Teaching for Transfer in the Statistics Classroom

Matthew D. Beckman
University of Minnesota

February 24, 2015

Outline

Definitions

Motivation

Promoting Successful Transfer

Small Group Discussion

Transfer & Statistical Thinking

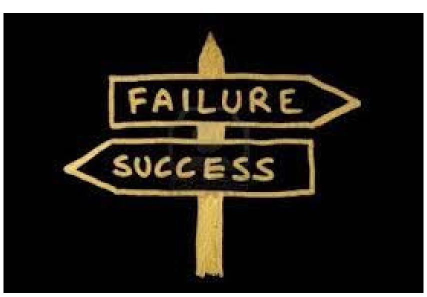
Transfer101

- Cognitive Transfer
  - Foundational issue to Western education paradigm
  - pertains to "how knowledge in one situation applies (or fails to apply) in other situations" (Singley & Anderson, 1989)
  - Knowledge from one context reaching out to enhance another (Perkins & Salomon, 1988)
- Many analogous terms and topics are studied throughout learning and psychology literature
  - expertise, synthesis, understanding, analogical reasoning
  - statistical thinking (e.g., Wild & Pfannkuch, 1999; Garfield et al., 2012)
  - skill specificity (obstacle of transfer)

Motivation

- "Undergraduate programs in statistics should equip students with problem solving skills they can effectively apply, build on, and extend over time"
  - ASA Guidelines for Undergraduate Programs (November, 2014)
- "Many introductory courses contain too much material, and students end up with a collection of ideas that are understood only at surface level, are not well integrated, and are quickly forgotten."
  - GAISE College Report (2012)
- Even students that do well in introductory statistics are unable to transfer that learning to novel applications (Ben-Zvi & Garfield, 2005)

Teaching for Transfer



FAILURE to Transfer

- "Transfer does not take care of itself" (Perkins & Salomon, 1988) even when contexts are remarkably similar
- Regardless of the distance or direction of transfer intended, successful outcomes require intentional effort
- Garfield (2002) explained that statistics instructors often present concepts and procedures expecting students to develop statistical reasoning or thinking through opportunities to apply content with software and data sets, but it seems this is simply not enough

Promoting Successful Cognitive Transfer

- Develop rich, interconnected schema
  - Students arrive with an existing schema network
  - Work toward abstraction and flexibility of cognitive elements
  - Context is important
- Metacognition
  - Sub-goals help with strategic thinking and organization
  - Worked examples & self-explanation promote high-road transfer
  - Again, context is important
- Manage cognitive load
  - Intrinsic & extrinsic components to cognitive load (Sweller, 1994)
  - Automation of cognitive processes reduces burden (Sternberg, 1998)

Small Group Discussion

- What are some things you could do to boost transfer outcomes in your classroom?
- What are some obstacles that you might face?
- How can we overcome those obstacles?

Relating Transfer & Statistical Thinking

- Develop rich, interconnected schema
  - Emphasize context and use real data (GAISE; CGUPSS)
  - Deliberate process of abstraction (GAISE; Wild & Pfannkuch, 1999)
  - Practice tool selection (GAISE; Lovett & Greenhouse, 2000)
- Metacognition
  - Sub-goals to aid strategic thinking and organization (Atkinson et al., 2003; Wild & Pfannkuch, 2011)
  - Model statistical thinking for students (GAISE)
  - Context diversity (CGUPSS)
- Manage cognitive load
  - Stress concepts, rather than procedural steps (GAISE)
  - Less breadth of content; more depth for core concepts (GAISE)

Implications for Teaching and Research

- Incorporate learning & cognition research for the benefit of statistics education
- Teach with transfer in mind
- Dissertation topic: curriculum independent assessment tool
  - Evaluate transfer outcomes
  - Comparison of disparate introductory curricula
- Future research
  - Transfer outcomes after nontrivial delay
  - Increase distance of transfer
  - Assess impact of disparate curricula on subsequent coursework
    - Statistics
    - Other quantitative disciplines (sciences, engineering, economics)

Questions

References

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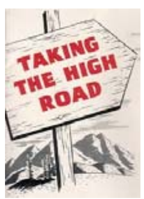
Dissertation Research

- Goal: Quantify cognitive transfer outcomes for introductory statistics students
  - *Introductory Statistics Transfer of Understanding and Discernment Outcomes (I-STUDIO)* Assessment
  - Design is flexible to accommodate disparate curricula
- Measurement Construct: Ability to transfer conceptual understanding of statistics for use in novel problem settings
  - Discern when a problem setting will benefit from application of statistical inference
  - Demonstrate how to apply statistical inference in novel contexts

