Concerning the Book Zen and the Art of Motorcycle Maintenance Fall 1993 thru Spring 1996.

Student writing in many of the reports herein are quite informal and even “improper”. Please remember the writing circumstances: Prior to writing their Zen Report, the student has just
completed writing a long arduous Lab Report or a long tiring Final Examination. Lab Reports and Exams are for grade credit calling for the students' best formal effort. Their Zen writing is *optional* and had no promise of a grade "reward". Their Zen writing was intended to be informal communication to me as their professor and no more. Please study what the student is saying inside the less than perfect grammar.

To prevent the problem of writing taken out of context, the entire (somewhat lengthy) student writing has been included. *Minimal* editing of punctuation and spelling has been supplied to preserve meaning and increase readability, where a reader unfamiliar with my physics classes would have difficulty understanding what the student means. [Brackets] indicate editing additions. Original text will be supplied on request. A (nearly complete) collection of final exams and laboratory notebooks is available on request.

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**Student Written Responses.**

*Zen and the Art of Motorcycle Maintenance*

**KM APHY 201 Fall 1993**

Well what can I say about this book? It is hard to put my feelings about this book down on paper, especially when your feelings change faster than the minutes of time. One moment I am in crystal clear water when he explains something and the next moment, I am at the bottom of murky water asking myself, "What is he talking about??" However, overall, this book has raised my awareness of what is going on around me and I have found that I am now questioning why things happen as they do. The scary part is that when I question something, I am never satisfied with a simple answer. I want to know more. I also have experienced some of the traps that he explained and how they lead me to frustration. This book made me go back to my past and remember what led me to my own "insanity". [Kimberly here makes reference to the fact that she is a “Type A” personality, and always takes on much more than she can handle.]

Even after finishing the book, I still feel that knowledge and concepts that we deal with as soon as we are born are "ghosts" that forever haunt the earth. They (concepts, knowledge, etc.) are discovered by one individual, or more, and then those individuals convince others that these "ghosts" exist. In turn these newly convinced individuals convince others and it goes on down the line. Just so everyone does not see their own "ghost", rules are set up to regulate these "ghosts" and verify them. These rules are referred to as the scientific method. Once a "ghost" is verified as existing, scientists stick them in schools so that students will be forced to acknowledge and accept their existence. Some schools allow students to question the "ghosts" as to why they exist, while other schools want you to just
The main objective I reached by reading *Zen [And the Art of Motorcycle Maintenance]* is the realization that the laws, rules, and equations are a part of my everyday life. “The equations mean nothing, but they really meant everything.” (taken from Zen quote). Before I never realized how important kinetic energy, potential energy, velocity, acceleration, gravity, and pendulums (just to name a few) affect my life. Some things (equations and all) seem so complicated and so philosophical; often, I would get so caught up in the complicated equations and meaning, just like the narrator in Zen did with quality and the real philosophical meaning about life, that I forgot (or ignored) what was really important - the general answer and how I am affected by things and people around me like the deteriorating relationship between the narrator and his some. The important objective I learned is to be aware of my surroundings at all times - even if I don't understand all points because getting caught up in the small details deters the focal image (can't see the forest for the trees!). It seems that modern society is caught up in these details and the movement of technology. Yes, understanding physics and the structure of knowledge is important. In fact, it is critical to the survival and further development of man. Life is precious - don't let it go to waste.

Author Anonymous APHY 201

More than anything else, *Zen and the Art of Motorcycle Maintenance* is helping me to understand modern society. In particular, in the early parts of the book, when he discusses people identifying or not identifying with their work, and people no longer caring about their work, has been especially helpful.

He talks, in an early part of the book, about the problems he has in getting his motorcycle repaired. The people in the shop seem to be only there in the spare time rather than the other way around. I see examples of this in everyday life and including the academic world. We have become so disgusted with our work, our occupations, and vocations that we tend to identify with our pass times rather than our work. He clearly reflects, in this section, the situation that permeates every fiber of modern society. We are too concerned with the end result to get the process down properly. The result is that we border on anarchy: A.) We are so concerned with profit that we make substandard products and give less than
adequate service. B.) We are so concerned with grades that [as a result] we might make an A and yet learn nothing.

KM  APHY 201  Fall 1993

I think of one of the author's main points: He is trying to look at life by means of every detail. Everything he does or everywhere he goes, he notices everything. He notices the weather, the ground, the sky, his motorcycle, and so on. He takes in everything, I guess I've kind of looked at life like that more so. I walked outside last week Wednesday, Thursday, and Friday. I noticed what the conditions were. It was fairly nice out and not real cold. It was so beautiful—the sky was pinkish red, and Venus [a planet & part of our astronomy study] was so bright and twinkly. I pointed it out to my mom and she agreed. We both watched it, on and off, as we rode to Aiken. I think something like that is what the author advises people to take heed of. Notice your environment and enjoy your environment.[ At a later time Kathleen continues.]

Zen helped me realize that I need to "stop and smell the roses!" I consider myself a go-getter but after reading Zen I wondered what "getting" goal really was. I have realized that you can memorize a million equations and get a correct answer, but what good does it do if you are confused and if you really don't care. The author tells you to look around and observe and learn from you surroundings. Take these principles, theories, and hypothesis and relate them to you everyday life. Don't just memorize something, [instead] enjoy it and learn from it.

Society, as a whole, are go-getters. Get a good job, drive a new car, and make the most money. But the author believes what good do these things do if you're not learning and most of all if you're not enjoying the process of learning and living. My father always pushes me to learn and enjoy it. He reminds me of the author in a lot of ways. I honestly believe that older people realize this much easier than younger people. I am finding myself maturing into thinking this way, rather than "get a grade." Zen, the book, influenced me to take a "chill pill" and not get upset when I don't make an A on a test. The author says to look at how much you learned and to strive to learn more from the class, the people, and the whole environment. There is so much to learn about every particle and atom in the universe.

Book Commentary

GS  Phys. 202  May 12, 1994
Since this is the last PHYSICS LAB, I thought it might be appropriate to write a little about something R. Pirsig wrote and how it relates to something I see a bit more clearly now. When I first came to your class last August, I was quite content to "jump through the academic hoops" you described to us. I wanted to do my work, get my A, go to dental school, [and] become a dentist. All I saw was the goal, and I was ignoring the journey that would take me there. I was being shallow! My attitude was not right. I was performing the prescribed tasks in the order given so that I may earn a treat (an "A") just as a dog performs a trick for a "dog biscuit" reward. I wasn't REALLY LEARNING, but I was getting' a lot of dog biscuits.

