

Syllabus



Basic Information

LOCATION: Room 220 Parkvale Bldg

TIMES: W 3:00-5:00 PM

CREDITS: 1

Grading: Letter Grades

Class Participation, including examples brought to class: 60%

Analysis of Instructional Case in final paper: 40%

Texts:

Willingham, D. (2009). *Why Don't Students Like School?* San Francisco: Jossey-Bass. [This may seem like a strange book for a graduate course in medicine, but it turns out to be a very efficient way to get into the key concepts that will drive discussion throughout the course. It also has pointers to a lot more basic sources, and we will supplement it with some other readings.]

Links to the four papers cited below are found immediately below these references.

Pashler, H., Bain, P., Bottge, B., Graesser, A., Koedinger, K., McDaniel, M., & Metcalf, J. (2007). *Organizing Instruction and Study to Improve Student Learning* (NCER 2007-2004). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education.

Graesser, A.C., Halpern, D.F., Hake, M. (2008). *25 Principles of Learning*. Washington, DC: Taskforce on Lifelong Learning at Work and at Home. Retrieved from www.psyc.memphis.edu/learning/whatwewknow/index.shtml

Zhang, J., Patel, V., Johnson, T. & Shortliffe, E., (2004). A cognitive taxonomy of medical errors, *Journal of Biomedical Informatics* 37, 193–204.

Embrey, D. (undated). *Understanding Human Behaviour and Error*. www.humanreliability.com/articles/Understanding%20Human%20Behaviour%20and%20Error.pdf



Core Readings

[\[Graesser Report\]](#) (84.405 Kb)

[\[Embrey paper\]](#) (213.359 Kb)

[\[Pashler paper\]](#) (924.931 Kb)

[\[Zhang paper\]](#) (223.632 Kb)



Course Director

Professor Alan Lesgold

Email

al@pitt.edu

Work Phone

412-648-1773

Office Location

5616 Posvar Hall

(School of Education, Office of the Dean)

Office Hours

Please schedule appointments with Ms. Susan Sherlock, 412-648-1738,

sks@pitt.edu, or Ms. Jill Braithwaite, 412-624-2909, jillb@pitt.edu

Personal Link

<http://www.education.pitt.edu/>

Notes

I am dean of the School of Education and also have appointments in Psychology, Intelligent Systems, and the Learning Research and Development Center.



>



Final Assignment

Due November 15

Take a current instructional problem you face as a medical educator and discuss which principles of learning covered in the course might apply to that problem and how those principles might lead to improved approaches to training.



Basic Approach

Of the nine class meetings, seven will be devoted to discussion of key principles of learning and how they relate to medical education. The key drivers for this discussion will be two recently proposed list of such principles and the daily experience of fellows in teaching newer colleagues their medical specialties. The remaining two sessions will be devoted to a discussion of medical errors, their cognitive origins, and known approaches to controlling errors rooted in limits of cognitive processing.

Instruction and Training

Willingham, D. T. (2009). *Why don't students like school?* San Francisco: Jossey-Bass. [book is available from Amazon at low cost]

This book may seem inappropriate, but in fact it contains an extremely readable presentation and defense of key principles of learning and teaching that have an extensive body of research behind them. Both more and less technical references are provided for each principle. The key principles introduced are:

- People are naturally curious, but they are not naturally good thinkers.
- Factual knowledge precedes skill.
- Memory is the residue of thought.
- We understand new things in the context of things we already know.
- Proficiency requires practice.
- Cognition is fundamentally different early and late in training.
- Learners are more alike than they are different in terms of the progression of learning.
- Intelligence can be changed through sustained hard work.
- Teaching, like any complex cognitive skill, must be practiced to be improved.

Pashler, H., Bain, P., Bottge, B., Graesser, A., Koedinger, K., McDaniel, M., & Metcalf, J. (2007). *Organizing Instruction and Study to Improve Student Learning* (NCER 2007-2004). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education. [report will be available via Blackboard]

This recent report also presents a set of basic principles of instruction, this time only seven, because of extremely specific standards of evidence imposed by the agency that commissioned the report. The principles are:

- Space learning over time.
- Interleave worked example solutions with problem solving exercises.
- Combine graphics with verbal descriptions.
- Connect and integrate abstract and concrete representations of concepts.
- Use quizzing to promote learning.
- Help students allocate study time effectively.
- Ask deep explanatory questions.

