Some Evidence-Based Principles of Student Learning: Implications for Best Teaching Practices

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Assumed Goal: **Facilitating Lasting, Transferable Change in Our Students**

Components of Lasting, Transferable Change	Guiding Principles/Literatures (categories of literature with references on next page)	Best Teaching Practices	Course-Planning	In-Class
	▪ Begin by defining purposes (teaching and assessing for student learning; teachers clued and clueless)	1. Aim. Clearly and specifically define your learning objectives, not just cognitive.	Learning objectives apparent in syllabus, assignments/tests	Simple agenda set for each class
Cognitive	**I. Use Students' Prior Knowledge Base**			
(knowledge, comprehension, long-term memory, meta-cognition)	▪ Prior knowledge is influential (misconceptions, novice-expert)	2. Detect. Find appropriate ways to gauge what your students know and don't know.	"Pretest" given	Students participate (talking, in-class surveys, etc.)
	▪ Concrete, personally relevant examples facilitate retention (personal relevance and examples)	3. Chunk. Simplify, categorize, and contextualize, so students will remember.	Readings, assignments, etc. in conceptually meaningful units (e.g., not just chronological order)	3-5 main conceptual points introduced, exemplified, summarized at end
	▪ Simplifying, chunking and repeating facilitates retention (organization, desirable difficulties)			
Behavioral	**II. Guide Students in Active Practice**			
(skills, habits, abilities, practices)	▪ Modeling academic methods explicitly fosters connection of knowledge to practice (scaffolding)	4. Model. Demonstrate and explain the reasoning behind what you do.	Disciplinary methods made transparent	Teaching methods made transparent
	▪ Practicing what is learned in spaced, variable, contextually meaningful situations fosters transfer (organization, desirable difficulties)	5. Activate. Provide well-timed, varied, contextual opportunities for students to elaborate and practice what they've learned.	Varied, spaced assignments and tests during semester	Students engage with material, tested in different ways during class
	▪ Feedback geared toward "self-editing" fosters transfer (transfer/internalization, self accountability)	6. Transfer. Offer feedback that tells students not just what to change, but how and why.	Feedback well-timed, uses "drafts," peer review, self-commentary	In class opportunities to try again after feedback
Affective	**III. Take Advantage of Emotions**			
(interest, motivation, emotional engagement)	▪ Individualized attention increases engagement (learning partnerships)	7. Know. Get to know your students.	Learn students names (at least), have office hours	In-class responses tailored to individual students
	▪ Epistemological development depends upon relationships (experience and development)	8. Show. Let them get to know you, your enthusiasms, and the reasoning behind your opinions.	Scholarly approach and debates made transparent	"Academic identity" made transparent
	▪ Praise and criticism are tricky to deliver in a way that will increase resiliency to challenges and interest (expectations, praise)	9. Expect. Communicate (a) high expectations and (b) capacity for improvement.	Grading scheme challenging, includes ability to improve	Fluid theory of intelligence communicated with praise and criticism
	▪ Get and use data about what worked (teaching and assessing for student learning, teachers clued and clueless)	10. Assess. Determine what went well and could use improvement	Interpret end-of-semester evaluations in terms of learning objectives, integrate	"minute papers," midsemester evaluations etc. interpreted, integrated

Select References * Some Evidence-Based Principles of Student Learning: Implications for Best Teaching Practices

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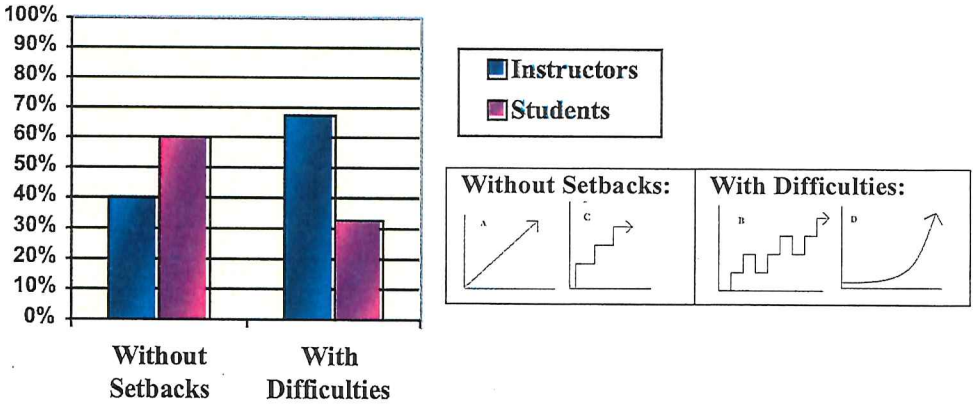
Novice-Expert Differences *Instructors think differently than students about information. How can instructors gauge what students know and don't know?*