You teach your class a bit differently from any of my other Professors and this class did require more "work" from the others. But, if you consider [in a usual science class] that one unit of work [produces] one unit of reward (not an A this time, but actual useful knowledge obtained). In [comparison to] any other class, then this class [Dr. Gurr's] would be 1 unit of work for 1.2 units of reward. Perhaps a better way to say it is: I got a better return on my investment (HIGHER INTEREST RATE) so the higher initial investment was warranted. I PROFITED MORE!

Anyway, three passages in Pirsig's book describe very well what I got out of this class besides a Hell of a lot of good physics knowledge. They are:

(1) "The nature of our culture is such that if you were to look for instruction in how to do any of these jobs, the instruction would always give only one understanding of Quality, the classic. It would tell you how to hold the blade when sharpening the knife, or how to use a sewing machine, or how to mix and apply glue with the presumption that once these underlying methods were applied, "good" would naturally follow. The ability to see directly what "looks good" would be ignored." (PIRSIG 262).

(2) "You want to know how to paint a perfect painting. It's easy. Make yourself perfect and then just paint naturally. That's the way all the experts do it. The making of a painting or the fixing of a motorcycle isn't separate from the rest of your existence. If you're a sloppy thinker the six days of the week you aren't working on your machine, what trap avoidance’s, what gimmicks, can make you all of a sudden sharp on the seventh? It all goes together." (PIRSIG 293).

(3) "TO TRAVEL IS BETTER THAN TO ARRIVE" (PIRSIG 136). [Here Greg quotes one of the 31 "Master Motifs" Pirsig repeatedly uses to drive home major points.]
AN OVERVIEW OF *ZEN AND THE ART OF MOTORCYCLE MAINTENANCE*

DL APHY 201 SPRING 1994

I found this novel to be overall excellent, despite it's confusing content at certain intervals. The story starts off very simply with the narrator and his son, Chris traveling across country to the West Coast along with two friends, John and Sylvia. The narrator is also accompanied by the "ghost" of a past self, named Phaedrus. It took me quite a few pages of reading before coming to this conclusion. I encountered the same process when reading about [the idea of] Chautauqua before I realized that it is his story of life.

I found that this novel is not a typical "story" of a man's journey to Montana. Rather, it is a search for identity and one's true self. The concept of Quality as a means for attaining spiritual wholeness is another major component in this book. The motorcycle traveled on and properly maintained served not only as a transportation device, but also as a metaphor for oneself that is constantly in need of attention for which Quality is the psychological medicine just as proper tune-ups is for his motorcycle. The paths taken and the weather encountered throughout the journey reflects the feelings and inhibitions of the narrator.

The experiences of Phaedrus are reflective of our times. His conflicts are our conflicts and it is directly related to the alienation of technology. John and Sylvia do not wish to enter the dehumanizing world of wrenches and fix things. Then they would be "ants" in society (so they think). The mechanics that worked on John's motorcycle where, in a way, like John and Sylvia. They were not willing to be fully involved with technology because they didn't care about the work they were doing. At 5:00 the wrenches dropped and it was time to go home no matter what. If they really cared about what they were doing they would take the time to do the job right and pay no attention to the clock on the wall. Caring about what you are doing is considered either unimportant or taken for granted. The mechanics' actions showed the lack of pride they have in their work and they view what they do as simply work. This part of the book stayed with me because I could relate to it so well. Being that I work in a machine shop I view the work on engines being rebuilt. [Often] The workers are
unsympathetic toward the engines they are rebuilding. [However] I can tell a difference when an engine is being rebuilt for someone the employee knows. It seems like they take extra precautions to make sure everything goes well.

As I read this book, I could relate to so many things that I never really sat down and thought about. By realizing this, the book has changed my life.

My favorite part of the book was at the end of Chapter three. Every culture has ghosts that they believe in. The Indians believe in ghosts and spirits in their own context of thought just as we believe in the laws of physics and logic - these are our ghosts. We believe in them so much, they seem real. Isaac Newton and his laws of gravity exist in peoples heads (ghosts). His [the author’s] explanation is "mass hypnosis" (education).

Therefore, science along with everything else is only in our mind. "The world has no existence outside the human imagination".

It is through our own life experiences that we come to believe in whatever we believe in.

Book Commentary

DB  Phys. 202  4/13/94

Zen and the Art of Motorcycle Maintenance (1974), by Robert Pirsig, is about a trip out West on two motorcycles, one ridden by the author, an editor and writer of engineering manuals, and his son; the other by a couple named John and Sylvia. The author fidgets with both, his surroundings and his new self that emerged from insanity and a series of shock treatments. The author also, demonstrates how each person relates to difficulties encountered in life, and how one ought to approach modern technology. At first, this means the motorcycle itself, but as the book goes on, we come to understand that the motorcycle represents the human form.

It is quite clear that Pirsig is a thinker dedicated to a new or "high" kind of seeing. This phenomenon identifies with the term "Zen", a realization in experience, not in theory.

After finishing the book, I could not help but to realize the similarities with a previous article, AHA--Memory, Perception, Insight, and Problem Solving, by Henry Gurr, Ph.D.
Physics. Along with the articles, I can also, correlate classroom conduct by Dr. Gurr with Pirsig. For example, in the book by Pirsig, there was a reference made to the whole grading system being eliminated, and to make it [the class] into something that involved the students in what they were hearing. After doing lab [and] trying to relate* to Dr. Gurr what we learned from each of the [labs], I can understand that all that he is trying to do is truly involve us and make us realize the efforts of what we do. This is where "Zen" and Aha! come into play.

When I finished my ride through Pirsig's book, I was surprised to learn that Zen and the Art of Motorcycle Maintenance was not as I thought it would be. In fact, it was rather interesting and taught me how to tackle and deal with some of my own difficulties in school, home, etc.

Basically, it seems as though the whole intent of Pirsig's book was to break through abstract divisions between our thinking and feeling, science and art, reason and emotion, and our outer and inner selves.

[* Deana's words “Trying to relate to Dr. Gurr what we learned”, must be translated here. The word “relate” is Deana’s way of expressing what she is trying to achieve when composing her weekly written lab report. Lab reports are to be an extensive written analysis of what the student has learned and are usually three pages or longer in addition to data tables, graphs, etc.]

Zen and the Art of Motorcycle Maintenance

JS APHY 201 Fall 1996

After reading this book I finally understood what its meaning was; I don’t believe any book has shown me in some ways how I am and what I am missing.

I am going to tell you what I got out of the book through my viewpoint. It has been brought to the attention more vividly now, that quality is far more than quantity. The richest people or poorest people in the world can never truly be happy by missing the quality of life -- the opportunities, the peace, and strength along with courage can be given by God. For a long time I did not see the Lord in my life. I have lost two brothers as a little girl and that closed a part of me that I couldn't open again. I am 22 years old now and I have finally found that peace I had been looking for. I let the Lord in. Like in the book, all my life, I have been satisfying other and neglecting me. People all over the world are seeking for peace - We are given education, freedom, technological advances, and beauty of the land; but no one sees why, where, and from who. Commitment in the right direction can give you a lift and encouragement in life. This book opened my eyes to how to look and teach our children. Love them unconditionally, teach them the
way, and be there for them though things may be bad. The book used the land, humans, animals, and even a motor bike to open the eyes and heart of a reader - me.

