Graduate Seminar Course Summary and Reading List

Physics 708: Graduate Seminar in Teaching College Physics for Physicists

Suggested reading list for a seminar course introducing the ideas of physics education research.

This seminar provides an introduction to physics education research. Students in the seminar read and discuss recent developments in physics education at the university level. Reading lists are appropriate for two 2-hour discussion periods per week. One possible model is to have one of the students in the seminar present an overview and synthesis of some of the relevant articles and to lead a discussion. Another approach would be to have all of the students responsible for reading all of the papers and select one at random upon arrival to give a brief overview and lead a discussion.

Topics to be covered include:

- **common student misconceptions at the introductory level**
- **conceptual assessment methods,**
- **models of student cognition and learning**

In addition, some readings from relevant parts of the cognitive and educational literature are included.

Reading List

Week 1: General overview

1. **Mestre, Jose, "Learning and instruction in pre-college physical science", *Phys. Today* 44:9 (1991) 56-62.**
2. **Reif, F., "Scientific approaches to science education", *Phys. Today* 39:11 (1986)**
3. **McDermott, Lillian C., "Research on conceptual understanding in mechanics", *Phys. Today* 37 (1984) 24.**
4. **Redish, Edward F., "Implications of cognitive studies for teaching physics", *Am. J. Phys.* 62 (1994) 796-803.**

Week 2: Physics Education Background

1. **Arons, A. B., "Cultivating the capacity for formal reasoning", *Am. J. Phys.* 44 (1976) 834.**
2. **McKinnon, J. W., and J. W. Renner, "Are colleges concerned with intellectual development?", *Am. J. Phys.* 39 (1971) 1047-1052.**
3. **Van Heuvelen, A., "Learning to think like a physicist: A review of research-based instructional strategies", *Am. J. Phys.* 59 (1991) 891-897.**

Week 3: Kinematics

1. **Trowbridge, David E., and Lillian C. McDermott, "Investigation of student understanding of the concept of velocity in one dimension", *Am. J. Phys.* 48 (1980) 1020-1028.**
2. **Trowbridge, D. E., L.C. McDermott, "Investigation of student understanding of the concept of acceleration in one dimension", *Am. J. Phys.* 49 (1981) 242-253.**
3. **Viennot, L., "Spontaneous reasoning in elementary dynamics", *Eur. J. Sci. Educ*., 1 (1979) 205-221**
4. **Champagne, A., L. Klopfer, and J. Anderson, "Factors influencing the learning of classical mechanics", *Am. J. Phys.* 48 (1980) 1074-1079.**

Week 4: Dynamics -- Newton's Laws

1. **Minstrell, J., "Explaining the 'at rest' condition of an object", *The Physics Teacher* 20 (1982) 10-14.**
2. **McDermott, L. C., Peter S. Shaffer, and Mark D. Somers, "Research as a guide for teaching introductory mechanics: An illustration in the context of the Atwood's machine", *Am. J. Phys.* 62 (1994) 46-55.**
3. **Clement, J., "Students' Preconceptions in Introductory Mechanics", *Am. J. Phys.* 50 (1982) 66-71.**
4. **Galili, Igal and Varda Bar, "Motion implies force: where to expect vestiges of the misconception?", *Int. J. Sci. Education* 14:1 (1992) 63-81.**

Week 5: Models of Thinking / Scientific Thinking and Rationality

1. **Norman, Donald, "Some observations on mental models", in Gentner and Stevens, *Mental Models* (Lawrence Erlbaum Associates, 1983) 7-14**
2. **Clement, J., "Using bridging analogies and anchoring intuitions to deal with students' preconceptions in physics", *Jour. Res. Sci. Teaching* 30:10 (1993) 1241-1257.**
3. **Minstrell, J., "Facets of students' knowledge and relevant instruction" in Duit, R., F. Goldberg, and H. Niedderer, *Research in Physics Learning: Theoretical Issues and Empirical Studies*, Proceedings of the International Workshop, Ludwigsburg, Germany, Sept, 10-14, 1984 (IPN, Kiel Germany, 1985) 110-128**
4. **Kuhn, Deanna, "Children and adults as intuitive scientists", *Psych. Rev.* 96:4 (1989) 674-689.**
5. **Brown, J. S., A. Collins, P. Duguid, "Situated Cognition and the Culture of Learning", *Educational Researcher* 18:1 (Jan-Feb, 1989) 32-42.**

Week 6: Dynamics -- Energy and Momentum

1. **Lawson, R. A., and L. C. McDermott, "Student understanding of the work-energy and impulse-momentum theorems", *Am. J. Phys.* 55 (1987) 811-817.**
2. **Duit, R., "Understanding energy as a conserved quantity" *Eur. J. Sci. Education* 3 (1981) 201-301.**
3. **Conceptual Change**
4. **Posner, G. J., K. A. Strike, P. W. Hewson, and W. A. Gertzog, "Accommodation of a scientific conception: toward a theory of conceptual change", *Science Education* 66:2, 211-227 (1982).**

5. **Dykstra, Dewey, "Studying conceptual change: Constructing new understandings", in Duit, R., F. Goldberg, and H. Niedderer, *Research in Physics Learning: Theoretical Issues and Empirical Studies*, Proceedings of the International Workshop, Ludwigsburg, Germany, Sept, 10-14, 1984 (IPN, Kiel Germany, 1985) 40-58.**

