

Selected Readings - TA Orientation 2004

Redish, Edward F. (2003). *Teaching Physics with the Physics Suite*. NJ: John Wiley & Sons.

Chapter 1, pages 1-16

This chapter discusses the goals, methods, and objectives of physics education. If the goals of physics education are not being met, then how should the community chart a new path?

In order to understand the rest of *Teaching Physics with the Physics Suite*, consider the following questions:

1. According to Redish, what are the goals of physics education? Are these goals being met with traditional instruction?
2. What aspects of the scientific method does physics education research utilize? Why do you think Redish emphasizes this?

Chapter 2, pages 17-50

This is a lengthy chapter on psychology as much as on education. Many educators do not spend much time thinking about how their students learn; the implicit model is that of a computer receiving programming. Extensive research shows that students learn in a much more complex way. Redish then lists some principles based on the psychology of learning. Keep in mind that these apply to the average student; as someone who chose to specialize in this field, there are ways in which you deviate from the average.

Here are some questions to guide your reading. Be prepared to discuss some of these questions in class.

1. What is a “chunk”? Can you think of any ways that you use chunks to help yourself learn, or to solve problems?
2. How does Redish’s “common naïve conceptions” compare to Wandersee’s “alternative conceptions”? How do “primitives” compare?
3. Consider the five principles of learning that Redish states; how does traditional education fail to utilize these? In light of this research, how might an educator maximize student learning by utilizing these principles?
4. One corollary to the Individuality Principle is stated by Redish: “Our own personal experiences may be very poor guides for telling us the best way to teach our students.” Have you experienced this as a student or instructor?
5. What does Redish say should be the goals of physics education? How does physics education incorporate the principles of learning into instructional methods?

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Chapter 6, pages 115-123

This is a short chapter on the differences between an instructor-centered classroom and a student-centered classroom. Each model produces a different set of results which flow naturally from the method of instruction.

1. What are the characteristics of an instructor-centered environment? What do you think are the specific skills acquired from instruction in this environment?
2. What are the characteristics of a student-centered environment? What do you think are the specific skills acquired from instruction in this environment?
3. Do you agree with the skills that Redish states are desirable? Are there any that you would add or subtract? Which environment is most conducive to developing these skills?

Chapter 8, pages 142-169

This chapter discusses different methods for running a recitation and laboratory. Redish lists the characteristics of the traditional method of each, as well as some activities to utilize some of the learning principles from chapter 2. There are also some alternative methods to running laboratory or recitations listed.

1. What are the characteristics of traditional labs and recitations?
2. What general characteristics do the non-traditional methods have in contrast to the traditional ones?
3. What outcomes do you expect from the traditional methods? From the non-traditional methods?
4. How does Redish's discussion of CPS compare to what you have heard in class?
5. Chapters 7 & 9 deal with the non-traditional methods of physics instruction, which may be interesting to you as well.

Wandersee, J.H., Mintzes, J.J., & Novak, J.D. (1994). Research on alternative conceptions in science. In D.L. Gabel (Ed.), Handbook of Research in Science Teaching and Learning, New York: Macmillan.

Pages 177-191

This is a lengthy chapter from the handbook that is used as a reference for science educators. It is a review of the literature on alternative conceptions. You should skim pages 177-180, which covers more than twenty years of research – don't worry about the details. Pages 181-183 discuss students' alternative conceptions in physics, biology, and chemistry. You can skim (or skip) the biology and chemistry sections if you like. What you *should read carefully* are pages 181-183 and 185-191, which talk about the authors' knowledge claims (the first is on page 181).

The following questions may help guide your reading. Be prepared to discuss some of these questions in class.

1. How do the connotations of “alternative conception” and “misconception” differ?
2. Claim #1: Learners come to formal science instruction with a diverse set of alternative conceptions concerning natural objects and events.

Which alternative conception surprised you the most? Why? Why do you think more of the studies on alternative conceptions have been in physics than in the other sciences?

3. Claim #2: The alternative conceptions that learners bring to formal science instruction cut across age, ability, gender, and cultural boundaries.

Why might an alternative conception be commonly held by people of all ages, abilities, genders, and cultures?

4. Claim #3: Alternative conceptions are tenacious and resistant to extinction by conventional teaching strategies.

Under what circumstances does high-quality conventional teaching work well? Not work well?

5. Claim #4: Alternative conceptions often parallel explanations of natural phenomena offered by previous generations of scientists and philosophers.

What kind of question would differentiate between students who hold the “impetus” alternative misconception and those who hold the Newtonian conception?

6. Claim #5: Alternative conceptions have their origins in a diverse set of personal experiences including direct observation and perception, peer culture, and language, as well as in teachers' explanations and instructional materials.

Most physics texts define “centripetal” force as $F=mv^2/r$. How might this treatment inadvertently result in an “alternative conception” about the causes of circular motion?