Zen and the Art of Motorcycle Maintenance

CG Fall 1995

Thanks to Zen, I now understand why I've had so much trouble deciding on whether to choose to study Science or English. This is because unlike many people, I am pretty close to equally split between a Romantic and a Classical mind. What I've come to realize through that is: I don't necessarily have to choose which discipline to go into, because studying both is actually going to make me a more "aware" human being.

I am also coming to accept (or should I say "tolerate"), more readily, ideas that are different from my own without passing judgment on the person who has that idea or belief.

The most important thing that I am taking away from this course is not a mathematical equation or even a physical law. It is the knowledge that gaining an education is so much more than manipulating formula. It is developing the ability to look at situations in life and being able to apply what you have learned to those situations. By the way, I finally figured out the isolation problems. (You know, the ones I've been struggling with since the beginning of time!) Check the back of my review sheet and you will find also that I did almost entirely without help from the book!

It's odd that you brought up the correlation between the road trip and Phaedrus story in Zen and the Art of Motorcycle Maintenance. [Here CG is referring to Pirsig's consistent practice of using the road traveling conditions, at the beginning and end of every chapter, to metaphorically amplify the philosophic discussions in the center of that chapter.] At first, I didn't see it. It wasn't until I was almost done reading the entire book before I even had the slightest glimmer of a relation between the two and had to stop reading to go back and prove the truth of that recognition to myself. One of the times that just seemed to jump out and slap me in the face was when (beginning on page 173) Phaedrus has his student write a term paper on the subject of the abolition of the degree and grade system. After its success with her, he began to use it as a "demonstrator" (p. 173) with his persuasive writing class. He "used the demonstrator to avoid talking in terms of principles of composition, all of which he had deep doubts about," (p. 173), so you see, Phaedrus was relatively at ease at this time. He had gotten out of nit picking his students' work accordingly. Chris and his father are at a place in their trip, where after the initial three days to the snow, there will be four easy days. The three days represent Paedrus' time spent having to perform the ritual nit picking and the four easy days represent the time after he had come to the solution of using his demonstrator to replace the despised ritual.

Also before the return to Phaedrus' story the comment is made that "There's a negative reaction to all the weight. As we go on though, it'll become more natural," (p. 174). This is symbolic of Phaedrus' decision to withhold his students' grades. At first they all hated the idea, but in the end it seemed natural and the majority of students approved of the idea.
In *Zen and the Art of Motorcycle Maintenance*, Robert Pirsig puts forth the idea that mental
"stuckness" is not a bad thing at all. He says that, basically, mental stuckness forces a person to sit back
and clear his mind until he see where to go from wherever he is. I think that I can relate to that. When
I've exhausted all of my options, eventually, when I completely clear my mind, new options make their
way in, almost like cells in the skin dying to make way for new cells; I say this to lead me into my second
appendix.

I am absolutely, positively, undoubtedly stuck! I can't figure out how to do the problems from the end
of chapter 3 for anything in the world. I have had everyone that I could think of try to explain it to me
and it gets me no further down the road at all. The problems that I am referring to are the isolation
problems. It's so odd. Most of the time when I don't understand how to do something, there is just one or
two parts of it that I don't understand. With these problems, I can't even get started. I am in desperate
need of an AHA!

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**Zen**

**BC APHY 201 Fall 1995**

This semester has been very educational. In other physics classes you learn just physics, but in here I
learned a large variety of lessons. I now have a deep love for the stars and planets. Every night I go
outside to see Orion, Pleiades and Taurus. (My roommate has software on his computer with Nebulas,
stars, and space travel. It’s great!) I have also learned to be practical by recycling and not being
wasteful. You’ve set a good example by using solar power and recycling as well. I’ve also gotten a fair
grasp on velocity and forces. I may not be able to do all of the math, but I do understand the principles
and why things happen the way that they do. But most of all I truly admire your work at the Ruth Patrick
Center. The lab over there was very enlightening. I learned how to use the sun to tell time and Earth
location. The planetarium was breath taking! I’m sure that everyone was impressed by the presentation, I
sure was. I also learned moral lessons from Zen. For example, taking care of responsibility of our lives is
the most important thing.

**JH APHY 201 Fall 1995**

I really enjoyed the chaos video and its relations to medicine. I was fascinated by the way brain waves
and respirations are chaotic while the heart beat is regular, but they are reversed when on drugs. I also
learned some valuable lessons from Zen that will stay with me for life. I am going to try to worry less
about grades and more about gaining information for myself. I am also going to concentrate on getting
rewards from my undergraduate instead of just doing it in order to get to medical school. That book has
really made me take a step back and look at my life and how I view things. I will definitely strive to
change my ways of thinking for the better.
I thoroughly enjoyed reading *Zen and the Art of Motorcycle Maintenance*. The book contained so many things that made me really think. I know that to understand many of the things in the book, I would have to read it again. I had read little by little all semester but finally got to finish it over the Thanksgiving break.

I think what I liked most about the book were the ideas expressed about education. The idea that students are taught to imitate in school. I agree with that because I feel that I was taught to imitate by my teachers in elementary school. From the time we are born we imitate our parents and adults to learn to speak, write, and even behave. In school, our teachers express their ideas and ways of doing things. If the student does things differently, their grades may be low even though they may understand to concepts and have learned the material.

Another part was about the fact that students only learn if they have the desire to learn. The real university is in the mind. I only learn when I want to [and] if I enjoy going to a class and find the material interesting. I really liked the part about the grades experiment. The students learned more when they didn’t have to worry about grades. I always try to predict what I have to know for a test and won’t try to at least learn a little about everything.

I also liked the part about instructions. By not following the directions, sometimes one can open up new ideas and ways to do things. One can be creative and possibly do things an infinite number of ways.

One other thing that I agreed with him about is that we control our lives. The decisions we make are our own and no one can make us choose to do something. We do what we want and the consequences are what we make them. We are the mechanic and our lives are our motorcycle!

There are many parts of the book that I don’t understand, but I found the book to be interesting. Throughout the book, the author mentions Zen as a philosophy, and he brings up interesting points that we think about in everyday life.

I found the part where Phaedrus discusses the withholding of grades very interesting. It’s true that if grades were removed, students would be forced to wonder each day what one is really learning.

