INSTRUCTIONAL DESIGN FOR DEVELOPING EXPERTISE

Rebecca L. Fiedler, Ph.D.
Kaner, Fiedler & Associates, LLC

AN EXPERT IS . . .

- "someone widely recognized as a reliable source of technique or skill whose faculty for judging or deciding rightly, justly, or wisely is accorded authority and status by their peers of the public in a specific well-distinguished domain. An expert, more generally, is a person with extensive knowledge or ability based on research, experience, or occupation and in a particular area of study." (Wikipedia, Jan 20, 2014)
- "the distinguished or brilliant journeyman, highly regarded by peers, whose judgments are uncommonly accurate and reliable, whose performance shows consummate skill and economy of effort, and who can deal effectively with certain types of rare or "tough" cases. Also, an expert is one who has special skills or knowledge derived from extensive experience with subdomains." (Adapted from Hoffman, 1998 as cited in Chi, 2006)

EXPERTS

Excel

- Generate the best solutions
- Detect and recognize features or structures novices cannot
- Self-monitor
- Choose appropriate strategies
- Are opportunistic in using available information & resources
- High performers with little cognitive effort

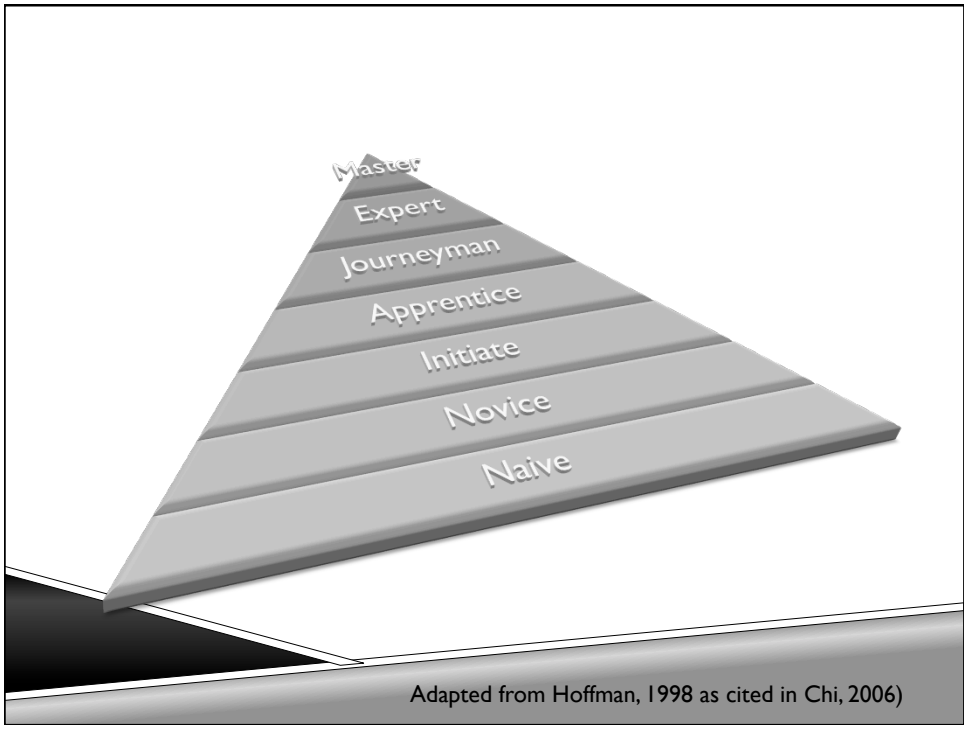
Fall short

- Limited to their domain
- Overly confident
- Gloss over details
- Inflexible
- Inaccurate predictions, judgment & advice regarding novices
- Bias and functional fixedness

Chi, 2006

TWO RESEARCH APPROACHES

- Expertise is absolute. Experts have innate talent or genetic advantage.
- Expertise is relative. It lies on a continuum. Novices can achieve expert-level performance.



Adapted from Hoffman, 1998 as cited in Chi, 2006)

A USEFUL DISTINCTION

- Expert
- Elite

"One way of looking at this might be that for 42 years, I've been making small, regular deposits in this bank of experience, education and training. And on January 15 the balance was sufficient so that I could make a very large withdrawal."

--Chesley Sullenberger

EXPERTISE REQUIRES PRACTICE

- Deliberate practice
- "a technique involving a learner's full mental engagement and oriented on the goal of overcoming current performance boundaries"
- This often requires problem-solving and better methods
- Ericsson (1990)

CONDITIONS FOR IMPROVEMENT

Individuals significantly improved performance when the following conditions were met:

1. Given a task with a well-defined goal
2. Motivated to improve
3. Provided with feedback, and
4. Provided with ample opportunities for repetition and gradual refinements of their performance.