Graesser, A.C., Halpern, D.F., Hakel, M. (2008). *25 Principles of Learning*. Washington, DC: Taskforce on Lifelong Learning at Work and at Home. Retrieved from www.psyc.memphis.edu/learning/whatwewknow/index.shtml

The 25 principles put forward by this task force of the American Psychological Association are especially helpful, as they bridge more clearly to the psychological literature while still having definite implications for effective teaching and training. *We will take the first two classes to go through these principles in a bit of detail and to explain them and tie them to medical education. Then, in the next five classes, we will consider examples from students' specialty areas that illustrate or could benefit from application of these principles.*

1. **Contiguity Effects.** Ideas that need to be associated should be presented contiguously in space and time.
2. **Perceptual-motor Grounding.** Concepts benefit from being grounded in perceptual motor experiences, particularly at early stages of learning.
3. **Dual Code and Multimedia Effects.** Materials presented in verbal, visual, and multimedia form richer representations than a single medium.
4. **Testing Effect.** Testing enhances learning, particularly when the tests are aligned with important content.
5. **Spacing Effect.** Spaced schedules of studying and testing produce better long-term retention than a single study session or test.
6. **Exam Expectations.** Students benefit more from repeated testing when they expect a final exam.
7. **Generation Effect.** Learning is enhanced when learners produce answers compared to having them recognize answers.
8. **Organization Effects.** Outlining, integrating, and synthesizing information produces better learning than rereading materials or other more passive strategies.
9. **Coherence Effect.** Materials and multimedia should explicitly link related ideas and minimize distracting irrelevant material.
10. **Stories and Example Cases.** Stories and example cases tend to be remembered better than didactic facts and abstract principles.
11. **Multiple Examples.** An understanding of an abstract concept improves with multiple and varied examples.
12. **Feedback Effects.** Students benefit from feedback on their performance in a learning task, but the timing of the feedback depends on the task.
13. **Negative Suggestion Effects.** Learning wrong information can be reduced when feedback is immediate.
14. **Desirable difficulties.** Challenges make learning and retrieval effortful and thereby have positive effects on long-term retention.
15. **Manageable Cognitive Load.** The information presented to the learner should not overload working memory.
16. **Segmentation Principle.** A complex lesson should be broken down into manageable subparts.
17. **Explanation Effects.** Students benefit more from constructing deep coherent explanations (mental models) of the material than memorizing shallow isolated facts.
18. **Deep questions.** Students benefit more from asking and answering deep questions that elicit explanations (e.g., why, why not, how, what-if) than shallow questions (e.g., who, what, when, where).
19. **Cognitive Disequilibrium.** Deep reasoning and learning is stimulated by problems that create cognitive disequilibrium, such as obstacles to goals, contradictions, conflict, and anomalies.
20. **Cognitive Flexibility.** Cognitive flexibility improves with multiple viewpoints that link facts, skills, procedures, and deep conceptual principles.
21. **Goldilocks Principle.** Assignments should not be too hard or too easy, but at the right level of difficulty for the student's level of skill or prior knowledge.
22. **Imperfect Metacognition.** Students rarely have an accurate knowledge of their cognition so their ability to calibrate their comprehension, learning, and memory should not be trusted.

23. **Discovery Learning.** Most students have trouble discovering important principles on their own, without careful guidance, scaffolding, or materials with well-crafted affordances.
24. **Self-regulated Learning.** Most students need training on how to self-regulate their learning and other cognitive processes.
25. **Anchored Learning.** Learning is deeper and students are more motivated when the materials and skills are anchored in real world problems that matter to the learner.

Medical Errors

Zhang, J., Patel, V., Johnson, T. & Shortliffe, E., (2004). A cognitive taxonomy of medical errors, *Journal of Biomedical Informatics* 37, 193–204. [article available from Blackboard]

Embrey, D. (undated). *Understanding Human Behaviour and Error*.
www.humanreliability.com/articles/Understanding%20Human%20Behaviour%20and%20Error.pdf

We will consider the range of sources of medical error suggested by these two key review articles and then discuss examples brought by the students in the class of their own experiences with medical errors, trying to understand the source and possible remediation of each.



Course Schedule

Overview

Wednesday, September 2

Wednesday, September 9

During the first two class meetings, we will review the various principles of learning that are covered in the Willingham book and in the report by Pashler and the compilation by Graesser. The goal will be to identify key principles that can be applied to the design of training approaches in medicine. Ideally, students will have read or at least skimmed the Willingham book prior to the first class meeting. The remaining readings should have been read prior to the second class meeting.