Students (N=434) and their instructors (TFs=23, Profs=7) in nine introductory Harvard College courses responded to the same questions…

Take-home message	Students' didn't match professor's at all	Matched professor's somewhat		Matched professor's
	43%	**17%**		**40%**
Three most difficult concepts to learn	None of the students' concepts matched	One matched	Two matched	All three matched
	53%	**37%**	**10%**	**0%**

Mastery Graphs



Experts, relative to novices…

Notice meaningful patterns (chunks) of information	Organize knowledge in way that reflects deep structure of subject	Can "conditionalize" knowledge; not just isolated facts but use info in a way that reflects application and context	Can retrieve information with little attentional effort	May not be able to teach others what they know

Meta-cognition From p. 47 of *How People Learn: Brain, Mind, Experience and School*, "Chapter 2: How Experts Differ from Novices"

The concept of adaptive expertise has also been explored in a study of history experts (Wineburg, 1998). Two history experts and a group of future teachers were asked to read and interpret a set of documents about Abraham Lincoln and his view of slavery. This is a complex issue that, for Lincoln, involved conflicts between enacted law (the Constitution), natural law (as encoded in the Declaration of Independence), and divine law (assumptions about basic rights). One of the historians was an expert on Lincoln; the second historian's expertise lay elsewhere. The Lincoln expert brought detailed content knowledge to the documents and easily interpreted them; the other historian was familiar with some of the broad themes in the documents but quickly became confused in the details. In fact, at the beginning of the task, the second historian reacted no differently than a group of future high school teachers who were faced with the same task (Wineburg and Fournier, 1994): attempting to harmonize discrepant information about Lincoln's position, they both appealed to an array of present social forms and institutions—such as speech writers, press conferences, and "spin doctors"—to explain why things seemed discrepant. Unlike the future teachers, however, the second historian did not stop with his initial analysis. He instead adopted a working hypothesis that assumed that the apparent contradictions might be rooted less in Lincoln's duplicity than in his own ignorance of the nineteenth century. The expert stepped back from his own initial interpretation and searched for a deeper understanding of the issues. As he read texts from this perspective, his understanding deepened, and he learned from the experience. After considerable work, the second historian was able to piece together an interpretive structure that brought him by the task's end to where his more knowledgeable colleague had begun. The future history teachers, in contrast, never moved beyond their initial interpretations of events.

Desirable Difficulties *Actively engaging with material promotes long-term retention. How to best give students opportunities for elaboration and practice?*

In Roediger & Karpicke (2006), experiment 2, participants "learned" about one of two texts on either the sun or sea otters in one of three ways (SSSS read passage 4 times; SSST read passage three times than tested; STTT read once then tested three times), then they completed a questionnaire, and then they were asked to recall as many "idea units" as possible either 5 minutes later or 1 week later.

	Mean # of times read passage	"Interesting" (7 point scale)	"Predict Will Remember" (7 point scale)	**5 minutes** Mean proportion of idea units recalled (out of 30)	**1 week** Mean proportion of idea units recalled (out of 30)
SSSS	14.2	3.8	4.8	.83	.40
SSST	10.3	4.1	4.2	.78	.56
STTT	3.4	4.6	4.0	.71	.61

In Pashler, Rohrer, Cepeda & Carpenter (2007), participants learned a simple but unfamiliar mathematics principle – combinatorics—in one of two conditions: Massed saw a tutorial and then did 10 practice problems in one sitting; Spaced saw a tutorial and did 5 practice problems, then five more one week later.

Bjork (2006) reports a study during which participants learned four concepts about volume in one of two conditions: Blocked read a tutorial and did four related problems about each concept sequentially; Mixed read all four tutorials and then did a randomized set of sixteen problems, four for each concept.