Week 7: Assessment

1. **Hestenes, D., M. Wells, and G. Swackhammer, "Force Concept Inventory", *The Physics Teacher* 30:3 (1992) 141-158.**
2. **Hestenes, D., and M. Wells, "A Mechanics Baseline Test", *The Physics Teacher* 30:3 (1992) 159-166.**
3. **Halloun, Ibrahim A., and David Hestenes, "The initial state of college physics students", *Am. J. Phys.* 53 (1985) 1043-1056.**

Week 8: Constructivism and Cognitive Psychology

1. **Gardner, Howard, *The Mind's New Science: A History of the Cognitive Revolution* (Basic Books, 1985) 114-118 (at least)**
2. **Piaget, J., *The Construction of Reality in the Child* (Basic Books, 1954) selections from chapter 1.**
3. **Inhelder, B. and J. Piaget, *The Growth of Logical Thinking: From Childhood to Adolescence* (Basic Books, 1958) 1-19.**
4. **Sachs, Oliver, *The Man Who Mistook His Wife For A Hat and Other Clinical Tales* (Summit Books, 1985) 8-22.**

Week 9: Heat and Temperature

1. **Granville, M.F., "Student misconceptions in thermodynamics", *Journal of Chemical Education* 62:10 (1985) 847-848.**
2. **Tiberghien, A., "Critical review on the research aimed at elucidating the sense that notions of temperature and heat have for the students aged 10 to 16 years", in Delacôte, G., A. Tiberghien, and J. Schwartz (Eds.), *Research on Physics Education*, Proceedings of the First International Workshop, La Londe Les Maures, France (Éditions du CNRS, Paris, 1983) 75-90.**
3. **Wiser, M. and S. Carey, "When heat and temperature were one", in: Gentner and Stevens (Eds.), *Mental models* (Erlbaum, Hilldale NJ, 1983) 267-297**
4. **Hewson, M. G. and D. Hamlyn, "The influence of intellectual environment on conceptions of heat", *European Journal of Science Education* 6 (1984) 254-262.**

Week 10: Light and Optics

1. **La Rosa, C., M. Mayer, P. Patrizi, and M. Vicentini-Missoni, "Commonsense knowledge in optics: Preliminary results of an investigation into the properties of light", *Eur. J. of Sci. Education* 6:4 (1984) 387-397.**
2. **Goldberg, F. M., and L. C. McDermott, "An investigation of student understanding of the real image formed by a converging lens or concave mirror", *Am. J. Phys.* 55 (1987) 108-119.**
3. **Goldberg, F. M., and L. C. McDermott, "Student difficulties in understanding image formation by a plane mirror", *The Physics Teacher* 24 (1986) 472-480.**

Week 11: Problem Solving

1. **Reif, F., "Teaching problem solving -- A scientific approach", *The Physics Teacher* 19 (1981) 310.**
2. **Reif, F., and Joan I. Heller, "Knowledge structures and problem solving in physicists", *Educational Psychologist* 17 (1982) 102-127.**

3. **Chi, M. T. H., P. J. Feltovich, and R. Glaser, "Categorization and representation of physics problems by experts and novices", *Cognitive Science* 5 (1981) 121.**
4. **Dufresne, R., W. J. Gerace, P. T. Hardiman, and J. P. Mestre, "Constraining novices to perform expert like problem analyses: Effects on schema acquisition", *J. of the Learning Sciences* 2 (1992) 307-331.**

Week 12: Electricity and Magnetism Concepts

1. **Rainson, S., G. Tranströmer, and L. Viennot, "Students' understanding of superposition of electric fields", *Am. J. Phys.* 62 (1994) 1026-1032.**
2. **Törnkvist, S., K.-A. Pettersson, G. Tranströmer, "Confusion by representation: On student's comprehension of the electric field concept", *Am. J. Phys.* 61 (1993) 335-338.**
3. **Viennot, L., and S. Rainson, "Students' reasoning about the superposition of electric fields", *Int. J. Science Education* 14:4 (1992) 475-487.**
4. **Ferguson-Hessler, Monica G. M. and Ton de Jong, "On the quality of knowledge in the field of electricity and magnetism" *Am. J. Phys.* 55 (1987) 492-497.**

Week 13: Laboratories

1. **Séré, Marie-Genevieve, Roger Journeaux, and Claudine Larcher, "Learning statistical analysis of measurement errors", *Int. J. Sci. Education* 15:4 (1993) 427**
2. **Eylon, B., and F. Reif, "Effects of knowledge organization on task performance", *Cognition and Instruction* 1 (1984) 5-44.**
3. **Reif, F. and Mark St. John, "Teaching physicists' thinking skills in the laboratory", *Am. J. Phys.* 47 (1979) 950-957.**

Week 14: The Role of Mathematics in Learning Physics

1. **Schoenfeld, Alan H., "When good teaching leads to bad results: The disasters of 'well-taught' mathematics courses," *Educational Psychologist* 23:2 (1988) 145-166.**
2. **Schoenfeld, Alan H., "On mathematics as sense making: An informal attack on the unfortunate divorce of formal and informal mathematics," in Voss, Perkins, and Segal (Eds.), *Informal Reasoning and Education* (Erlbaum, Hillsdale NJ, 1991) 311-343.**
3. **Viennot, L., "Common practice in elementary algebra," *Eur. J. Sci. Ed.* 3:2 (1981) 183-194.**
4. **Clement, J., J. Lochhead, and G. S. Monk, "Translation difficulties in learning mathematics," *Am. Math. Monthly* 88 (1981) 286.**