A key principle that we will focus on first is that memory is the residue of thought. This principle encapsulates the basics of how learning takes place. Each of the other principles will be reviewed in the context of this key principle. For example, that we understand new things in the context of what we already know follows from the basic mechanism of learning, which associates states of mind with cognitive and motor actions. A second key principle, that spans several of those listed in the three primary reference sources, is that cognitive capacity is limited. Most of the other principles, including the differences between thinking early and late in the course of training, come from that. Moreover, since there are only certain ways that a sequence of mental actions can be created (something for memory to be the residue of), it follows that learners will be as alike as their experience bases.

After we have done a bit of basic exploring of the core principles of learning, we'll go through all of the principles on the three lists and tie each to a simple medical education situation or to some other learning situation that we are all likely to be familiar with.

Applying the Principles to Medical Education

September 16 - October 14

We'll take the next five classes to discuss specific medical education problems that students bring to class and to apply the principles of learning to them.

Practice

Wednesday, September 16, 2009

In past years' classes, a number of training issues involving practice have been brought to the class. For example, there are areas of history taking and other medical data gathering that are often missed by new physicians. What can a fellow do to help minimize this problem. There are cognitive skills of medicine that need to be practiced, including techniques for getting certain kinds of information from patients, techniques for educating patients about the importance of certain life changes and how to make them, office hour time management, etc.

Assignment

For this class, please come prepared to discuss in detail a specific problem that you have encountered as a teacher/mentor that involves the practice and refinement of basic medical skills.

Activity

We will take the examples brought to class and apply the principles of learning to them, focusing on how the principles might lead to better training.

Problem Solving

Wednesday, September 23, 2009

Much of the practice of medicine is problem solving, making diagnostic decisions and decisions about optimal treatments. In this session, students will bring examples from their experience of difficult-to-teach aspects of problem solving.

Assignment

Bring to class an example of a medical education situation in which you have found yourself that involves a difficult issue of diagnosis or treatment selection.

Activity

We will consider these examples in light of the principles of learning. A key principle to be considered in depth is that of limited cognitive capacity, as well as other principles that derive from that.

Complex Procedures

Wednesday, September 30, 2009

In some medical specialties, much of training consists of learning how to perform complex procedures. As imaging systems and distal effectors (such as robots and tools connected to imaging devices) have become more prevalent and more powerful, there is need for continual retraining of physicians and surgeons in the use of new tools. In this class session, we will consider key principles that apply to providing mentored practice in doing complex procedures.

Assignment

Bring to class an example of a procedure that is difficult to learn that you need to deal with in your role as a medical educator. It can be a surgical procedure, but it also can be a data-gathering procedure (e.g., for people early in training, auscultation).

Activity

We will apply principles of learning to identifying what makes training in these procedures difficult and also to the design of improved approaches.

Embedding Instruction in Clinical Work Situations

Wednesday, October 7, 2009

Much of medical education takes place in clinical contexts. Senior house staff and attendings work with new physicians and medical students in hospitals and clinics, using the course of medical care for patients to present teaching opportunities. In this session, we will consider the particular issues of training that are of special importance because of this approach. Learning by doing with reflection afterwards is a powerful approach to education; we will look at why that is and what maximizes the power of the approach.

Assignment

There is no advance assignment for this class. However, as topics are discussed, students will be asked to think of examples from their own work that support or challenge the points being made.

Key Steps in Designing Instruction

Wednesday, October 14, 2009

Assignment

Each student will be prepared to discuss in rough terms his/her plans for the final assignment.

Activity

We will, as a class, consider ways in which the ideas put forth by each student might be strengthened further. We also will do a quick scan of the range of final topics to see if there are particular areas of instructional principle that no one has addressed.

Medical Errors and their Implications for Medical Education

Monday, October 29

Wednesday, October 31

Learning Objectives

Be able to apply the several models of human error to the case of medical error.

Assignment

Bring to class one example of a consequential medical error with which you had some relatively direct experience.

Activity

We will review the literature on medical errors and consider, given what we have learned throughout the course, how different kinds of errors can best be prevented. In some cases, this will involve training, but in other cases, the best approach may be various safeguards that can be built into the care delivery system. We will consider the core research on medical errors in light of the examples brought to class and also will consider whether it is possible to improve training or make other systemic changes that might decrease the likelihood of such errors.



Readings In Addition to Textbook

Interesting Readings

These readings are not required for the course but may be useful in your future work.