(Ericsson, 2008)

BIGGEST CHALLENGE - TRANSFER

"The ability to perform an acquired skill in new, unfamiliar situations. A distinction can be made between near transfer, where the transfer tasks closely resemble the trained tasks, and far transfer, where the tasks are different from the trained tasks."

--Merrienboer (1997)

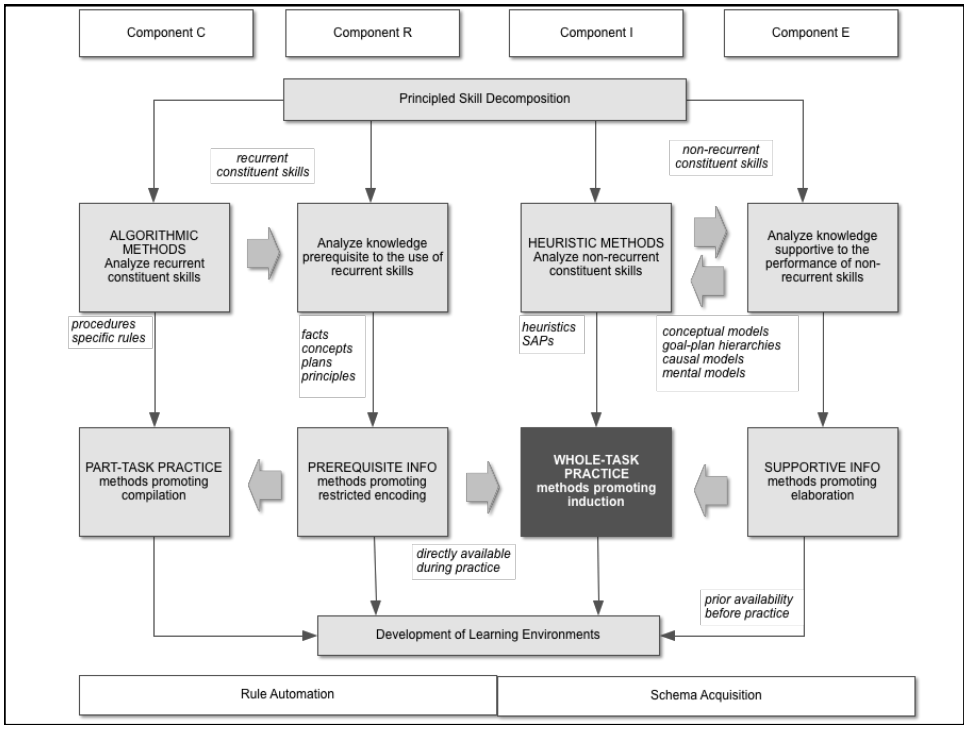
4 CAUSES OF FAILURE

1. Workplace lacks a culture of transfer
2. General skills don't transfer to specific job requirements
3. Training for the "how" but not the "why"
4. Learning is context bound

Clark, 2008

SCHEMA/MENTAL MODEL

- "A knowledge structure stored in long-term memory that is the basis for expertise." – Ruth Colvin Clark, 2008
- "Describes an organized pattern of thought or behavior that organizes categories of information and the relationships among them. It can also be described as a mental structure of preconceived ideas, a framework representing some aspect of the world, or a system of organizing and perceiving new information. . . Schemata can help in understanding the world and the rapidly changing environment. People can organize new perceptions into schemata quickly as most situations do not require complex thought when using schema, since automatic thought is all that is required. "—Wikipedia, Jan 23, 2014



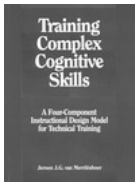
REFLECTIVE EXPERTISE

"The ability to solve new problems, or to perform a complex cognitive skill in new situations by (1) application of domain-specific rules or productions to perform familiar aspects of the task, and (2) the conscious use of cognitive schemata to solve unfamiliar aspects of the task."