The basis of the Zen practice being the idea that truth is indefinable and can be apprehended only by non-rational means is also discussed in the book. It’s strange how much importance the author places on the maintenance of the motorcycle like it is just as important as or equal to life itself. The motorcycle is fixed, altered, and maintained throughout the book just like our lives are changed or altered in some way because of different circumstance. If a motorcycle is not maintained, it will break down or fall apart just like our lives will if they are not maintained.
The discussion of boredom meaning that you’re off the “quality” track was also interesting. The author says that when you’re bored, you’ve lost your “beginner’s mind” and your motorcycle is in great danger. Boredom means your gumption supply is low. My reading this was a big plus one for me personally because rarely am I bored because I feel that there is always something that needs to be done.

Beginning in chapter 8, I learn that Phaedrus and the author are the same person. The author has been talking about himself and his life teaching and as a student throughout the book. I believe that he was thought to be insane at some point in his life, and Phaedrus tries to prove to himself throughout the book that he is not insane. At the end of the book, he admits that he was insane for a long time, and is close to it again. However, a better relationship between Chris and his father has been established.

Recently, I have had two flashes of insight. One flash was concerning the book. It really puzzled me that the name of the narrator was never said in the book. I know the book was an autobiography, and the name of the main character and the narrator was on the front cover of the book. I wanted to believe that Zen was his name because it is in the title of the book. My flash of insight came when Dr. Westbrook told me that had had to do with philosophy, not the name of the narrator. I thought to myself...Self, it pays to look up unknown words and phrases. I also thought to myself, aahhh! Now, I am beginning to understand what the principles of the book are based on philosophies.

Another flash of insight came while I was working on my organic chemistry. We are now working on reactions with alcohols to make ketones, aldehydes, etc. using Grignard reagents and other reagents. I thought to myself, I am never going to understand this complicated stuff. Just as I was about to give up, I worked one last problem, and I got it right! Then it hit me. All of the reactions we are studying follow a particular pattern to get the desired product. Of course, not all reactions work completely the same way, but I now have the understanding and tools needed to work most of the problems.
Nothing signifies a great book more than its ability to leave the reader in deep contemplation or with a different perspective of life. *Zen and the Art of Motorcycle Maintenance* has achieved just that effect. The author, Robert M. Pirsig, describes his search for identity within himself while observing Quality in the world around him. His obsession with the logical definition of Quality resulted in a lack of it in his relationship with Chris.

Pirsig sees technology as an art form; beautiful ideas uncovered through the scientific method; but he despises the way in which it is presented to society in such a dull lackluster, confusing form with no defining basis. As a result, many people form opinions based on their personal experiences with technology. For example, a car owner doesn’t understand why his engine keeps misfiring; he feels too intimidated by the complexity of its appearance, so he allows someone else do the work for him. If the owner understood the functions and concepts involved in the engine, he would feel more comfortable in pinpointing the problem on his own. I believe a comparison to the quality of learning and education applies to this. Individually gaining true knowledge and understanding depends on the attitudes of both the teacher as well as of the student. An effective teacher must first care about his line of work, about those involved in it, and he must apply that care to his methods before the student can truly benefit from his instruction. Building enthusiasm, reducing anxiety, encouraging creativity with a challenging presentation of the material can build a better, more experienced learner. If an instructor cares for his work it will show in his approach and in those students willing to listen.

However, the student must also recognize the importance of a good quality education and the most effective methods of achieving it. Too many students come into college with conditioned attitudes originating from previous learning experiences that usually hinder the potential for new learning. Lack of enthusiasm, intimidation, fear of failure, fixed adherence to values, boredom and impatience all hold the deadly potential to destroy interest in learning. It is up to the individual to become educated to his fullest potential. He must develop a strong desire for learning; he must hold an interest and a positive attitude towards the material; he must not be intimidated by the unknown, but overall, he should keep an open mind to new ideas. When "gumption traps" arise, the ability to overcome them can only benefit the student if he learns from his experiences, (Pirsig, p. 274). Applying the scientific method to a certain problem an individual may have can result in a positive solution. Developing a hypothesis as to why the problem might be occurring and then to test it by seeking additional help or information from other sources actually enhances learning. The entire point, however, is that the student must be willing to struggle with his difficulties, be persistent in finding a solution, learn from his mistakes, and most of all he must care about the quality of his education----- emotional involvement that is felt from within. This view can be applied to any type of problem that may confront an individual.

The author himself discovers that his struggle to find his identity resulted in an improved relationship with his son, Chris. Before his confinement to a mental hospital, Phaedrus was an honest, eager, and extremely passionate individual------ he believed in his concept of Quality but had reached a level of understanding that was beyond the comprehension of his peers. His confinement changed him--- destroyed his passion--- the ultimate gumption trap. He no longer was the emotionally driven, caring man that Chris knew; he had become a recluse within himself. Pirsig
consistently observed the world around him and analyzed his observations logically. However he became blind to the emotional needs and desire for attention that his son desperately tried to convey—he neglected to analyze the Quality in his relationship with Chris. He did not reach full understanding of Chris’ behavior and feelings only until Pirsig looked within himself and discovered his own. Phaedrus was not the enemy, it was the man he had [to] become.

So how does this book apply to a Physics class? It is an attempt to encourage the new Physics student to take a new approach in learning; it is a description of learning itself and of the best methods to achieve it. This book can serve as a guide, as a motivator, or as a "gumption builder" for the struggling student. It has definitely changed my way of perceiving things, and has reinforced the desire to understand the world that I am a part of

[A Series of Five Writings That Shows a Student’s Development.]
Lab Appendix.  Zen and the………………
LI 8-30-96
Thoroughly enjoying this novel every night before bed. Latest thoughts→ His son does not seem to show interest in some beautiful things, but shows an interest in other beautiful things. (At a young age)----

Why do we begin to appreciate more of the simple things as we grow older? What is in us at a young age that doesn’t see the beauty if the simplest things? Why do we look past them at times? (Even now as a young adult.) What are we looking for in place of them? [Lisa continues her thoughts in a series of writings below.]

Lab Appendix.  Still enjoying Zen and the Art………………
LI 9-5-96
Learned a great deal about the levels of machinery involved in a motorcycle→ inspired me to try and change my own oil, etc. Bought some decent tools to do some work--my own work--on my own car--if I can with out causing a disaster. Enjoyed reading the Scientists view of the Romantic and vise versa.→Very true.→ to the point where it’s comical. [Lisa continues her thoughts below.]

Lab Appendix.  ZMM
LI 10-24-96
Unfortunately my progress has become slow on reading the novel. Since I am now caught up from being sick, I will have more time to read. Where I am at right now: Phaedrus is looking back at why he chooses to study philosophy more than science when he pondered the question
“What does it all mean? What is the purpose of all this?” [Lisa continues her thoughts below.]