7. Claim #6: Teachers often subscribe to the same alternative conceptions as their students.

We all have alternative conceptions, and some cut across age levels. Think about what you have to do to learn a difficult concept. How is this different than strategies your students might use?

8. Claim #7: Learners' prior knowledge interacts with knowledge presented in formal instruction, resulting in a diverse set of unintended learning outcomes.

What are the five possible outcomes of formal instruction?

9. Claim #8: Instructional approaches that facilitate conceptual change can be effective classroom tools.

How do “instructional approaches that facilitate conceptual change” differ from traditional formal instruction?

Pages 191-194

In the short assigned sections, the authors discuss very briefly some teaching strategies for helping students “overcome” or change their alternative conceptions.

Reading Question: Which strategies do you think the UMN labs try to employ?

McDermott, L.C. (1984). Research on conceptual understanding in mechanics. *Physics Today*, 37(7), 24-32.

This article summarizes many studies conducted to determine common physics alternative conceptions held by students. The article also makes recommendations for instruction intended to overcome these difficulties. For the Summer Orientation, you are only required to read pages 24-25. You will read the rest of the article later.

Reading Questions for the summer Orientation:

1. What are some preconceptions about passive forces?

Reading Questions for later:

2. What are some preconceptions about the gravitational force?
3. What are some preconceptions about velocity and acceleration?
4. What are some preconceptions about force and motion?
5. What are some implications of the research on traditional instruction?

Larkin, J.H. (1979). Processing information for effective problem solving. *Engineering Education* (December), 285-288.

Much of the early work in physics problem solving was done by Jill Larkin and her associates at Carnegie Mellon University. Her articles are referenced in almost everything written about problem solving in physics. This article is one of their earlier, shorter, and easier to read articles. Her conclusions from this article have since been confirmed by other research studies using a wide variety of different methods of collecting data.

The following questions may help your reading:

1. Larkin states that an expert and a novice problem solver can have the same amount of knowledge, but this knowledge is organized differently in their memories. What is the difference in the knowledge organization of experts and novices?
2. On a table like the one shown below, summarize three differences in the approach an expert and novice take when solving a physics problem.

	Expert	Novice
1.		
2.		
3.		

3. What does Larkin recommend be done to help students become more effective problem solvers? How should this be done? What do you think of this idea?
4. Compare the ideas of Redish and Larkin on problem solving.

Brown, J.S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.

The Minnesota Model for teaching large introductory physics courses is based, in part, on cognitive apprenticeship (situated cognition). The article discusses several examples of cognitive apprenticeship in the classroom. It was written for people with a background in theories of learning and educational psychology, so the terminology is sometimes difficult to follow. You may need to use the dictionary and read some sentences several times to “unchunk” what they mean. (Note: Your experience reading this article is like that of a non-science major reading a physics article in *Scientific American*...)

You should read the first half-Page introduction, and pages 37-42.

In this reading, JPF behavior refers to the behavior of “Just Plain Folks”. Several studies show that the way JPF learn is very different from what we usually ask students to do in school.

The following may help guide reading:

1. In your own words, what is cognitive apprenticeship? (Hint: See page 39.)
2. According to the authors, what are the four “salient features” of collaborative learning? Describe them briefly.
3. Are any of the “salient features” of collaborative learning missing from Karen Cummings’ implementation of CGPS? If so, which ones? (if Karen’s article comes later, use this question for her)
4. Can you think of experiences in your undergraduate career that you consider to be, at least in part, cognitive apprenticeship?
5. Does cognitive apprenticeship have any value over traditional instruction? If so, what?

Smith, K., Johnson, D., & Johnson, R. Cooperation in the college classroom. Handout. University of Minnesota.

This large handout is a good introduction to cooperative learning. Its principal author is a professor of civil engineering at the University of Minnesota who has collaborated with the Johnsons from the College of Education. We use cooperative learning in our labs and discussion sessions. This article is a useful reference, but for orientation, you are only required to read pages 2-6.

The following questions may help guide your reading:

1. What are some reasons to have students learn in cooperative groups?
2. What are the key concepts in structuring cooperative learning groups? State each in your own words.
3. What are the differences between cooperative learning groups and traditional learning groups? Which of these do you think are the most important? Why?

Cummings, K. & Marx, J. (1999). Evaluating innovation in studio physics. *Physics Education Research, American Journal of Physics Supplement*, 67(7), S38-S44.

1. How would you describe this education experiment in terms of the scientific method?
2. How do the non-traditional methods described by Cummings compare to methods described by Redish?
3. What did Cummings think were the most important points of CGPS?
4. What problems did Cummings have implementing CGPS?
5. Did Cummings draw any distinctions between regular groups and cooperative groups?
6. How were the traditional method, ILD, and CGPS compared? What conclusions about the pros and cons of each method might an administrator draw?