Azevedo, R. and Lajoie, S. P. (1998). The cognitive basis for the design of a mammography interpretation tutor. *International Journal of Artificial Intelligence in Education*, 9, 32-44.

Boshuizen, H. P. A., & Schmidt, H. G. (1992). On the role of biomedical knowledge in clinical reasoning by experts, intermediates and novices. *Cognitive Science*, 16, 153-184.

Boshuizen, H. P. A., Schmidt, H. G., Custers, E. J. F. M., & van de Wiel, M. W. (1995). Knowledge development and restructuring in the domain of medicine: The role of theory and practice. *Learning and Instruction*, 5, 269-289.

- Capon, N., & Kuhn, D. (2004). What's So Good About Problem-Based Learning? *Cognition and Instruction*, 22, 61-79.
- Coderre, S., Mandin, H., Harasym, P. H., & Fick, G. H. (2003). Diagnostic reasoning strategies and diagnostic success. *Medical Education*, 37, 695-703.
- Dörner, D., & Schaub, H. (1994). Errors in planning and decision making and the nature of human information processing. *Applied Psychology: An International Review*, 43, 433-453.
- Embrey, D. (undated). *Understanding Human Behaviour and Error*. <http://www.humanreliability.com/Understanding%20Human%20Behaviour%20and%20Error.pdf>
- Engeström, Y. (1995) Objects, contradictions and collaboration in medical cognition: an activity-theoretical perspective, *Artificial Intelligence in Medicine*, 7(5), 395-412.
- Farrow, R., & Norman, G. (2003). The effectiveness of PBL: the debate continues. Is meta-analysis helpful? *Medical Education*, 37, 1131-1132.
- Forbus, K., Gentner, D., & Law, K. (1995). MAC/FAC: A model of similarity-based retrieval. *Cognitive Science*, 19, 141-205.
- Garland, A. (2005). Improving the ICU, Part 2. *Chest*, 127(6), 2165-79.
- Groopman, J. *How doctors think*. (2007). Boston: Houghton Mifflin.
- Hatala, R. M., Brooks, L. R., & Norman, G. R. (2003). Practice Makes Perfect: The Critical Role of Mixed Practice in the Acquisition of ECG Interpretation Skills, *Advances in Health Sciences Education*, 8, 17-26.
- Heine, M. F., & Lake, C. L. (2004). Nature and prevention of errors in Anesthesiology. *Journal of Surgical Oncology*, 88 (3), 143-152.
- Klein, G., & Klinger, D. (2001). Naturalistic Decision Making. (2000). *Human Systems IAC GATEWAY*, 11 (3), 16-20. See <http://iac.dtic.mil/hsiac/Gateway.htm#Past>
- Kushniruk, A. W. (2001). Analysis of complex decision-making processes in health care: cognitive approaches to health informatics. *Journal of Biomedical Informatics*, 34, 365-376.
- Lesgold, A., & Nahemow, M. (2001). Tools to assist learning by doing: Achieving and assessing efficient technology for learning. In D. Klahr & S. Carver (Eds.), *Cognition and instruction: Twenty-five years of progress*. Mahwah, NJ: Erlbaum.
- Lipshitz, R., Klein, G., Orasanu, J. & Salas, E. (in press). Taking stock of naturalistic decision making. *Journal of Behavioral Decision Making*.
- Lowenstein, J., Thompson, L., & Gentner, D. (2003). Analogical learning in negotiation teams: Comparing cases promotes learning and transfer. *Academy of Management Learning and Education*, 2(2), 119-128.
- Martenson D. (2001). Learning: current knowledge and the future. *Medical Teacher*, 23, 19 - 197.
- Neerincx, M. A. (1995). Harmonizing tasks to human knowledge and capacities. Dissertation. Groningen: University Library Groningen. Available online from <http://www.ub.rug.nl/eldoc/dis/ppsw/m.a.neerincx/>
- Norman, D. A. (1981). Categorization of action slips. *Psychological Review*, 88, 1-15.