Lab Appendix.  ZMM  (Where I am right this minute.)
LI 11-14-96

John, Sylvia, Chris, and his father travel through beautiful Montana to visit with their friends, the DeWeeses. Apparently, Mr. DeWeese and the narrator go way back to their college [teaching] days. However, the narrator appears to have changed a lot more than Mr. DeWeese—who may have liked the way the narrator thought in the past more so than the present. Before this, however, I saw exactly where you [Dr. Gurr] get some of your thinking and opinions on college or the Church of Reason:

“The Real University is not a material object” it is a state or mind”, and “there is a legal entity which is unfortunately called by the same name, but which is quite another thing.” (Page 131, 132)

Unfortunately, grades, syllabus outlines, project deadlines, etc keep this theory of the Church of Reason down. [One month later, at the end of the semester, Lisa continues her thoughts below.]

The Church of Reason
LI 12/12/96

The narrator speaks of the offense of a group of townspeople after seeing an old church renovated into a bar. He explains the emphasis they had on the building itself, not so much what happened inside. He coincides this thought with the principle of the university.

The author explains that most students have lost touch with the purpose of attending a university - to learn for themselves, not to, as a previous student said, "jump through hoops". We should not, the author states, come to get grades, but, instead, attend to better ourselves. This is not always easy - in fact, it is not easy at all.

So much emphasis is put on grades in many areas of academia. Your GPA may not be as important later on, but at the time, this number may have given you a scholarship to attend school. I have gone through this personally.

In high school, my vision of what college would be like was partly clouded. I believed that college would make me an intellectual, someone well rounded. I saw most of my professors this way, and this motivated me.
During my first few semesters, I was very observant as to how my older peers and professors portrayed themselves. I decided to become very involved in extracurricular research and study in order to better myself. I worked very hard, but this was very satisfying to me. Looking back, I believe I had grasped the idea of the Church of Reason. However, through the years here at USCA, as one who strived to be amongst the professional and scholastic, I learned another side of the coin. The closer I became to my peers, the more I saw the truth. It was there all along, but I choose to cover it with my "intellectual fantasy". The people, who had seemed the least likely to jump through hoops, were doing it the most. This may sound like a bold statement and very critical, and I do not want to go farther with detail, but it was very disappointing to see this. I have since reevaluated why I am here. I have realized that I have also fallen into this trap, and have decided to make a conscious effort to stop myself from going any farther like this.

During the summer, I picked up *Zen and the Art of Motorcycle Maintenance* in the school bookstore because I thought the title looked very interesting. Reading the book a second time though, I have caught on to much more, I believe anyway. Regardless, I would definitely say the narrator's description of the Church of Reason truly grabbed my attention.

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Zen Discussion Group; A Series of Lab Appendix Writings

AB Physics 201 April 1996

In the Zen discussion we wound up talking about more analogies and why the book was even written. We talked about how the Author was talking in his sleep and how Chris had noticed and asked him about it. The Author thought Chris was crazy and had no idea that he was really talking [the one whom was sleep talking]. We talked about similar experiences we'd all had and also about why the Author even took time to write Zen. We came to the conclusion that it was to help himself out in deciding what to do about Phaedrus. I know in my everyday life, I work things out better after talking about them and/or writing, Sometime when I ask for advice I figure out my [own] answer just my trying a different approach. Now we are really making connections with this book.

[The next week AB continues in her lab report book:] Because were late arriving, the Zen discussion was rather short but was on gumption traps and how pushing yourself to the limit was not always good. We discussed the monkey with the rice and the roses. Both of these symbolize how to learn to let go (literally for the monkey) and learn how to prioritize your life. A very beneficial discussion as far as I'm concerned!!
[The next week AB reports in her lab book, a discussion she had with her classmates as they were traveling on a field trip.]....... We also discussed Zen [and the Art of Motorcycle Maintenance]. I talked about quality and the train, romantic and classical personalities, and the rewards in life and how each step to the end should be a separate reward in itself. ......

CH  Physics 201  December 9, 1996

Zen and the Art of Motorcycle Maintenance is a very complex book. The story is of a man who is with his friends and his son on a motorcycle voyage. At first the reader is made to believe that it is his first visit to the towns and cities the voyage takes them through. The reader soon finds out it is not his first time but he has been to these places before. The man has a past that is jumbled and not quite put together. His memories have been erased, because of his mental problems. His memories are coming back to him as he reaches certain places on their voyage and as he thinks of certain thoughts. The man in the past was called Phaedrus. Phaedrus was a professor at one time and had his own way of thinking. He saw the world in different modes, for example the classical and romantic mode. The classical mode saw the world and how things work. This mode got into the nitty-gritty of why things happen. The romantic mode was more of the immediate vision of things, take things as they are. He split these modes from reality. Classical was with the mind and intellectual. However romantic was physical and used emotions.

While reading this book I began to judge myself and I realized I use my emotions and just take things as they are. I never really sat down to think of how things work and why they work the way they do. At first when I started reading this book I asked myself why are we reading this book, it has nothing to do with physics. But as I read more and more it started to make sense. Physics happens at every moment in time whether it be a drop of water being pushed up a windshield of a car or a person falling off a ladder. There is more to life than meets the eye. Most people don't think about why things work the way they do. This book compelled me to reason what I am doing in life and what am I doing it for.
APHY 202 FINAL EXAM RESPONSES SPRING 1996.

On APHY 202 FINAL EXAM SPRING 1996 Students were asked two questions: 1) Convince me, as your professor, that you really understand proportion at “deeper levels” and 2) What did you learn in Physics? These questions were placed at the end of the examination, after the student had completed eight physics problems.

PLEASE NOTE THAT SIX STUDENTS OUT OF A CLASS OF SEVENTEEN STUDENTS SPONTANEOUSLY MENTIONED THE ZEN BOOK AS A SIGNIFICANT PART OF THEIR PHYSICS LEARNING!!

To avoid “words being taken out of context”, the complete student responses of all students are transcribed below. Portions of the student response that refer to the Zen book are shaded darker.

WHAT I HAVE LEARNED IN APHY 202

JK

SPRING 1996

1) [I learned that] I don’t need to memorize a bunch of formulas, now that I know how to use proportions. For example, I know that with an increase in mass, volume increases. \( M \propto V \) leads me to my constant, which is density. Using proportionalities I can calculate any constant. Now constants are not so ambiguous. I can see where they come from.