Sexual Harassment & Cheating

Equal Opportunity and Affirmative Action at the University of Minnesota, Booklet (1998).

This booklet is published by the university for all the faculty, staff, students, and visitors. It is intended to clarify any misunderstanding and fear that people might have about the university's policy. It is very important that you understand the policy and how it will affect you as a student and as a teacher.

Reading questions:

1. Why is there a sexual harassment policy at the University of Minnesota?
2. Have you seen or heard about behavior in any of the examples?
3. Do you agree with the booklet's definition of sexual harassment?
4. What will you do if you feel sexually harassed by a faculty member? A staff member? Another graduate student? One of your students?

University of Minnesota Board of Regents Policy on student conduct.

Shymansky, J.A., & Penick, J.E. (1979). Do laboratory teaching assistants exhibit sex bias? *Journal of College Science Teaching*, 8, 223-225.

This is a short paper on a study done at the University of Iowa, where the researchers asked the question of whether the behavior of lab instructors with students depend on the sex of the students.

Reading Questions:

1. Do you think there is enough evidence to support the two "basic assumptions" on page 223?
2. What do you think is the most interesting result of their study?

Seymour, E. (1992). Undergraduate problems with teaching and advising in SME majors – explaining gender differences in attrition rates. *Journal of College Science Teaching*, 21, 284-292.

There are high dropout rates from science, math, and engineering (SME) majors in both sexes. This article describes a study done on the reasons people drop out of SME majors, some of which are gender-specific.

Reading Questions:

1. What are some of the reasons that people drop out of SME majors? Were these factors at the school where you got your undergraduate degree? Do you expect that they are a factor at the University of Minnesota?
2. What are some gender differences in the reasons given for dropping out of SME majors?
3. What are the differences in what women and men describe as good teaching?

Appendix

Heller (2004). “What is Cooperative Problem Solving (CPS)?”

As noted in Karen Cummings, “Evaluating Innovation in Studio Physics,” working in groups is not more effective than traditional instruction. Cooperative problem solving involves actual group interactions and decision-making in solving a problem that rewards group behavior.

Here are some questions to consider when reading this article. Be prepared to discuss your thoughts in class.

1. What are characteristics of traditional group problem solving? How do these compare to cooperative group problem solving?
2. What skills does traditional group problem solving develop? What about for cooperative group problem solving?
3. What outcome does traditional group problem solving produce? What about for cooperative group problem solving?

Heller (2004). “How do Beginning Students Solve Problems?”

One of the major points of the summer orientation is that experts solve problems differently than novices do. An expert has an internalized problem-solving strategy, which may not always be used but is available if needed. Novices do not know how to solve problems efficiently, and must rely on other methods, such as plug-and-chug or pattern matching. This leads to specific problems in student performance.

1. What are the disadvantages to using plug-and-chug or pattern matching as problem-solving strategies?
2. What do you think might be evidence that a student is using one of the above mentioned strategies?

Heller, P., Keith, R., & Anderson, S. (1992). Teaching problem solving through cooperative grouping. Part 1: Group versus individual problem solving. *American Journal of Physics*, 60(7), 627-636.

Heller, P., Hollabaugh, M. (1992). Teaching problem solving through cooperative grouping. Part 2: Designing problems and structuring groups. *American Journal of Physics*, 60(7), 637-644.

This is the second part of a two-part article that describes some of the research that Pat Heller and her colleagues have done at the University of Minnesota. In this part, Heller and Hollabaugh discuss the types of problems that work best and how to form and maintain well-functioning cooperative groups.

The following questions may help guide your reading:

Pages 637-640: Designing Physics problems to Promote Effective Problem Solving

1. Why are standard textbook problems NOT effective in helping students use a more effective problem-solving strategy (heuristics) than their novice strategy of immediately plugging numbers into formulas?
2. How does the use of context-rich problems in an introductory physics course relate to McDermott's (1993) fifth generalization (E) about the failure of traditional instruction?
3. How does the use of context-rich problems help promote students' use of a more effective problem-solving strategy (heuristics)?
4. In what ways is cooperative-group problem solving of context-rich problems (part of the Minnesota Model for teaching introductory physics courses) similar to cognitive apprenticeship methods (Brown, Collins, and Duguid, 1989)? In what ways is it different? (Hint: See also Heller, Keith, and Anderson, 1992.)
 - a. Where is the "modeling" of problem solving done?
 - b. Where and how does the "coaching" of problem solving occur?

Pages 640-643: Forming and Maintaining Well-Functioning Cooperative Groups (Optional)

5. What is the "optimal" group size for physics problem solving?
6. What ability and gender composition of groups results in the best problem-solving performance?
7. How can problems of dominance by one student and conflict avoidance within a group be addressed?
8. How can groups be structured so students are concerned about the performance of all group members, as well as their own?