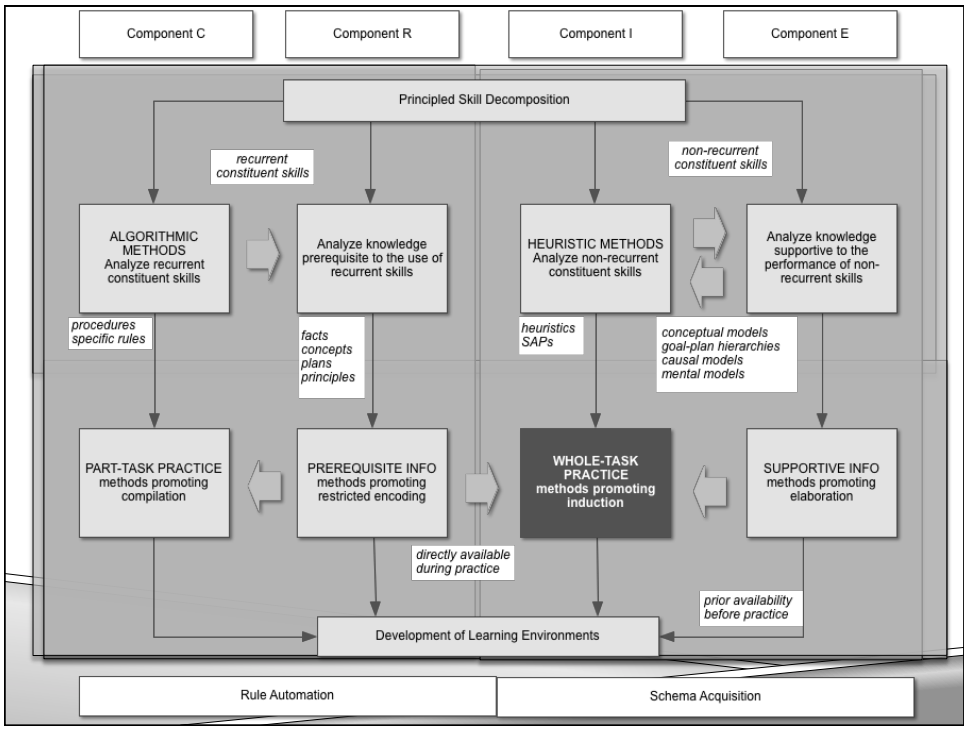
-Merrienboer (1997)

REFERENCES

- Training Complex Cognitive Skills: A Four-Component Instructional Design Model for Technical Training by Jeroen J.G. van Merrienboer



- Ten Steps to Complex Learning: A Systematic Approach to Four-Component Instructional Design by Jeroen J.G. van Merrienboer and Paul A. Kirschner



IDEAS ABOUT TRANSFER

- Formal discipline
- Identical elements
- Mental models

	Zero	Near	Moderate	Far
Description	No transfer from instructional environment to job	Transfer of step-by-step skills as learned in training to the job; ability to solve well-defined routine problems practiced during training	Transfer of skills to new situations or problems not encountered in training. Ability to solve non-routine problems not encountered in training.	Invention of new solutions not addressed in training. Ability to solve ill-defined problems not encountered in training
Example	Learners complete class that demonstrates spreadsheets but are unsuccessful when trying to use them 3 months later to prepare budget reports	Learners complete spreadsheet class and work with job aids to produce routine budget reports on the job as practiced in training.	Learners complete spreadsheet class and create new formulas and spreadsheets to apply to inventory tasks not discussed in class	Learners design spreadsheets and report formats for use by revenue managers throughout the organization
Resulting from	New skills not learned during training/New skills not applicable to the job/ New skills learned but not supported in work environment	Rote learning of routine tasks/Practice of procedures/Step-by-step working aids	Learning the how and why of tasks/Building mental models that support understanding/ Practice with multiple contexts/Strategic working aids	Deep knowledge/ Collaborative work/ Thinking outside domain-specific solutions/High productivity/Cultures that encourage innovative thinking
Based on	Lack of knowledge/Lack of working aids/Lack of job standards, feedback, incentives, etc.	Emphasis on factual and procedural knowledge	Emphasis on conceptual, process, and strategic knowledge Crystallized intelligence	Emphasis on conceptual, process, strategic, and metacognitive knowledge Crystallized and fluid intelligence

Ruth Colvin Clark, 2008

TWO MORE THOUGHTS

- Surface vs deep structure
- Transfer and intelligence

MENTAL MODELS

- "Allow you to distinguish and generalize concepts,
- Solve problems,
- Make predictions, and
- Interpret situations.
- Two types
  - Simple – Supports cognitive operations such as discrimination and generalization of concepts and situations and implementation of routine procedures.
  - Complex –Mental models that support problem-solving – both routine and novel."

Clark, 2008

EXPLICIT INSTRUCTIONAL METHODS

- Elaborative practice exercises
- Distributed practice
- Explanatory feedback
- Effective questioning techniques
- Actively engage learners
- Effective collaborative learning activities
- Provide lecture notes or job aids
- Worked examples
- Modeling
- Process worksheets/cognitive tools

ELABORATIVE PRACTICE

- Simulations of the work environment with authentic tasks
- Make decisions based on specific job tasks
- Argumentation

DISTRIBUTED PRACTICE

- Exactly what it sounds like – practice throughout training rather than just at the end

EXPLANATORY FEEDBACK

- Implicit vs. instructional feedback or both
- More than correct or incorrect. Includes explanations.