2) I learned a lot in physics this year. My favorite part was on the light chapters. I liked doing the [optical] grating— I have learned how rainbows are made [and that] there are hexagons of water----crystals that light refracts through. Constructive and destructive [light wave interference] caused by single-slit diffraction and double-slit refraction, were very interesting. I could actually see how it all worked. I’m glad you had us do all those diagrams, otherwise I would never have gotten it.
Even my least favorite part, which is electricity, I still learned a lot. I know about voltage, current, power and energy. I can calculate how much it costs to leave the light on. I know that a microwave [home oven] is a system of step-up transformers. I have learned not to put metal in the microwave, at least thin metal or metal with sharp points. I learned many more practical applications of physics. I think those were the most important. You [as professor] were also aware of that. You brought in examples of things we see and use every day. This is the kind of physics I like, and I can tell you like it too. You encouraged us to do things with our own two hands. I learned that I learn better if I actually do the things myself. The author of Zen [Zen and the Art of Motorcycle Maintenance] couldn't know as much as he does if he hadn't experienced it for himself. Learning is a process of experience.

WHAT I HAVE LEARNED IN APHY 202

JH

SPRING 1996

1) The sheet on understanding proportion deeper really did help me [to] understand it [proportion] deeper. Every equation (almost) has a constant. Whenever 2 things are proportional, they always have a constant. Starting the sheet was difficult, but once I understood that 2 things are proportional with a constant, writing the 3 steps became easy. I never understood this until I sat down with this sheet, by myself, and made myself figure it out. I did not ask anyone, I made myself understand it, and now I will always know how to work with proportions: The item on the left of the proportion is the numerator, while the proportion [item] on the right is the denominator, and this fraction is equal to the constant.

2) This semester I learned a lot in physics. I learned about electricity, Coulomb's Law, electric fields, capacitance, Joule's Law, Ohm's Law, resistivity, resistors, circuit diagrams, magnetism, magnetic fields of induction, impedance, transformers, reflection, refraction, microscopes, telescopes, converging and diverging lenses, magnification, single and double slit diffraction, wave interference, grating, relativity, plank's constant, photoelectric properties, Heisenberg's uncertainty, Bohr's Orbit size and energy levels, Bohr photon energy, quantum numbers, decay of radioactive materials and half-life, fission and fusion energy, crystal making, proportionality, and much more. I have learned the basics of physics, but I have also learned a few life lessons. I have learned to try
not to depend on grades. I need to learn this [truth] for myself. I also learned to take one day at a time, one semester at a time, and that each one is important. I also learned how valuable sleep is, and as much as I hated it, that sometimes I need to say I cannot do something and just take the consequences. I cannot do everything and stay sane. I have really had a good year and I appreciate the physics you taught us, but even more I appreciate the life advice and "Zen of Motorcycle Maintenance" discussions. I learned as much there, as in class. Jennifer's decision to “not to depend on grades” comes from her reading of the Zen book and the Zen Book discussion group.]

WHAT I HAVE LEARNED IN APHY 202

CB

SPRING 1996

After looking at the review worksheet, I began to understand the concept of proportions "deeper." As one looks at the equations, one begins to see a pattern forming throughout the sheet: Left over right! If one looks at the practical equation, one can see what is proportional (the more of this, then the more of this or less). For example, this was really clear in the equation Q=VC. The charge of the object, Q, is proportional to the voltage of the object, V. It is easy to see that if an object has voltage, this amount will be directly related (proportional) to how much charge the object has. The new concept or definition step, is just a way of showing how these proportional terms relate. Capacitance (in this case) is the way of showing how the charge relates to the voltage. The working equation is only a rearrangement of what the definition is. So only knowing the working equation is not knowing where the equation originated from.

What haven't I learned in APHY 202! This is one of the few classes in my life that I've had in which the main subject (physics in this case) is only one of the many topics discussed. Besides learning about Farads, electron volts, and coulombs I have learned many important lessons about life. One of the major tools through which I've learned this lesson has been Zen. [Zen and the Art of Motorcycle Maintenance] I've taken with me, the fact that grades are not nearly as important as I had thought before taking this class. The truth is that if true learning is taking place, the grades are bound to follow.
I've also learned not to be so one-dimensional. I used to be strictly a science person who didn't give a rip about the arts, humanities, or philosophy. Boy was I missing out! I have thoroughly enjoyed my theater and music classes as much as my physics and chemistry classes. [Integration of Art, Science, Literature, Philosophy is one of the major themes of the Zen book. Chris was an active participant in the Zen discussion group.]

I have also learned to be tolerant of others and not assume so much. There are many times when a death in the family or some other crisis comes up where they feel really down. Sometimes the best thing someone can say is that "I feel for you and I will do anything I can to help you."

I can definitely say that I am a better overall person after taking this class.

WHAT I HAVE LEARNED IN APHY 202

TR

SPRING 1996

1) Before working on the sheet this semester, I took proportions for granted. Even last semester, I did not realize the importance of proportion. When you were showing us how to do the sheet on the board, I had an AHA. The world is full of proportions as well as constants. For example: distance $\propto$ time. I always knew this because $D = vt$, but I never thought of it (rate) as a constant similar to an electromagnetic constant or an electrostatic constant. But it's true that you can go 60 miles in one hour or 120 miles in 2 hours if you go 60 mph. I do understand proportionality now, especially after filling out the sheet. I could simply look at an equation and figure out the constant as well as the proportions. I could also do vice versa by knowing the proportions. In essence, I learned to manipulate equations by knowing parts of the equation.

2) Although I may not have shown this on the test, I did actually learn a lot in Physics 202. I gained understanding of many concepts that were previously unknown to me, such as how
electricity "works", how batteries work, and how transformers work. This learning though was very difficult for me because ... you cannot see charge or current. I am more of a visual person. The fun learning came with optics. I loved optics. I somewhat knew how lenses worked but I had no idea that the Camera Obscura worked in a similar fashion --- [or] that the net effect was the same.

I really don't know where to begin. Physics has made me more aware of my environment and why things happen. For example, if I see iridescence at work, I understand why various colors are seen. I really liked the work done on reflection, refraction, separation of white light into its various color components, and wave interference. I am now aware of the moiré patterns (zebra patterns) due to wave interference. There are other things I learned in Physics 202 that can't be found in the text. For example, like in Zen [Zen and the Art of Motorcycle Maintenance], values are the pushing force in life, leading you in a specific way. I also learned about the stars and planets, [and] many aspects of each.

WHAT I LEARNED IN APHY 202

KL

SPRING 1996

During APHY 202 this year I learned that to understand proportion is to understand various equations including their definition (if a constant exists) and the proportions in our date!! [My learning ranged] From taking pictures and actually do[ing] hands-on experiments, [which] supplemented the Homework. I found myself understanding how proportions are all around us and exist infinitely!! I think the chapters I enjoyed the most were on wave interference and patterns. Here, I enjoyed understanding how areas of contact have different changes in the wave interference of visible light causing, various hands were bright while others are dark, etc ... actually seeing what you [as professor] teach is so very beneficial! I found that this semester you supplied more visual aides which helped (I believe) benefit our learning. For ex: [better learning] is proportional to: [visual experiments, done hands-on in class.]