- Norman, G. (2002). Research in medical education: three decades of progress. *British Medical Journal*, 324, 156 - 1562.
- Ohlsson, S. (2007). The effect of order: Constraint-based explanation. Pp. 151-168. In F. E. Ritter, J. Nerb, E. Lehtinen, & O'Shea, T. M. (Eds.), *In order to learn: How the sequence of topics influences learning*. Oxford: Oxford University Press.
- Patel, V. L. & Arocha, J. F., & Kaufman, D. R. (2001). A primer on aspects of cognition for medical informatics. *Journal of American Medical Informatics Association*, 8, 324-343.
- Prince, M., (2004). Does Active Learning Work? A Review of the Research. *Journal of Engineering Education*, 93(3), 223 - 31.
- Reason, J. (2000). Human error: models and management. *British Medical Journal*, 320, 768 - 70. Available from <http://bmj.com/cgi/reprint/320/7237/768.pdf>
- Reye, J. (2004). Student modeling based on belief networks. *International Journal of Artificial Intelligence in Education* 14, 1 - 3.
- Rikers, R. M. J. P., Loyens, S. M. M., & Schmidt, H. G. (2004). The role of encapsulated knowledge in clinical case representations of medical students and family doctors. *Medical Education*, 38, 1035 - 043.
- Shortliffe, E. H., Patel, V. L., Zhang, J., & Freed, M. (2000). Slips, mistakes and faulty reasoning: The nature of human errors in medicine. *Proceedings of 2000 American Medical Informatics Association Annual Meeting*.
- Small, S. D., Wuerz, R. C., Simon, R., Shapiro, N., Conn, A., & Setnik, G. (1999). Demonstration of High-fidelity Simulation Team Training for Emergency Medicine. *Academic Emergency Medicine*, 6 (4), 312-323.
- Stevens, R., Johnson, D. F., & Soller, A. (2005). Probabilities and Predictions: Modeling the Development of Scientific Problem-Solving Skills. *Cell Biology Education*, 4, 42-57.
- Tan, J., Wen, H. J., & Awad, N. (2005). Health care and services delivery systems as complex adaptive systems. *Communications of the ACM*, 48 (5), 36-44.
- Thompson, L., Gentner, D., & Lowenstein, J. (2000). Avoiding missed opportunities in managerial life: Analogical training more powerful than individual case training. *Organizational Behavior and Human Decision Processes*, 82, 60 - 75.
- van Welie, M., van der Veer, G. C., & Eliëns, A. (1998). *Euterpe - Tool support for analyzing cooperative environments*. Ninth European Conference on Cognitive Ergonomics, Limerick, Ireland.
- Vicente K. (2002). From patients to politicians. a cognitive engineering view of patient safety. *Quality and Safety in Health Care*, 11(4), 302-304.
- Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, 9(4), 625-636.
- Zhang, J., Patel, V. L., & Johnson, T. R. (2002). Medical Error: Is the Solution Medical or Cognitive? *Journal of the American Medical Informatics Association*, 9 (Nov-Dec supplement), S75 - S77. Available from within the Pitt network as http://www.jamia.org/cgi/reprint/9/6_suppl_1/S75.pdf
- Zhang, J., Patel, V., Johnson, T. & Shortliffe, E., (2004). A cognitive taxonomy of medical errors, *Journal of Biomedical Informatics* 37, 193 - 204.



Course Policies

Academic Integrity:

Students in this course will be expected to comply with the [University of Pittsburgh's Policy on Academic Integrity](#). Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and programmable calculators.

Disabilities:

If you have a disability that requires special testing accommodations or other classroom modifications, you need to notify both the instructor and the [Disability Resources and Services](#) no later than the 2nd week of the term. You may be asked to provide documentation of your disability to determine the appropriateness of accommodations. To notify Disability Resources and Services, call 648-7890 (Voice or TTD) to schedule an appointment. The Office is located in 216 William Pitt Union.



Copyright Notice

These materials may be protected by copyright. United States copyright law, 17 USC section 101, et seq., in addition to University policy and procedures, prohibit unauthorized duplication or retransmission of course materials. See [Library of Congress Copyright Office](#) and the [University Copyright Policy](#).



Course Requirements and Grading

There will be small assignments for each class - involving coming to class with specific examples from medical experience or medical education experience that meet criteria set by the instructor. These examples will allow us to better discuss the topic of the day and to tie it clearly to medical education and medical practice.

In addition, there will be a final assignment that will involve considering a specific component of medical education and discussing how it can be done better taking into account content covered during the course.



G-Grade Policy

If there are unusual circumstances that prevent completion of the final assignment by the due date, an extension can be given until the end of Fall Term. In extreme circumstances, if an arrangement is made by December 15th, a G grade can be given and the work completed no later than February 1st.



Accessibility

Blackboard 5.5 is ADA Compliant and has fully implemented the final accessibility standards for electronic and information technology covered by Section 508 of the Rehabilitation Act Amendments of 1998. Please note that, due to the flexibility provided in this product, it is possible for some material to inadvertently fall outside of these guidelines.