EFFECTIVE QUESTIONING TECHNIQUES

- Open-ended
- Stimulate elaborative rather than maintenance rehearsal
- Show a sample and ask students to draw on lesson content to analyze

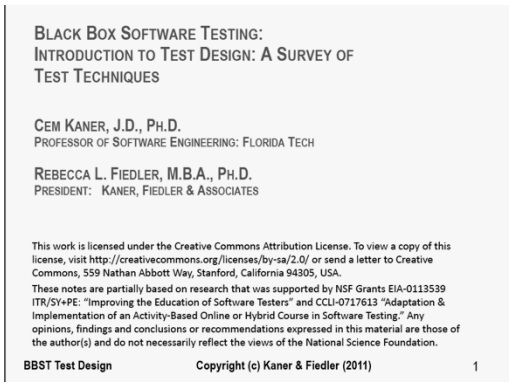
ACTIVELY ENGAGE LEARNERS

- Assign real-world tasks
- Require students to explain their work and their thinking
- Peer reviews are helpful here, too.

EFFECTIVE COLLABORATIVE LEARNING ACTIVITIES

- Structured tasks
- Groups of 2-5 so everyone has a chance to participate
- Heterogeneous groups
- Collaborative assignment that requires input from everyone
- Grades should depend on individual contributions

PROVIDE LECTURE NOTES OR JOB AIDS



BLACK BOX SOFTWARE TESTING:
INTRODUCTION TO TEST DESIGN: A SURVEY OF TEST TECHNIQUES

CEM KANER, J.D., PH.D.
PROFESSOR OF SOFTWARE ENGINEERING: FLORIDA TECH

REBECCA L. FIEDLER, M.B.A., PH.D.
PRESIDENT: KANER, FIEDLER & ASSOCIATES

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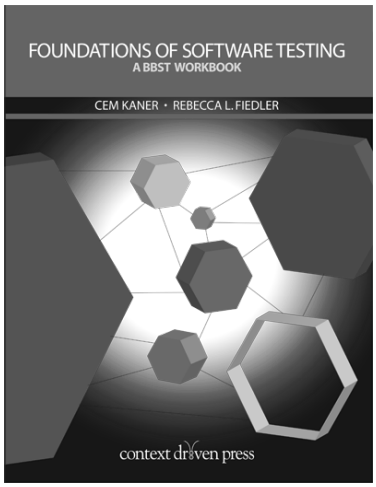

WORKED EXAMPLES

- The study of examples that are already worked out
  - Describe a situation
  - Set a goal
  - Provide a good solution

MODELING

- Experts modeling how they approach a problem

PROCESS WORKSHEETS/COGNITIVE TOOLS

- Also known as scaffolding

SUMMARY

- Training fails if students can't transfer what they learned to the workplace
- Make explicit instructional design decisions to foster schema acquisition
- Schemata are the basis of expertise

REFERENCES

- Chi, M.T.H., (2008). Two Approaches to the Study of Experts' Characteristics in The Cambridge Handbook of Expertise and Expert Performance edited by Ericsson, Charness, Feltovich and Hoffman.
- Clark, R.C., Building Expertise: Cognitive Methods for Training and Performance Improvement. (3rd ed.) San Francisco: Pfeiffer.
- Ericsson, K.A., (1990). Deliberate Practice and Acquisition of Expert Performance: A General Overview in Academic Emergency Medicine, vol 15, no. 11
- Merrienboer, J.J., (1997). Training Complex Cognitive Skills: a Four-Component Instructional Design model for technical training. Englewood Cliffs, N.J. Educational Technology Publications.
- Merrienboer, J.J., Clark, R.E., & Croock, MB.M de (2002). Blueprints for Complex Learning: The 4C/ID-Model in Educational Technology Research & Development, 50 (2).
- Merrienboer, J.J. & Kirschner, P.A. (2007). Ten Steps to Complex Learning: A systematic approach to four-component instructional design. Mahwah, N.J.: Lawrence Erlbaum Associates.
- Wikipedia, Chesley Sullenberger at http://en.wikipedia.org/wiki/Sullenberger. Retrieved Jan 20, 2014.
- Wikipedia, Expert at http://en.wikipedia.org/wiki/Expert. Retrieved Jan 20, 2014.
- Wikipedia, Schema (psychology) at http://en.wikipedia.org/wiki/Schema_%28psychology. Retrieved Jan 23, 2014.