You are right; proportions are all around us!
It has been a great 2 semesters. I've enjoyed [it]! One of the most important things I've picked up from your class is by reading *Zen and the Art of Motorcycle Maintenance*. It definitely has opened my eyes and has made me change the way I live my life. Ex: The chapter on grades in institutions - I found that if I worried less about my grades I do better - I learn more - and I develop better understandings.

**WHAT I HAVE LEARNED IN APHY 202**

SC

SPRING 1996

1) "Deeper Levels"?

If you mean that I understand if two charges \((Q, & Q')\) are directly proportional to the product of the magnitudes of the charges, this means that as \(F = QQ'\), then yes, I do. Or that as you lose potential energy, you have an increased kinetic energy. I do understand how many factors work together, though I won't say I do clearly.

2) What did I learn in APHY 202? I've learned more than I'll ever be able to write; though I must admit it has been quite a challenge for me. I learned how transformers work and actually understand how and why you can induct (or deduce) voltage for more or less current. I learned the importance of having a magnetic field and how to manipulate for certain frequencies. I've learned why my sunglasses block the harmful ultra-violet rays from the sun. I've learned how fluorescence and phosphorescence leave the glow they do. I've learned about Huygens's principle and wave interference that gives me brighter light and dark bands (as in Young's experience). I don't go home any more without seeing something I've always taken for granted. For example, why the sky is blue (scattered light!). Now I find myself asking why, or [and] either get excited because I do understand, now, the way things work! My eyes have truly been opened to the wonders of physics. I have realized that physics does indeed apply to life itself. Unfortunately, it took me almost a whole year to understand this. I know you think that I don't care. I tried not to, but it didn't work. Every lab opened a new experience and "AHA" for me. I really enjoyed lab. I guess my problem has been the problem solving itself. It's something I've learned I'm not good at. Concepts, however, I can. I grasp concepts fairly easy - it's the application [of the equations] I have a difficult time with. Perhaps this means I don't grasp concepts as well as I think I do. However, I understand physics a lot more than what you think I do. The truth is many times, when you have asked me a simple and obvious question, I've looked beyond the obvious and was attempting to find deeper
answers - I noticed the obvious, but thought it was too simple. This class helped me learn that about myself (I suppose Zen helped) [[Zen and the Art of Motorcycle Maintenance] You're right, Dr. Gurr, where our train tracks lie, there are our values. Your class is actually one of the few that has refreshed my lust for education. I’ve just been so tired of fighting. Perhaps the most important lesson I’ve learned in your class is "don't give up."

WHAT I HAVE LEARNED IN APHY 202

AB

SPRING 1996

1) Proportionality in this class was the basis for everything. Relating one thing to another was the whole way to figure out problems and come up with solutions. For example density is related mass and volume. For a set density, mass is proportional to volume and for a set volume, mass is proportional to density. They all tie in and relate. They are dependent upon one another. This allows a pattern or maze to go through to find what you are looking for. If nothing was proportional, nothing could be solved! Because all of the things on our "master sheet" were related, and most of the forces in this world are related in some way, shape or form, we can try and explain some of the mysteries of our world. This is the "deeper meaning" of proportion for me.

2) This class has been a real learning experience for me. I feel as if I've learned so much about the world around me that I’m full of explanations when people wonder aloud "why?" I cannot write every single thing out but I’ve learned about astronomy, microwave ovens, crystals, telescopes, reflection, refraction, chemistry, etc., etc., The list could go on forever but I would like to say physics teaches you about life. You learn to respect the world you live in through knowledge, and, of course, the more knowledge, the more power! This class has been more than memorizing from a text. I feel I will actually retain the things I've learned and will carry them with me throughout my life. Thank you Dr. Gurr, it's been a great year! [Angela is one of the students who originally requested the Zen and the Art of Motorcycle Maintenance book discussion group. She was an active participant and attended nearly all our group meetings.]
1) [My learning started] At the several beginning chapters such as chapters about electric charge, electric field, magnetic, capacity, circuit....

I think I understand them very well because I see them in daily light and they are also popular topics. Through the lab, I also can imagine or visualize how they look. I know proportion is "both go Up" or "both go down" at the same time. For instance: $V = RT$ [means] $V \propto R$ and $V \propto I$ which means if $V$ increase/decrease RI also increase /decrease....

2) In later chapters 31–34, such as optics applied, the information is little difficult to process. The information are so abstract, cannot visualize easy. However with proportion... I be able to memorize some formulas such as

$$E = \frac{1240}{\lambda} \text{ eVnm} \quad \text{or} \quad \gamma = \frac{0.693}{T^{1/2}}$$

In short, I think that I learn a lot in this class. I learn about magnetic and electric field, lenses, microscope, telescope, reflection and refraction of light etc.... I am not only learn about them but see them by my eyes and practice them with my hands, such as get my hands shocked by let e jump to them while they contain positive charge. I also learn more about power, electricity and circuit, antenna, radio wave, etc. which I see and meet and need as householder. Anyway, I enjoy the class. I think in this semester, this is the only class I enjoy spending more times and also the class I learned most.
1) What has always interested me is how scientists get all of these concepts. For example: [how] distance and time lead to velocity - [and how] velocity and time lead to acceleration. Now I understand that they just didn't pick some concept out of a hat. By experimentation they saw relationships between velocity and acceleration. I've just wondered how did they know to go a step further from velocity to acceleration? I know now: Concepts are related by [a] Proportionally Constant, a new concept derived from the relationship between distance and time. Proportions provide a quick and easy understanding of concepts.

2) I've learned quite a lot in APHY 202, everything I've wanted to know and learn, as well as some things that I had no idea about! Electricity, magnetism, lenses, electrons and other subatomic particles. I've gained a better understanding of electricity and its application to my life since I use it everyday without knowing it. I've learned about batteries and especially resistance in wires. What sticks out to me in electricity is voltage. Voltage is the "jump" of electrons from a wire to another. I've learned how we know the electron exists by [use of] a Cathode-ray tube. One thing that I had no idea about, that helped me solve a mystery of mine, was that energy can "create" mass. I've always wondered how light bends when it approaches a black hole. Because there is mass in light! (I've mentioned this in my lab book.) Another thing I've learned is that atoms can "hold" energy [received earlier] from light (as in fluorescence and phosphorescence) and release it quickly or very slowly. This has really been an exciting and educational semester. I've known rainbows involve water droplets, but I did not know how or why until this semester. The knowledge of light explained this phenomenon. A lot of new concepts have been introduced to me and I can see them all around me! Thank you, Dr. Gurr, for showing examples, analogies, and applications of these concepts because I see it everyday.