Dissertation Research

- Desired transfer outcomes
  - Forward-reaching high-road transfer
  - Backward-reaching high-road transfer
- High-road & Low-road transfer
  - (Salomon & Perkins, 1989)
  - Controlled processing vs. automation
- Forward-Reaching & Backward-Reaching
  - (Salomon & Perkins, 1989)
  - Nature of abstract thinking required



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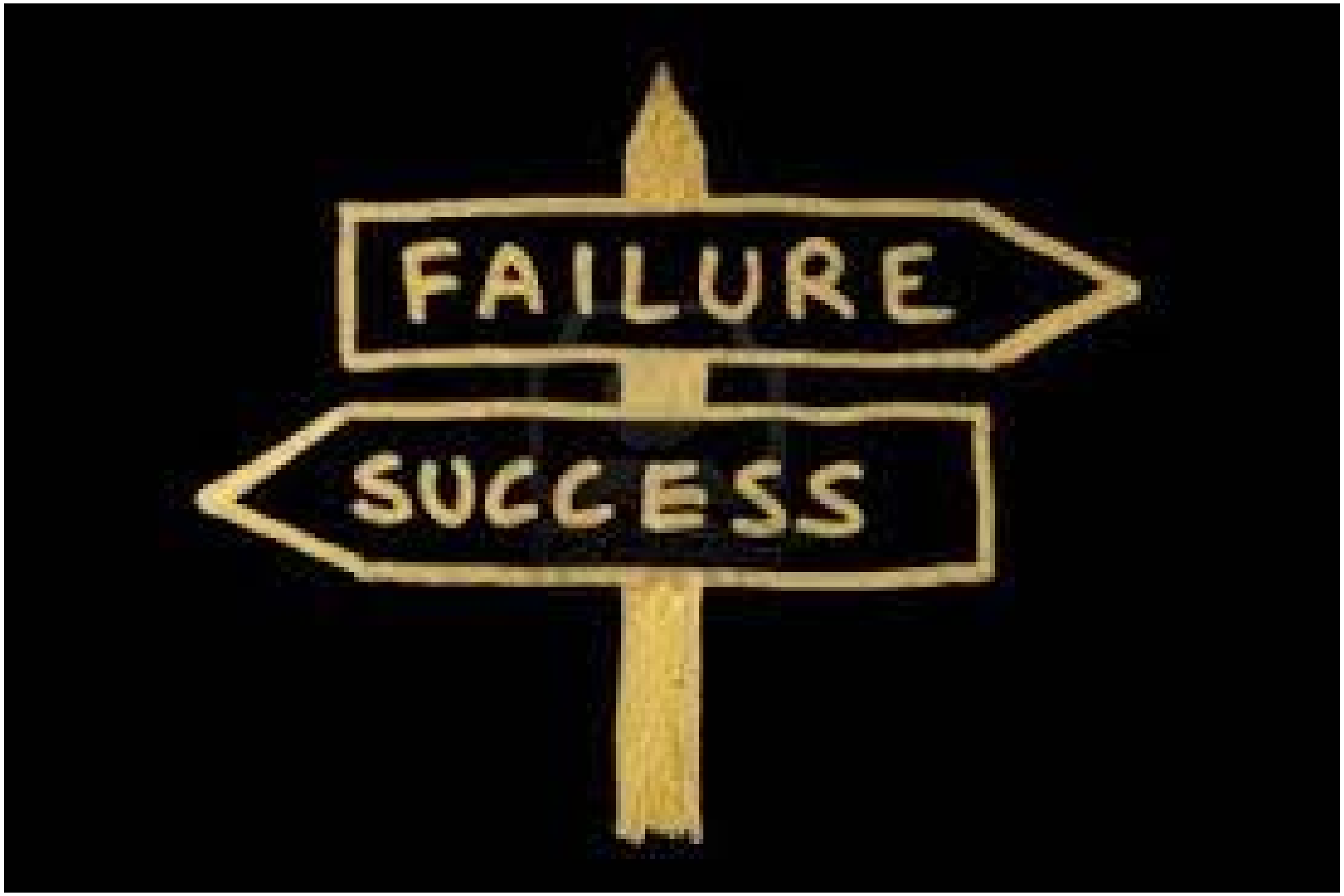

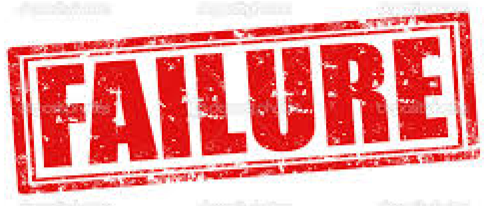

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