Pashler et al. (2007)

	1 week % correct on test	**4 weeks** % correct on test
Massed	75%	30%
Spaced	71%	65%

Bjork (2006)

	Right after practice % correct on test	**1 week** % correct on test
Blocked	89%	20%
Mixed	60%	63%

Inquiry Instruction and **Knowledge Integration** From "The Science of Learning and the Learning of Science" (Bjork, & Linn, 2006)

Conditions of practice that appear optimal during instruction can fail to support long-term retention and transfer of knowledge and, remarkably, conditions that introduce difficulties for the learner – and appear to slow the rate of the learning – can enhance long-term retention and transfer. Such "desirable difficulties" (Bjork, 1994) include: spacing rather than massing sessions; interleaving rather than blocking practice on separate topics; varying how to-be-learned material is presented; reducing feedback; and using tests as learning events…Certain conditions that pose difficulties and challenges can both impede performance and enhance long-term retention; this emphasizes an important distinction that learning theorists (e.g., Hull, 1943; Estes, 1955) found essential decades ago: namely, the distinction between the momentary activation of a memory representation, which can be heavily influenced by local conditions such as contextual cues, versus its "habit" or "storage" strength, which *is* an index of learning and reflects how interassociated or integrated that representation is with related representations in memory (Bjork & Bjork, 1992). From that perspective, two interrelated ideas from education research are relevant and important: *inquiry instruction* and *knowledge integration* (see Linn, in press). Inquiry processes confront students with variability, require generation, interleave topics, and tap into other desirable difficulties. Achieving knowledge integration is akin to developing the kind of elaborated and inter-linked memory representation that laboratory researchers have shown will sustain access to knowledge, retard forgetting, and enhance transfer.

Praise *Feedback about performance can motivate or de-motivate students. How can instructors increase student's resiliency to challenges and motivate?*

Carol Dweck and colleagues show subtle differences in the way praise is given can impact learning and motivation in significant ways.

400 kids in 12 NYC schools…

Phase I—Easy Puzzles & Praise	Phase II—Choice	Phase 3—Hard	Phase 4—Easy
After given their score, praised in one of two ways.	Then given a choice to either "learn a lot more from attempting a difficult set of puzzles" or "can do an easy test, just like the first."	Everyone has to do a difficult test and almost everyone fails; their reactions are coded.	Everyone does another easier set of puzzles, akin to the first.
"You must be smart at this"	40% choose difficult	Stressed	On average 20% worse score than on first set of puzzles
"You must have worked really hard"	90% choose difficult	Engaged	On average 30% better score than on first set of puzzles

24 four year olds do pretend drawings using a puppet and a pipe-cleaner, with a teacher puppet instructing them…

After each of four drawings about stories offered by teacher puppet, the teacher puppet praises in one of two ways	Following the third successful drawing, asked questions about how they feel about their drawings (e.g., did you like what you drew or not like it?)	After each of two subsequent drawings, the teacher puppet calls out a mistake that is made (e.g., "you didn't draw the ears on the cat")	"Did what happen in the last story make you feel happy or sad" (answered on a 6-point scale, from 1, *really sad* to 6, *really happy*)	"If you had a chance to do something tomorrow, would you draw or do something else?" (forced choice)
"You are a good drawer"	Happy about drawings		1.7	<10% draw
"You did a good job drawing"	Happy about drawings		3.2	>50% draw

Malleable Intelligence From "Implicit Theories of Intelligence Predict Achievement Across an Adolescent Transition: A Longitudinal Study and an Intervention" Blackwell, Trzesniewski, and Dweck (2007), *Child Development*

Abstract: Two studies explored the role of implicit theories of intelligence in adolescents' mathematics achievement. In Study 1 with 373 7th graders, the belief that intelligence is malleable (incremental theory) predicted an upward trajectory in grades over the two years of junior high school, while a belief that intelligence is fixed (entity theory) predicted a flat trajectory. A mediational model including learning goals, positive beliefs about effort, and causal attributions and strategies was tested. In Study 2, an intervention teaching an incremental theory to 7th graders (N=48) promoted positive change in classroom motivation, compared with a control group (N=43). Simultaneously, students in the control group displayed a continuing downward trajectory in grades, while this decline was reversed for students in the experimental group.