WHAT I HAVE LEARNED IN APHY 202

TE
1) Proportion: Convincing you that I understand proportion is not easy, because proportion is not a clear-cut discrete idea. To truly understand proportion on a "deeper level," one must understand it intuitively; that is, someone who understands proportion rarely thinks of it because it is a concept that becomes integrated into one's psyche. But, given that, I am required to try to put this idea into words, I will try; and, the best way to do so would be by using an analogy. Proportion, to me, is analogous and the concept of derivatives. I say this because both of the ideas are used to qualify related variables within a given range and for a specific set of conditions.

2) I could not possibly begin to address the massive amount of knowledge I obtained during this course. But, as with PHY 201, this course offered me the opportunity to go beyond learning the basic equivalents of physics and allowed me to focus on the web of ideas, which interconnect the many topics, which physics covers.

WHAT I HAVE LEARNED IN APHY 202

BR

SPRING 1996

In physics this year I learned how many things physics relates to: EVERYTHING! However, I found the class quite frustrating while also taking baby physical chemistry (300 level). Many of the concepts I was missing in P-Chem, I was also missing in physics. You would think these complimentary classes would have helped, but together they compounded my frustration. In the end, I think I realized that they actually were helping each other along, but it was painful along the way. I had an English professor that said the semester was like childbirth (something neither you or I have experienced). "It starts out easy, but once it gets started there is no stopping!" Her advice was to work hard throughout. That was my first mistake in P-Chem. The class was so initially overwhelming, and I had forgotten so much chemistry I didn't try as hard as I should have. (Or gotten help as early as I should have). However, this is about what I learned in physics. So, I'll say I look at my world in new ways.
I know that a fly looks green cause of reflection, I know that radioactive atoms are trying to calm down, but some will take thousands of years to do it. I understand why my glasses don't work like a magnifying glass (I'm nearsighted), and I think I have a greater appreciation for all things. Now I'm going to expose my nephews and later my children to all the neat "hands on" physics things a person can do. I'll start with flashing wintergreen lifesavers. Physics is sweet!

WHAT I HAVE LEARNED IN APHY 202

VH

SPRING 1996

This semester of physics covered a wide range of [subject] matter. It ranged from electric charge to lens equation, and from outer atoms to particle emission. It was very hard for anyone to learn these many subjects in only four months. But Dr. Gurr, by using outside examples and illustrations, led us to understanding the subject matter and always providing out of class help to make sure everyone was on the right track. Since the book did not explain enough, I always have trouble on understanding when I read the chapter. Even though I could do the problems by comparing the examples in the book, but I still did understand why I should do that. Dr. Gurr was always there to explain the matter thoroughly and got me to understanding things.

For example, when we learned about the single slit, I couldn't understand how the slit causes image on the screen. Dr. Gurr illustrated this by showing how "grading" on the screen is formed by a single slit. He also did a very good illustration in the planetarium and showed how the decrease of the size of hole causes the forcing of the outside image on the screen. The image formed is reverted [related] to a real image.
I think it would be easier to list the things I didn't learn (ha-ha). I will list the things that were of most interest to me.

-Electrical charge: I learned about current (amperes) power (watts), capacitance, resistance ($R = \frac{V}{I} = \frac{P}{I}$ in ohms), step up and step down transformers, the behavior of + and - charges. All of these helped me understand a little about my husband's job (electromechanical engineer).

-Magnetism: I learned about induction, why hair stands up when next to balloon or lightning storm, learned about magnetic field of magnet, [and] can always impress people with the right hand rule.

- Optics & light: I learned a lot about how microscopes, telescopes and eyeglasses work, converging and diverging lenses, reflection and refraction, where all the pretty rainbows come from (sun dogs, etc.), wave interference was an eye-opener. I still don't like these diagrams!!

I learned a lot, but most of all I learned that some instructors can be compassionate and care about students. Thanks!
For understanding proportion at the deeper levels, basically, if you have the proportion, you know that there is a constant. And the ratio of the proportion is this constant. From this, you can deduce the practical equation.

For example: \( m \propto v \) so \( d \equiv m/v \) and \( m = dv \).

In physics 202, aside from learning a lot about physics, I also earned how to be more organized, how to work with a group better. I also learned to think for myself more. If at first I could not do a problem, I would just keep trying and eventually I would get it. I also got a much better understanding of electricity and how it works, and I learned a lot about light waves and particles.

1) As far as understanding things at deeper levels goes, that is what APHY was all about.
9) As I've said before, the more you find out about the universe, life, religion, etc., the more you realize that there's more to learn! AHA!!!!!!

WHAT I HAVE LEARNED IN APHY 202

MG

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1) I understand proportions at "deeper levels" because I know now that every mathematical formula is related to proportions. Not only does proportions help you to memorize formulas, but also helps you to understand how things are related. For instance, if one number on one side of the equation increases, proportion helps you understand why the number on the other side of the equation increases or decreases.

2) What did I learn in Physics 202? In physics 202 I learned about proportions, and how the proportions can help me understand and memorize formulas. I also learned how to make alum crystals, and I learned more about the operation of my microwave by the home laboratory project. I also learned how to calculate the wavelength of a certain spectrum of light using not only \( c = 3 \times 10^8 \text{ M/S} \) and the frequency, but also using 1240 eVnm.

I also learned about lenses and how a good diagram of a lens is drawn. I also learned things about reflection, refraction, and my personal favorite- Snell's Law.
Learning must be its own reward. There is no other way.

My physics classes were organized so students would gain useful, practical, and personally meaningful knowledge. I was slow to discover that, despite my best efforts, my intentions were only partly realized. “Empty learning” was solidly implanted in even the best students. As I increased my efforts to achieve more meaningful learning, I apparently was introducing actions and processes and requirements that were out side student expectations. Students could not function in their normal learning modes that they had acquired in their prior educational experiences. Consequently they rated me low on “Course Objectives Are Clear” on my end of semester Student Evaluation. To help explain to the students what I was trying to accomplish, I composed a student handout: This document “Objectives of Physics (Spring 97)” explains my philosophy and practice of teaching, and is available upon request.

My larger motivation for this requirement is spelled out in a separate document available upon request. Any person who really would understand the potential for “Zen and the Art of Motorcycle Maintenance” to improve undergraduate education, and indeed the personal life of any reader, should read this book for themselves.

These students did not come to me. I had to go to them to find out why they had not presented any Zen Reports. One student stated that other people would think he had compromised his religion if they saw him reading such a book. He said he had purchased a copy of the Zen book, and probably would eventually read it. Another student thought that reading the Zen book was in excess of what he considered a proper workload of a physics class, and was not going to read it as a matter of principle.

See Edward O. Wilson, Consilience/The Unity of Life. Knoff

You, dear reader, must take the time to read the student own words, even if you read just a random small sample. Otherwise you will not believe the assertions I have given above,